INTERNATIONAL WHALING COMMISSION

Contribution from the Secretariat of the International Whaling Commission to Part I of the report from the UN Secretary-General to the seventeenth meeting of the United Nations Open-Ended Informal Consultative Process on Oceans and Law of the Sea

Marine debris, including plastics and microplastics

This report has been produced by the IWC Secretariat in consultation with the Commission, the Chair of the Scientific Committee, and the marine debris intersessional group. It draws upon reports of the IWC Scientific Committee and two expert IWC workshops (IWC, 2014 and IWC/65/CCRep04) on marine debris, and cites published and un-published evidence reviewed by those workshops. Though the IWC expert workshop reports on marine debris have been endorsed by the Commission, the recommendations within them are not subject to active agreement through a Commission Resolution. Thus the recommendations in this report are not binding upon IWC contracting governments.

SUMMARY

The IWC began formally to consider marine debris in 2011 following its endorsement of the United Nations Environment Programme's Honolulu Commitment. Subsequent work has shown that marine debris, such as abandoned, lost and discarded fishing gear (ALDFG) and plastics, including microplastics, can be a conservation and welfare concern for cetaceans throughout the oceans.

Impacts of marine debris on individual cetaceans depends on the nature of the debris but can include direct entanglement, chronic or lethal impairment through ingestion or inhalation and associated impacts including toxicity. More broadly, debris can have a detrimental effect on cetacean habitat and prey. The IWC has endorsed a need for more research on these impacts, especially with respect to quantifying potential population-level effects as a result of direct death, decreased reproductive capacity and/or decreased survivorship. However, awaiting the results of such studies must not preclude serious efforts to remove existing debris and prevent future accumulation in the environment. From an animal welfare perspective, injuries and deaths due to entanglements or ingestion are a severe problem, irrespective of population-level effects.

In addition to regular work by its Scientific Committee, the IWC has: held two expert workshops on marine debris and three on large whale entanglement in all fishing gear, including ALDFG; established a global network for disentanglement of whales from gear, including a training and support programme for new teams around the world; and increased its efforts to strengthen international collaboration.

Relevant IWC recommendations summarised in this report cover the broad areas below.

(1) Enhanced collaboration on issues related to marine debris with a variety of stakeholders including: intergovernmental organisations; national and local authorities; relevant industries including fishing, shipping, plastics and waste disposal; local communities, non-governmental organisations; and the development sector.
(2) Enhanced multi-disciplinary research on the effects of non-ADLFG marine debris on cetaceans and their habitats, at the level of individuals and populations.
(3) Enhanced development and testing of innovative approaches to preventing problems related to ADLFG including: gear marking; ADLFG collection and recycling; gear modifications and improved fishing practices.
(4) An enhanced training and capacity building approach in dealing with marine debris.
(5) Collaborative development of a range of effective measures (e.g. through education, legislation and economic incentives) to improve marine and terrestrial waste management, including: international and national policy and guidelines; stakeholder partnerships; industry training schemes; and means to reduce public consumption of potential sources of marine debris such as packaging waste.

INTRODUCTION

Reports of IWC workshops on marine debris, including full lists of references, presentations and contributors to these workshops can be found online at https://iwc.int/marine-debris and in Annex 1. These also contain a number of case studies on the distribution and impacts of marine debris and national and international programmes to address this problem.

The IWC was set up in 1946 under the auspices of the International Convention for the Regulation of Whaling (ICRW). The Commission has a membership of 88 Contracting Governments. The ICRW contains an integral Schedule which sets out specific measures that the IWC has collectively decided are necessary in order to regulate whaling and other methods/mechanisms to conserve whale stocks. In addition, the IWC undertakes, co-ordinates and funds conservation work on many species of cetacean. Through its Scientific Committee it undertakes extensive study and research on cetacean populations, develops and maintains scientific databases, and publishes its own peer reviewed scientific journal, the *Journal of Cetacean Research and Management*. IWC is mandated, on many issues, to cooperate with other intergovernmental organisations including the International Maritime Organisation (IMO), the Regional Fisheries Management Organisations (RFMOs), the Marine Council, UNEP, FAO and the biodiversity-related MEAs (CMS, CBD and CITES).

The work of the Commission and its sub-groups has increasingly considered a wide range of environmental issues that are also addressed by UN General Assembly resolutions on Oceans and Law of the Sea, for example marine debris, including plastics and microplastics. This report presents a summary of IWC work to date on marine debris (with a focus on fishing gear, plastics and microplastics) and on ways to mitigate these including through strengthened international collaboration.

1. Challenges of marine debris

Marine debris is a global problem and a threat to our environment, navigation safety, the economy and human health. Marine debris is widely recognised as a major threat to marine biodiversity (CBD 2012) and impacts on a wide range of species including cetaceans and other species such as sea birds, Chelonioidea species (Sea Turtles) and Pinnipeds (Seals and Sealions). Studies of the scientific aspects and impacts of marine debris on cetaceans have shown that marine debris and its contribution to entanglement, chronic problems resulting from ingestion or inhalation and associated impacts, including toxicity, are welfare and conservation issues for cetaceans on a global scale and a growing concern.

The evidence of impacts on cetaceans is discussed in more detail below. The IWC has endorsed a need for more research on these impacts, especially with respect to quantifying potential population-level effects as a result of direct death, decreased reproductive capacity and/or decreased survivorship. However, awaiting the results of such studies must not preclude serious efforts to remove existing debris and prevent future accumulation in the environment. From an animal welfare perspective, injuries and deaths due to entanglements and ingestion are a severe problem, irrespective of population-level effects.

Whilst there are often good legislative frameworks in place aimed at preventing marine debris, legal requirements for preventing, monitoring and responding to marine debris vary around the world, and their success has been hindered by poor implementation at national level, inadequate enforcement capacity and a lack of incentives for compliance and good waste management practices.

1.1 Impacts of marine debris on Cetaceans

The IWC is working through a number of programmes and activities (see Section 2) to better understand the threats to Cetaceans from different types of debris. This work to date is summarised below in relation to two major types of impact - entanglement, primarily entanglement in fishing gear; and ingestion of plastics and microplastics.

i. Entanglement

This section discusses the impacts of cetacean entanglement including as a result of Abandoned, Lost or Discarded Fishing Gear (ALDFG). Entanglements in ALDFG are part of an even larger problem of entanglements in active fishing gear and by-catch. This is global problem with significant impacts on cetaceans at individual and population levels that has been considered by the IWC for more than 30 years.

The entanglement of Cetaceans in both Commercial and other active fishing gears (COAFG) and Abandoned, Lost or Discarded Fishing Gear (ALDFG) have lethal and chronic impacts on cetaceans and are both a conservation and animal welfare issue that occurs wherever their distribution overlaps with rope and net fisheries. "Ghost fishing" by ALDFG removes both target and non-target species of fish and shellfish as well as a range of non-target species including sea birds, sea turtles and marine mammals. The biggest problems come from passive fishing gear such as gillnets and pots (Gillman *pers. comm.* in IWC/65/CCRep04 page 15). Given its cryptic nature and most countries lack of reporting infrastructure, the problem of entanglement is often severely under-reported.

Whilst the extent to which marine debris contributes to cetacean entanglements is not fully understood (see below), the impacts and potential responses once entangled are largely the same. Welfare concerns related to cetacean entanglement in active fishing gear and marine debris have been well recognized by the IWC following publication of the extended time-to-death of chronic entanglement in right whales (Moore *et al.*, 2006). Recent publications have reinforced this concern (Moore *et al.,* 2013; Moore and van der Hoop, 2012).

Entangled cetaceans can become asphyxiated when entrapped below the surface of the water. If the animal can surface, it can remain anchored in place, or if it is cut free or can break away, the result may be chronic entanglement, with resultant laceration, incision, constriction, feeding impairment, increased drag (van der Hoop *et al.*, 2013 a.), loss of body condition, bony proliferation, infection and ultimately death (Cassoff *et al.,* 2011). The timing of death can be minutes to years after the initial event (Moore *et al.,* 2006). The symptoms can include acute distress in whales that cannot surface and therefore drown at some point soon after the normal dive duration (ranging from minutes to more than an hour in the case of some whales). Chronic cases are likely to suffer from severe and chronic pain (Moore and van der Hoop, 2012).

In terms of population impacts for entanglements generally, scar studies looking at survivors show a high rate of large-whale entanglement ranging from 20-80% of the overall populations affected. The number of observed entanglement deaths has the potential to impact population viability (e.g. van der Hoop *et al.,* 2013 b., Glass *et al.,* 2010). Entanglement rates are sufficient to be a threat to the recovery of endangered populations such as gray whales in the western North Pacific and some populations of right whales (e.g. North Atlantic right whales, North Pacific right whales, Southern right whales in the south-eastern Pacific) and the Arabian Sea humpback whales. In the case of North Atlantic right whales, research suggests that reproductive rates are also impacted by entanglement (Knowlton *et al.,* in press).

Distinguishing entanglements in ALDFG vs active fishing gear

The degree to which marine debris *per se* has population-level entanglement impacts in cetaceans is an important issue that requires further study. A key difficulty is in separating out COAFG and ALDFG entanglements. Entanglements have been reported for most cetacean species in a wide variety of fishing gear, but predominantly in gear that is either drifting or anchored. A large percentage of the materials removed are reported as being of "unknown" origin and only in a few instances (less than 5%), are the materials determined to have been lost, abandoned or otherwise discarded, prior to entanglement. However, one review of gear loss and continued ghost fishing found that in some regions it may account for up to 30% of entanglements (Mattila and Lyman, 2006). In addition, it is generally agreed that the numbers of both types of entanglements are widely and severely underreported.

Other major challenges to addressing the issue of entanglement in ALDFG include difficulties in detection (e.g. surface visibility) of ALDFG; lack of reporting of gear loss and of animal entanglements; a lack of reliable information on many factors related to gear (e.g. loss rates of different gear types, persistence of different gear types as threats in the water column and fishery of origin of recovered gear) and lack of incentives for the fishing industry e.g. for collection and recycling of gear. In addition, there may be costs to the fishing industry

from poorly tested but mandated gear modifications. Thus the solutions can only be reached through full engagement with the manufacturers of fishing gear and the raw materials used to produce it, fishers and other involved parties. Capacity building, better data collection, innovation and industry incentives are all fundamental to better management and ultimately prevention of this problem.

Though prevention of entanglement is the far better solution, disentanglement of large whales on a case by case basis can be valuable for critically endangered species, particularly for smaller populations (e.g. North Atlantic right whales) in which each individual counts towards population or species survival. For more information on the IWC programme providing training and capacity development in disentanglement see Section 2.3

ii. Ingestion of plastics and microplastics

Primary and secondary sources of plastic are another major issue related to marine debris. Plastics can be ingested by marine life and lead to starvation and death. Sub-lethal effects may include internal injury, dietary dilution and reduced appetite with resulting reductions in body condition and other fitness-related pathology. There are also many questions related to the chemical impacts of plastics and microplastics and research is underway to address these.

Literature reviews of data on debris ingestion by cetaceans (Simmonds 2012; Baulch and Perry, 2014a; 2014b) have found that ingestion of debris has been documented in 48 (56%) of cetacean species, with rates of ingestion as high as 31% in stranded animals analysed from certain populations. Plastics were the dominant type of debris ingested, with parts of fishing gear also frequently ingested.

Debris-induced mortality rates of 0–10% have been documented in stranded animals where a cause of death could be determined, suggesting that debris could be a significant threat to some populations (if rates of debris-induced mortality in stranded animals correlate to those in the wild) (Baulch and Perry, 2014a; 2014b). However data on ingestion and mortality rates are only available for a few species and regions and there is no information on rates of sub-lethal pathology in stranded animals examined. A significant problem is the lack of storage of information on debris interactions by strandings networks (groups responding to cetacean strandings).

In a paper presented to the IWC Scientific Committee, Baulch and Simmonds (2015) reported on new cases of ingestion published in 2014 and 2015. These include a Longman's beaked whale (*Indopacetus pacificus*) which stranded on the Saurashtra coast, India which was presumed to have been killed by the ingestion of four plastic bags, blocking the passage of food to the intestine (Kaladharan *et al*., 2014). In a rare stranding of True's beaked whales (*Mesopledon mirus*) in Ireland, macroplastic items were identified in the stomachs of both the adults, though not in quantities likely to cause satiation and with no signs of malnutrition (Lusher *et al*., 2015). A comparison of debris ingestion in two coastal species in Brazil, Franciscana (*Pontoporia blainvillei*) and Guiana dolphin (*Sotalia guianensis*) found that prevalence of debris ingestion was higher in Franciscana (15.7% compared to 1.3% in *Sotalia guianensis*), a trend attributed to the feeding activity of Franciscana, which mainly feeds near the sea bed, the main zone of accumulation of debris in the study area (Di Beneditto *et al*., 2014a, b).

A number of studies have suggested that deep-diving cetaceans (sperm whales and beaked whales) may be especially vulnerable to ingestion. Research based on strandings data from Japan (Yamada *pers comm.* in IWC 2014 p.17) has also suggested that ziphiids (Beaked Whales) may be particularly susceptible to ingesting plastic debris because of their stomach structure.

The IWC has expressed concern regarding the high rates of debris ingestion in ziphiids, sperm whales and certain populations of Franciscana dolphins and found that, depending on the severity, the ingestion of debris is a welfare concern at the individual level comparable to that of entanglement. Whilst it remains unclear whether there are any species or areas where it is a population- level concern, the conservation threat should be assessed in the context of the local population size, where even low mortality levels may be of concern. There is a need for significant improvements in data collection and collation to improve understanding of the threats of ingestion of marine debris including further research on the physical and toxicological impacts of debris ingestion (Section 3).

Microplastics

By 2050, an extra 33 billion tonnes of plastic is expected to be added to our planet (Rochman *et al*., 2013). This material enters and persists in environments from the poles to the equator and down to the depths of the sea. Slow degradation into smaller particles means that microplastics[1]have been accumulating in the environment, adding to primary sources of microplastics (Thompson *et al.,* 2004; Browne *et al*., 2007; 2010; 2011). Once ingested by animals, microplastics can accumulate within the guts of organisms where it can be engulfed and stored by cells (Browne *et al.,* 2007; 2008). This provides a feasible pathway for microplastics to transfer absorbed contaminants, constituent monomers and additives into the tissues of animals and affect physiological processes that sustain health (Teuten *et al.,* 2007; 2009). Ingestion has been demonstrated in many marine species, including plankton, fish and several species of Cetacean including Mediterranean fin whales, in which they may act as endocrine disruptors (Fossi *et. al*., 2012; Fossi and Depledge, 2014; Frias *et al.,* 2014; Lusher *et al.,* 2013; Van Cauwenberghe and Janssen, 2014; Wright *et al.,* 2013*).* However, whilst there are established techniques for quantifying other contaminants in tissues of cetaceans, there is still little information on the uptake and toxicological consequences of microplastics (e.g. endocrine disruption) and the physiological and toxiological effects of microplastic ingestion for cetaceans are poorly understood.

Research supported by the Italian Ministry for Environment (Fossi *pers.comm*. in IWC, 2014 p5., Fossi *et al*., 2012 and Fossi *et. al*. 2014) provided evidence of the potential toxiological impact of microplastics in a baleen whale in a study of Fin Whale *Balaenoptera physalus,* in the Mediterranean Sea, using phthalates (a plastic additive which leaches from plastic debris) as a tracer of microplastics consumption. Subsequent research has suggested that exposure to microplastics may pose a major threat to the health of this population (Fossi et al., 2016). In the last two years microplastic ingestion has been identified in two further species including a stranded True's beaked whale and in the intestines of a stranded humpback whale (Lusher et al. 2015 and Besseling *et. al*. 2015 cited in Simmonds and Baulch 2015). It is suggested that other baleen whale species could have higher microplastic ingestion than the humpback due to the lunge feeding behaviour of the humpback as opposed to other baleen species that skim water or sediment when feeing (Besseling et al. 2015). It has also been suggested that, as surface feeders, right whales may be exposed to high quantities of microplastics in the surface microlayer.

As well as direct uptake of microplastics from the water column, cetaceans may also ingest microplastics and associated chemicals via prey species. Simmonds and Baulch (2015) reviewed the latest evidence of uptake of microplastics, and associated impacts in a range of other species. Uptake of microplastics had been recently demonstrated in zooplankton (Frias *et al*., 2014; Setälä *et al*., 2014), shellfish (Van Cauwenberghe & Janssen, 2014), benthic organisms (Browne *et al*., 2013; Besseling *et al*., 2013), planktivorous fish (Boerger *et al*., 2010) and pelagic and demersal fish (Lusher *et al*., 2012) and may be retained in the gut, translocate into tissues or be excreted (Browne *et al*., 2008; Wright *et al*., 2013). Impacts recorded in a range of marine fauna include effects on feeding activity, survival, growth, metabolism, behaviour and reproduction (Besseling *et al*., 2014; Mattsson *et al*., 2015; Rochman *et al*., 2014; Wright *et al*., 2013). Ingestion of microplastics by individual organisms at lower trophic levels could have consequences for organisms at high trophic levels if contaminants that are transferred have the potential for biomagnification (Teuten *et al*., 2009).

iii. Cumulative impacts

The IWC Scientific Committee has repeatedly highlighted possible synergistic effects marine debris can have on cetaceans together with other known threats. For example, cetaceans entangled in marine debris or ADLFG may be more likely to be hit by ships due to decreased swimming speed or inhibited manouevrability and diving capability. Also, cetaceans ingesting plastic debris (including microplastics) may be subject to heavily increased contaminant loads, since plastic particles are known to accumulate persistent pollutants such as PCBs and POPs in large concentrations. Thus, when considering the effects of marine debris, it is important that this takes into account how threats may influence each other in an accumulative or synergistic way.

[1] Defined by the IWC as fragments smaller than 5mm

2. Activities and actions undertaken by the IWC

The IWC has conducted extensive consideration of marine debris through its Scientific Committee, Conservation Committee, through its working group on Whale Killing Methods and Welfare Issues and through expert workshops on marine debris and on entanglement. The competence of the IWC on this issue falls into two important areas. The first is work to model population and human activities to determine priorities for action from a conservation perspective and to evaluate potential and actual mitigation measures. This is supported by the IWC's long term monitoring of Cetaceans. The second area concerns the welfare of individual animals independently of the conservation status of the population to which they belong; at present the IWC has focused on entanglement in fishing gear. IWC activities are summarised in more detail below.

2.1 Research

The IWC Scientific Committee and its sub-committee on environmental concerns have been receiving information on entanglement and ingestion of marine debris for several years. The ongoing and planned work of the Scientific Committee relevant to marine debris includes:

- *Expert workshops* on threats to Cetaceans including marine debris and entanglement (Section 2.2)
- *Long term monit*oring of Cetacean populations
- *Development of modelling approaches* and their application in a management context. Future work will explore ways of combining estimates of oceanic debris and information on Cetaceans to identify priorities for mitigating and managing the impacts of marine debris on Cetaceans
- *Review of recent research* on threats to Cetaceans imposed by marine debris and identification of research priorities (Section 3).
- *Improvements to data collection* including means to improve and better share information on rates of marine debris ingestion and entanglement; potential ways to distinguish between entanglements in COAFG as opposed ALDFG; and data collection, monitoring and modelling exercises that might help to improve understanding of the extent and significance of the impacts of marine debris at the individual and at population level. This will include the development of standardised data collection protocols and data collection forms for strandings networks; as well as improvements to reporting of information relevant to marine debris through the annual progress reports and conservation reports submitted by IWC Member countries
- *Development of a Global entanglement database*. The IWC is developing a Global entanglement database to improve the understanding of the impacts of entanglements on whale populations and the factors associated with entanglement risks. This database could also help to identify the fisheries/gear types and practices leading to high risks of entanglement; differentiate COAFG from ALDFG and other debris; identify particularly vulnerable species and help to inform, prioritise and develop mitigation measures.
- *Review of mitigation approaches* and their effectiveness, including those reported by IWC members.

2.2 State of the Cetacean Environment Report

This annual report provides updates of environmental threats facing cetaceans, and has included summaries and references to the latest publications dealing with marine debris. https://iwc.int/socer

2.3 Expert workshops and knowledge exchange

The IWC has held two expert workshops on marine debris. The first workshop, held at the Woods Hole Oceanographic Institution (WHOI) in May 2013 (IWC, 2014 and Annex 1) focused on an evaluation of known effects of marine debris on cetaceans. The workshop made many recommendations, and highlighted the importance of trying to distinguish whether or not entangling gear was active or derelict at the time of entanglement. It called for improved data-sharing and recommended that marine debris interactions should be reported by Commission Members in National Progress Reports. It also recommended that debris sampling should be conducted during cetacean field studies; there should be improved efforts to work with industry

and fishermen; and that the Scientific Committee should work to further evaluate the risks of ingestion. Finally, the desirability of working in collaboration with other intergovernmental bodies on this issue was highlighted.

The second workshop (IWC/65/CCRep04 and Annex 1) was held in August 2014 in Hawaii. The primary objectives were to explore how the IWC can engage with the existing international and regional mitigation efforts concerning the management of marine debris, determine how best to ensure that these efforts are updated on cetacean-specific impacts of marine debris, and advise on how best the Commission can lead and engage in regions where marine debris has the greatest potential impacts on cetacean populations. Topics that were discussed included fishing gear marking, potential gear modifications, fishing gear recycling programmes and methods for identifying debris hotspots, modelling approaches, and work conducted on other species, such as seabirds and turtles. In addition, the role and responsibilities of other Inter-governmental Organisations (IGOs) such as the International Maritime Organisation's (IMO) International Convention for the Prevention of Pollution from Ships (MARPOL) and governmental and non-governmental marine debris programmes were also discussed. The Workshop agreed that the Commission's primary contribution should be to ensure that cetacean-related issues are adequately represented within existing initiatives, and that its strong scientific and other expertise is made available in collaborative efforts. It made specific recommendations for the IWC to collaborate with a number of other Intergovernmental Organisations.

The IWC has also held three entanglement workshops (IWC, 2012; IWC, 2013 and SC/66a/COMM2) that have focused on entanglement of large whales, including in ALDFG, and capacity building for entanglement response. A forthcoming IWC workshop (anticipated May 2016) on prevention of the incidental capture of cetaceans will incorporate discussion of ALDFG as well as in-use gear.

2.4. Disentanglement

Whilst it is recognised that prevention is a much better solution than disentanglement, in smaller populations, e.g. North Atlantic right whales, disentanglement is still important as each individual counts towards the population or species survival. Until there is a preventative solution, people will attempt to release entangled whales, whether it is a fisher trying to recover his gear, or a well-meaning member of the public. This can have serious negative results for both the rescuer and the whale.

The IWC entanglement programme was established in 2011 to address the growing problem of whale entanglement by building a global network of professionally trained and equipped entanglement responders. Since its first training workshops of 2012, with the support of the USA (NOAA), UNEP-CEP-SPAW, SPREP, CPPS, World Animal Protection and other NGOs, along with the support of many of the countries for which training occurs, this initiative has reached more than 500 scientists, conservationists and government representatives from over 20 countries.

The training curriculum includes techniques and methodologies for investigating the causes, scope and impact of large whale entanglements, including in marine debris, as well as current information on attempts to prevent it. Capacity building is undertaken in partnership with the country in which training is taking place and, in some cases, in partnership with regional IGOs under regional action plans (e.g. the SPAW marine mammal action plan in the Wider Caribbean, and the SPREP whale and dolphin action plan in the South Pacific). The trainees, who are chosen by the respective government have been a mix of natural resource personnel, eco-tour operators, fishers, navy personnel, scientists, etc. At the end of training, key participants are identified who may be able to undertake a three week apprenticeship with one of the existing networks- in an effort to train future trainers for the country represented. Two apprentices from Mexico are now involved in delivering training in Spanish speaking countries, most recently on the Chilean coast- an important habitat for the critically endangered Southern Right Whale.

2.5 Conservation Management Plans

The IWC introduced Conservation Management Plans (CMPs) (https://iwc.int/conservation-management-plans) as a practical tool to help member nations to coordinate conservation work being undertaken. The CMP approach has thus far been used for southeast Pacific right whales, South Atlantic right whales and gray whales in the western North Pacific and other populations are being considered for candidate CMPs (e.g.

Arabian Sea humpback whales). In response to recommendations from the IWC expert workshops on marine debris, marine debris considerations are being integrated into existing CMPs and the Commission is further considering the development of a threat-based CMP.

2.6 International collaboration

IWC expert workshops on marine debris have stressed the absence of a single overarching agreement or Convention dealing with the issue of marine debris and the importance of international collaboration on this issue to ensure consistency of approach, synergy of efforts and exchange of information. To this end it was recommended that the IWC's primary contribution should be to ensure that cetacean-related issues and specific impacts on cetaceans are adequately represented within existing marine debris initiatives and that its strong scientific and other expertise is made available in collaborative efforts. The expert workshops highlighted a number of opportunities for the IWC to work together with the Secretariats of other IGOs including with RFMOs, FAO, IMO and the biodiversity-related MEAs and these are currently being pursued by the Secretariat in liaison with the Marine Debris Intersessional group and other IWC Committees.

2.7 Outreach

The IWC Scientific Committee has asked the IWC Secretariat to examine ways in which it and its member nations can most effectively communicate its recommendations to the relevant target audience(s) including IGOs, appropriate government agencies and NGOs. In addition, the IWC has developed a dedicated section of its website to the issue of marine debris. The IWC seeks to highlight the IWC's work on the impacts of marine debris on cetaceans at meetings of other IGOs and to input expert advice as appropriate.

3 **Recommendations for future action**

The IWC added the issue of marine debris to the agendas of its Scientific and Conservation Committees in 2011. Since then the IWC has convened two expert workshops, and the consideration of marine debris and related issues by the IWC have led to a number of recommendations for future action. Those most relevant to discussions under the United Nations Open-Ended Informal Consultative Process on Oceans and Law of the Sea are summarised here. In some cases this also reflects follow up consultations with other IGOs. The IWC recommendations in their full and original form can be found in the two workshop reports in Annex 1.

3.1 International collaboration.

The IWC Secretariat and those of other major IGOs and RFMOs relevant to this issue should work together on issues related to marine debris to ensure consistency of approach, synergy of efforts and exchange of information to develop appropriate mitigation strategies that recognise that a) prevention is the ultimate solution but that b) removal is important until that ideal is realised. Individual countries should be encouraged to collaborate with such initiatives. Given that the issue of marine debris is multi-dimensional, dealing with it requires considerable co-operation amongst intergovernmental organisations, governments, industry and nongovernmental organisations.

In addition, there is a need to identify a coordinating body to review all of the international efforts related to marine debris and compare the resolutions and recommendations, identify those that overlap and facilitate prioritisation and implementation. This could be undertaken, for example, by the UNEP Global Partnership on Marine Litter.

Strengthened engagement with international aid agencies and international financial institutions (such as the World Bank) involved in the development of fisheries management in developing countries would also be useful- for example, to ensure they take into account the impacts from unintended consequences of the various types of fishing gear being brought into communities as an economic development strategy.

3.2 Research and Data collection

Addressing the problem of marine debris will require multidisciplinary research solutions, with all relevant partners such as international organisations, governments, industry, NGOs and local communities all involved in marine debris prevention, research and response. The IWC Scientific Committee and IWC expert workshops have made a number of detailed recommendations concerned with research and data collection on marine debris and impacts on Cetaceans. These are summarised below:

- *Fisheries research.* Since fishing gear, both active and derelict, is a major cause of injury and mortality in cetaceans there is a need for more research and experimentation to develop and evaluate the efficacy of alternative fishing practices, including innovative methods, gear marking and management regimes.

- *Macrodebris ingestion and microplastics.* Microplastics, their associated chemical pollutants and microbes, and macrodebris ingestion should be prioritised for further research. Further research might include: developing and validating the use of direct (vibrational spectroscopy) and indirect (e.g. contaminants associated with plastic: phthalates, PCBs, PBDEs) measures of ingested microplastics; examining whether ingested micro- and nano-plastic can transfer into the food chains of cetaceans; evaluating the use of established biomarkers of exposure to assess the toxicity of microplastics, including endocrine disruption; and laboratory and field experiments to investigate the bioavailability and toxicity of priority pollutants and additives from microplastics. Further examination of the lethal and sub-lethal pathology caused by macro-debris ingestion and rates of such interactions in cetacean populations should also be a priority for future non-lethal research. Future research on the uptake and toxicological impacts of microplastics in filter-feeding species of whales should include both species with intense surface feeding activities (e.g. right whales) and species with feeding related to the sediment (e.g. gray whales).

- *Research on Cetacean-debris interactions.* This should include development and use of global models that help identify locations where there is greater potential for interactions of cetaceans with debris. Modelling approaches should examine the relationship between marine debris "hot spots" and information on distributions, feeding strategies and mortality rate data already collected by the IWC and other organisations. The determination of hazard function of specific debris could be connected to the modelling data. (Wilcox et al., 2013, 2016).

  Modelling of debris "tracks" is of potential use in cetacean marine debris interaction estimations. This modelling considers the path of debris that the animal encounters as well as general distribution of debris, and uses this information to make projections that may be applicable to stock assessment. Obtaining more acoustic information on how marine debris is perceived by cetaceans would help understanding of the causes of ingestion and establish whether and which debris items are being selectively ingested by cetaceans.

- *Debris sampling* should, where possible, be undertaken when conducting research at sea and results reported to relevant groups including the IWC.

- *Cumulative impacts.* There is a need for more research on and modelling of the cumulative effects of different stressors on cetaceans including marine debris and other environmental threats.

- *Improved fisheries data.* The collection of small-scale commercial and artisanal data on total global distribution of fisheries effort extrapolated from global catch would be useful- given that there are limitations to the data that FAO collects. In addition, estimates of gear loss from relevant fisheries would be very helpful toward understanding the distribution and abundance of ghost gear and the relative risk of active versus derelict gear.

- *Improved information from Cetacean strandings.* Such information would include rates of debris occurrence in animals necropsied (presence/absence) as well as rate and type of pathology (impact on animal) to gain a better understanding of the extent of the threat debris poses to different species and populations.

- *Study of gear*. Wherever feasible, all gear removed from cetaceans should be retained, documented and detailed, archived, and analysed, though collection of entangling gear should not compromise human or cetacean safety. (For more detailed guidance on diagnosis of entanglement and ingestion impacts of marine debris in Cetaceans see IWC 2014 p13-15.

- *Improved reporting by countries*. Rates of marine debris interactions with Cetaceans (e.g. stranding and by-catch) should be reported by countries (e.g. IWC member countries, in the appropriate data fields within their National Progress Reports) and data should be recorded in such a way that it is available for future analysis.

3.3 Capacity building

The IWC encourages all members and non-members of the IWC to take advantage of the IWC disentanglement network and opportunities for IWC training especially in those regions where entanglement of large whales represents a threat at the population level (e.g. Western Pacific, Eastern South Atlantic and Arabian Sea).

More widely, IWC discussions on marine debris have stressed the importance of a training and capacity building approach, including through existing marine debris initiatives. Such an approach could assist in developing technical expertise and activities related to marine debris including: (1) removal of ALDFG from marine areas where it accumulates (2) collection and proper disposal of end of life fishing gear and (3) marine debris outreach and awareness campaigns that target fisheries and other sectors from which debris originates to explain their impacts, the importance of reducing the amount of such debris, and actions that can be taken to prevent its impacts.

3.4 Fisheries management and fishing gear

i) Gear marking

Recognising their past and existing efforts, FAO COFI should be encouraged to conclude their work on gear marking and take into account the value that gear marking can contribute to mitigation approaches.

Gear marking can bring positive benefits to the fishing industry as a tool to reduce gear loss, address unintended biodiversity impacts and to distinguish *bona fide* gear from Illegal, Unreported and Unregulated (IUU) gear. There are considerable advantages in gear marking from a cetacean entanglement perspective. If gear is traceable it can be further studied to understand the factors leading to entanglement. Even a 'low-tech' gear marking scheme in combination with examinations of gear removed from whales could resolve three key questions: (1) the region in which gear is set; (2) the fisheries from which gear came (e.g. traps vs gillnets); and (3) the part of fishing gear from which it came (e.g. buoy lines vs. groundlines between traps). This could be used to analyse factors such as gear types, loss rates of the various gear types, persistence of ghost gear by type as a threat in the water column, and the origin of ALDFG. This information is particularly important in helping to develop mitigation measures and priorities. Gear identification also creates an opportunity for communication with the fisherman, who can provide useful information for 'real-time' entanglement response as well as long-term solutions. More detailed discussion of gear marking can be found in Annex 1/ IWC/65/CCRep04 (p11-12, 19-20 and 31).

Although there is value in a standardised global marking system, it is important to recognise that approaches that may be appropriate in developed large scale fisheries may be impractical or economically infeasible in artisanal fisheries or fisheries in the developing world. However, there may be value in a centralised global database (or perhaps regional databases) for gear and the reporting of lost gear.

IWC expert workshops have reviewed several successful national initiatives on gear marking (see Box 1) and recommended that similar initiatives and pilot studies should be funded and encouraged.

Box 1. Gear marking in Dungeness Crab Fisheries

The California, Oregon and Washington Dungeness crab trap fisheries, the largest trap fisheries off the US west coast, mark individual traps as part of a trap limit system. Fishermen are allowed to apply for replacement tags for up to 10% of their trap allotment. Through this system, the state fishery management can quantitatively measure and track the (reported) trap loss. The report of a whale entanglement in California highlights the information that can be gleaned with traceable gear marking. On 30 June 2014, a highly degraded humpback whale fluke was found off San Clemente Island in southern California wrapped in commercial fishing line and five fishing buoys. The buoys were marked with commercial fishing license numbers and California Dungeness crab buoy tags. The gear markings allowed for contact with the owners of the two sets of gear, through the California Department of Fish and Wildlife. The fishermen stated that they had set their gear off the San Francisco area and had lost their gear at the end of March or April. The fluke was found over two months later and approximately 360 n.miles south of the original gear set location. The buoy tags were industry initiated and implemented in California in 2013 as part of a trap limit system.

Source: Saez *pers comm.* in IWC/65/CCRep04 p.11 and Saez *et al.*, 2013

ii) Gear collection and recycling

A challenge in addressing ALDFG is the lack of facilities in some places for collection of end of life fishing gear and the lack of incentives for fishermen to use these facilities- for example, revenue from recycling. There are some successful national initiatives (Box 2 and Box 3) for the collection and recycling of discarded fishing equipment. Though these are promising, changes to legislation are required in some countries where currently there are laws that fisheries waste must go to landfill.

At the global level, MARPOL Annex V requires signatory nations to provide adequate port reception facilities for accepting garbage (including ALDFG) generated by ships. The Global Integrated Shipping Information system (GISIS) website, provided and managed by IMO, provides a database of garbage management facilities searchable by port and waste type. There is the potential for this to be more up to date in terms of specific identification of those ports and waste management providers that accept and/or recycle end of life fishing gear. Improved knowledge of where end of life fishing gear could be responsibly disposed of (ideally free of charge or with a financial incentive), if combined with education outreach, could reduce the incidence of gear discards.

IWC expert workshops have recommended that the relevant Member states should be encouraged to review national level implementation of MARPOL Annex V and other conventions relevant to marine debris reduction. They could also be encouraged to ensure that the GISIS database is updated to specify which ports accept end of life fishing gear, and additional useful information (such as any restrictions on gear and recycling potential) and to establish port reception facilities with fee systems that incentivise and streamline waste delivery. Greater reporting of inadequate port facilities would also be useful.

Box 2. Fishing gear collection and recycling in Norway

The Norfir project (http://www.nofir.no) for recycling fishing gear in Norway has created a profitable national system for collecting and recycling discarded fishing equipment, now being extended into several other European countries. Norway has a very long coastline and an important fishing sector. Large-scale fisheries include trawl nets, gillnets and aquaculture. Fisheries waste, particularly old nets, was not welcome at waste facilities as it entangles the machinery. Old gear therefore either went to landfill, was dumped at sea or was burnt. The Nofir project collects discarded gear for free. Selling the valuable plastic contents of the gear pays for the disposal of net components (including other types of plastics) that cannot be recycled or are less valuable as well as collection of the more remote debris. The Norwegian Directorate of Fisheries collects and recycles discarded gear and the dismantling and processing is carried out in a plant in Lithuania. In part this has been possible because of the large size and number of nets. Challenges to the project include transport, laws and regulations regarding hazardous waste (since copper is used on the nets as an antifouling agent) and difficulties in dismantling and recycling (plastics recycling is complex). In addition effort is needed to increase awareness of the problem for the fishing sector as well as to improve the ability to make a profit from the enterprise.

Source: Rudd *pers comm*. In IWC/65/CCRep04 (p17)

Box 3. Philippines- NET-WORKS

Net-works is a partnership between the Zoological Society of London (ZSL), Aquafil (nylon net recyclers), and Interface (carpet company). Communities living in the Danajon Bank of the Philippines collect and sort nets, which are a major entanglement hazard and threat to the reef and its ecosystem. ZSL coordinates the collection efforts and payment structure through the creation of community banks, Aquafil then processes the netting into yarn, and Interface buys the yarn to make carpet tiles, fulfilling their company mission of a closed-loop supply chain. Since June 2012, 9,000 kilos of discarded fishing nets have been converted to carpet tiles; 892 local fishers and their families collect fishing nets in exchange for payment; for every 2.5 kilos of nets collected, villagers receive enough money to buy 1 kilo of rice. This project, which actively pursues a role for the private sector continues to succeed, by assigning a commercial value and price point to the 'product' of marine debris.

Source: Case study in IWC/65/CCRep04 (p18)

iii) ALDFG recovery

Lost gear recovery provides immediate benefits to marine animals, including cetaceans, by removing gear that is a threat to entanglement and ingestion (McElwee and Morishige, 2010) and has saved thousands of animals. It has also been shown to be economically viable (Box 4). Combining government mandates to conserve endangered species and marine mammals with conservation of commercially valuable species makes a strong case for supporting lost gear recovery. Although some people have considered lost gear as 'artificial habitat', the entanglement risk of man-made materials on the sea bed and other environmental consequences likely exceed the perceived benefits that items may have by creating artificial habitat. Where possible, dedicated observers (biologists) on board during gear recovery efforts can collect data on the species, composition, and numbers encountered in the gear, as well as on the type and condition of the gear.

There are a number of successful gear recovery programmes in different parts of the world and knowledge and experience from these on-going programs could be beneficial to other countries that have not yet tackled the problem of derelict fishing gear.

Box 4. Modelling economic benefits of gear recovery in Puget Sound

In collaboration with the Northwest Straits Initiative, derelict nets in Puget Sound in Washington State, US were monitored by divers over two-month periods to measure entanglement rates, in order to develop a predictive model for estimating total mortality caused by a net during its lifetime as derelict (Gilardi *et al.*, 2010). This model was then used to estimate the cost-to-benefit ratio for commercial fisheries of derelict gear removal, based on true costs and market values. This evaluation suggested that, regarding entanglement of Dungeness crab in derelict gill nets specifically, the cost-to-benefit ratio was 1 to 14.5. When the model was applied to estimate total mortality of marine mammals in derelict gillnets in Puget Sound, and costs of gear recovery compared to costs to rehabilitate marine mammals impacted by oil spills, derelict gear removal was determined to be a highly cost-effective.

Source: Gilardi *pers comm.* in IWC 2014.

iv) Gear modifications and Fisheries management

There have been promising developments in gear technology methods to reduce "ghost fishing" by ALDFG (see report from Gilman et. al., In prep in IWC/65/CCRep04). Efforts to reduce ghost fishing by derelict gillnets and trammel nets include increasing gillnet filament diameter, modifying the weaves (e.g. using multi-monofilament instead of single monofilament- which has been shown to give them shorter fishing efficiency), using larger floats on the top rope and heavier weights or lead-core on the bottom rope, and infusing compounds to make the net stiffer (increase net tension), reducing the likelihood of entangling large organisms. Efforts to make nets more detectable, such as through net colour, thicker twine diameter and attaching corks or other visual markers within the net, has in some cases been shown to effectively reduce bycatch rates of marine mammals and turtles. Similarly, attaching materials such as thick polyester rope and chains to fishing nets, and infusing nylon nets with metal compounds such as barium sulphate and iron-oxide has the potential to reduce cetacean captures either because the materials increase acoustic reflectivity when using echolocation, increase the net's visibility or the infused metals increase twine stiffness. In some cases, the use of less durable materials (e.g. thinner net twine diameter and weaker material) to produce a breaking strength that allows large organisms to break free of the gear and escape might also reduce ghost fishing mortality. Designs that employ degradable materials have been developed to reduce the duration of the fishing power of ALDFG. Degradable escape panels and cords can be used to reduce ghost fishing by traps, and are required in some fisheries. Synthetic gear materials have been developed that can be broken down by microbes and ultraviolet light. Acoustic pingers and alarms and illuminating nets with chemical or battery-operated light sticks might reduce bycatch but would likely be ineffective methods to reduce ghost fishing mortality once the energy source has drained.

Concern has been expressed that some gear modifications mandated by government regulators whilst intuitively believed to reduce whale entanglements, have yet to produce scientific proof of their effectiveness. These may prove costly to fisherman without producing the desired results. The onus should therefore be on collaborative research with industry (including gear manufacturers and the fishing industry) as well as with small-scale and artisanal fisherman to identify practical solutions that provide local incentives to adopt alternative fishing methods. In addition, the importance of individual behaviour and operator proficiency (e.g. some individuals using the same gear as others may have higher bycatch rates and gear loss rates) should be considered as part of mitigation strategies. Addressing this may in some cases prove more effective than general, industry or sector-wide measures.

In addition, it is possible that some gear modifications to reduce by-catch might increase the amount of gear (marine debris) in the environment. It is therefore important that the assessment of such alternatives in active fishing gear include evaluation of their potential to alter the contribution of marine debris in the environment and the risk of entanglement or ingestion by marine species.

In some cases, fisheries management schemes such as Individual Transferable Quotas, and Total Allowable Catches (TACs) can facilitate the incorporation of fishing methods that can be better for cetaceans and that lead to a reduction of marine debris. Marine spatial planning and technological innovations might also help to reduce conflicts between different maritime activities that may result in the creation of marine debris.

3.5 Waste management

Countries should be encouraged to prioritise the strategic use of a range of measures to improve marine and terrestrial waste management, including international and national legislation, policy and guidelines; stakeholder partnerships; industry training schemes and economic tools aimed at reducing public consumption of key types of debris such as packaging waste. Examples include bans and taxes on single-use plastics (e.g. carrier bags, polystyrene packaging), extended producer responsibility schemes and bans on microplastics in personal care products, as recently adopted in the U.S.

There are some calls (see IWC 2014 p5-6; Rochman *et. al.* 2013 in Simmonds and Baluch 2015) for marine debris, particularly plastic wastes to be classified as and addressed as hazardous wastes and assertions that this would increase the power of environmental agencies to restore affected habitats and prevent more dangerous debris from accumulating.

3.6 Outreach

It is essential that action to tackle the issue of marine debris is led through outreach to all relevant stakeholders including policy makers, the public and scientific community, industry and local communities particularly (with respect to ADLFG), gear manufacturers and the fishing industry. There are opportunities for outreach to lead to better data on marine debris (e.g. from the fishing sector, mariners and beach users) as well as to help bring about behaviour change, and inform the identification and development of innovative solutions. There are many good examples of outreach tools including those developed at national level and by international organisations and partnerships such as the Global Partnership on Marine Litter.

In general, outreach materials on this topic should be developed in cooperation with all key stakeholders, including industry and be tailored to specific target audiences. Different strategies will be needed in different parts of the world with regards to the best approach to different target audiences. In many parts of the world, cetaceans can be good educational and outreach tools that can help relate the problems of the oceans to wide audiences. In this context, information from the IWC Scientific Committee and ongoing disentanglement initiatives could be of assistance to other organisations to inform their work, including outreach to policy makers and the public.

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Annex 1

Report of the IWC Scientific Committee Workshop on Marine Debris

Report of the IWC Scientific Committee Workshop on Marine Debris[1]

1. INTRODUCTORY ITEMS

1.1 Welcome and opening remarks

The Workshop was held from 13-17 May 2013 at the Quissett Campus of the Woods Hole Oceanographic Institution (WHOI). The first day was a public seminar consisting of a number of keynote presentations and question and answer sessions.

Michael Moore, the Director of the Marine Mammal Center at WHOI welcomed everyone. He gave a brief description of the Woods Hole scientific community and noted that Woods Hole village had been a small whaling port, with the old spermaceti factory extant, and still known as the Candle House.

Mark Simmonds, as Workshop Convener, thanked Michael and WHOI for hosting the Workshop and everyone for coming. He commented that the old adage that things at sea tend to go on out of sight and out of mind certainly applied to a significant extent to marine debris. However, whale entanglement was a well-known phenomenon in this part of the USA and one that many here were working hard to respond to. He added that this is an historic meeting. Both the IWC and the Woods Hole Oceanographic Institution were born long ago (the IWC in 1949 and WHOI in 1930). Both are concerned with marine conservation but this the first time that they have joined together in an initiative, and the first time that the IWC had held a public seminar. He then thanked all the sponsors of the IWC's work on marine debris, including Oceancare, the World Society for the Protection of Animals (WSPA), the US National Oceanic and Atmospheric Administration (NOAA), the UK, the Environmental Investigation Agency (EIA), Humane Society International and the WHOI Marine Mammal Center.

A list of attendees is provided at Annex A.

1.2 Procedural matters

Simmonds was elected as Chair and Baulch, Brockington, Hudak, Rosa, Saez and Thiele were appointed as rapporteurs.

The adopted Agenda is given in Annex B.

1.3 Review of documents

Simmonds drew attention to the documents which had been submitted to the Workshop and were available through the IWC's document management website.

2. KEYNOTE PRESENTATIONS

2.1 Introduction to the work of the International Whaling Commission on environmental issues

Simon Brockington, Executive Secretary of the IWC, introduced the range of environmental work being undertaken by the Commission. In particular, he highlighted progress to coordinate national programmes established to respond to whales entangled in marine debris. The IWC strives to facilitate a co-ordinated, global capacity for responding to entangled whales, where apprentices from more than 15 countries have already been trained in safe disentanglement procedures. Other environmental work includes development of measures to reduce incidents of ship strikes, development of guidelines for sustainable whale watch operations and a range of dedicated conservation projects for small cetaceans.

The IWC recently introduced Conservation Management Plans (CMPs) as a practical tool to co-ordinate the diverse work being undertaken. To date, three CMPs have been prepared: one for gray whales *Eschrichtius robustus* in the western North Pacific, and two for southern right whales *Eubalaena australis* on the east and west coasts of South America. Additional plans are currently being developed. The successful implementation of the CMPs will depend on continued and increased partnership working between range states and the full range of stakeholder organisations.

2.2 Marine debris in our oceans – an overview

Nancy Wallace, Marine Debris Programme (MDP) Director and Division Chief, US National Oceanic and Atmospheric Administration (NOAA) provided an introduction to the issues arising from marine debris in the world's oceans. The MDP was formed in 2006 after passage of the Marine Debris Research, Prevention and Reduction Act.

Wallace noted that, in 2006, Senator Daniel Inouye of Hawaii stood on the floor of the Senate chamber and introduced a bill he felt very passionate about; one that focused on a problem that he felt went unnoticed. That problem was marine debris. He said: 'From the shore, our oceans seem vast and limitless, but I fear that we often overlook the impacts our actions have on the sea and its resources. In a high-tech era of radiation, carcinogenic chemicals, and human-induced climate change, the problem of the trash produced by ocean-going vessels and dumped at sea must seem old-fashioned by comparison. Sea garbage would seem to be a simple issue that surely cannot rise to the priority level of the stresses our 21st century civilization places on the natural environment. Regrettably, that perception is wrong. While marine debris includes conventional 'trash', it also includes a vast array of additional materials. It is discarded fishing nets and gear. It is cargo washed overboard. It is abandoned equipment from our commercial fleets. Nor does the 'low-tech' nature of solid refuse diminish its deadly impact on the creatures of the sea. Dead is dead - whether an animal dies from an immune system weakened by toxic chemicals, or drowns entangled in a discarded fishing net.' Senator Inouye proposed giving the USA the tools it needed to develop effective marine debris prevention and removal programmes, and with that, the NOAA Marine Debris Program was formed.

Marine debris is a global problem, and it is an everyday problem. There is no part of the world that is untouched by debris and its impacts. It is pervasive, it is an eyesore, and it harms our natural resources. Marine debris is a threat to our environment, navigation safety, the economy, and human health.

Derelict fishing gear is a major marine debris issue that has a profound impact on natural resources. Discarded nets, rope, and monofilament fishing line continue to fish even as they drift through the ocean. They can entangle animals, maim them, or prevent them from hunting food. Lost or

[1]Presented to the meeting as SC/65a/Rep06.

discarded traps and pots can continue to entrap animals for years after they are lost adding to resource and economic losses. Both primary sources and secondary sources of plastic are another major issue related to marine debris. Plastics can be ingested by marine life and can lead to starvation and death. There are also many questions related to the chemical impacts of plastics and research is underway to address these.

A majority of marine debris can be prevented but some cannot. Natural disasters such as Hurricane Katrina, the 2009 tsunami in American Samoa and the 2011 tsunami in Japan are examples of events that led to substantial amounts of debris entering the ocean. Working with federal, state, and local partners to implement response plans help to mitigate impacts from this type of debris.

While there are many challenges related to marine debris, there are also many efforts to reduce the impacts. The NOAA Marine Debris Program has established a presence throughout the USA and has formed partnerships with local organisations to carry out removal and prevention projects. As well, research projects are underway to address the impacts of microplastics and derelict fishing gear on marine life, and to understand the economic impacts of marine debris. Examples of these projects can be found at *http://www.marinedebris.noaa.gov*. Interagency collaboration is mandated by the Marine Debris Act and NOAA works very closely with US agencies such as the Environmental Protection Agency, the Department of Interior, and the Department of Defense, the US Coast Guard, the Department of State, as well as other federal agencies.

Marine debris is a global problem and solutions must be at the global level. Two years ago, NOAA, the United Nations Environment Programme (UNEP), and stakeholders from all over the globe came together to draft the Honolulu Strategy[2], a global strategy for reducing marine debris.

2.3 Cetacean entanglement: detection and impacts

Moore noted that entanglement of cetaceans can involve peracute underwater entrapment, or chronic debilitation, lameness, impaired gait, chronic infection, host immune responses and ultimately death. This usually begins by entanglement in actively fished gear, whereas debris is discarded material floating, in the water column or on the bottom. Where active gear is torn away by the power of the animal, or the entangled animal is cut out from the gear by the fisher, it could be defined at that point as debris. Fishing gear consists of rope, traps and floats from fixed trap fisheries, especially lobster gear, gillnet and its associated ropes and floats, monofilament and braided hook and line fishing gear, and mobile trawl gear. On the eastern seaboard of the United States and Canada, large whales (Van der Hoop *et al.*, 2012), dolphins, porpoises and seals all get entangled in fishing gear. An annual average of 2,773 whales, dolphins and seals died in fishing gear in the NW Atlantic waters of the United States for the period 2005 to 2009[3]. Relocation of floating whale carcasses at sea has been successful using drift forecasts by the US Coast Guard SAR plot model assuming the carcass is a 70% submerged 40' container drift paradigm.

Entangled cetaceans can become asphyxiated when entrapped below the surface of the water; if the animal can surface, it can remain anchored in place, or if it is cut free or can break away, the result may be chronic entanglement, with resultant laceration, incision, constriction, feeding impairment, increased drag (Van der Hoop *et al.*, 2014), loss of body condition, bony proliferation, infection and ultimate death (Cassoff *et al.*, 2011). The timing of death can be minutes to years after the initial event (Moore *et al.*, 2006). The symptoms can include acute distress in whales that cannot surface and therefore drown at some point soon after the normal dive duration, which ranges from minutes to more than an hour in the case of some whales. Chronic cases presumably suffer from severe and chronic pain (Moore and Van der Hoop, 2012). Diagnosis of acute drowning entanglement often involves subtle surface markings from the gear, airway froth and systemic congestion, suggestive of a terminal struggle (Moore *et al.*, 2013). Chronic entanglement cases often exhibit resultant wounds and emaciation. Mitigation can include reactive disentanglement on a case-by-case basis, which may be valuable for critically endangered species. This may include large whale disentanglement programmes, with substantial tool innovation, which could perhaps be enhanced by available at-sea sedation techniques (Moore *et al.*, 2010). Low impact tagging systems to enhance relocation of entangled animals would also enhance disentanglement response. Major challenges to addressing the issue of cetacean entanglement in fishing gear include:

(1) cost to the fishing industry of poorly tested but mandated gear modifications, or seasonal and area closures;
(2) poor detection and reporting of entangled animals; and
(3) competing agendas in terms of other regulatory priorities for fishing industry goals and stock management.

Most efforts to reduce marine mammal entanglement have been driven by concerns over species and stock survival. There seems to be minimal legal or popular motivation to reduce these very serious welfare concerns for the sake of the individual animal. The welfare status of all cetaceans should be independent of their conservation status. For most whales, actively fished gear is the primary entanglement problem. Ingestion of macrodebris is a problem at least for sperm whales, *Physeter macrocephalus*. Mitigating debris interactions is politically easier than mitigating interactions between cetaceans and actively fished gear – hence the focus may be on the former when the latter may be the bigger problem.

2.4 Cetacean entanglement: scope and response

David Mattila, the technical adviser to the International Whaling Commission, noted that the IWC has a long history of investigating the scope and impacts of large whale entanglement, through the Human Induced Mortality (formerly Bycatch) Working Group of the Scientific Committee. Additionally, recent findings concerning both the welfare and conservation impacts of entanglement have brought the topic to the attention of both the Commission's Whale Killing and Associated Welfare Issues Working Group and its Conservation Committee. While the extent to which marine debris may contribute to cetacean entanglements is not fully understood, the impacts and potential responses once entangled are largely the same. In response to the growing awareness of the impacts of entanglement, Australia, Norway and the USA convened an IWC-endorsed Workshop of experts on the topic (IWC, 2012). The Workshop reviewed the scope, impacts and potential responses to large whale entanglement, and found that all large whales can become entangled anywhere in the world's oceans where they encounter rope and net in the

[2] *http://marinedebris.noaa.gov/projects/pdfs/HonoluluStrategy.pdf.*
[3] *http://www.nefsc.noaa.gov/nefsc/publications/tm/tm213/.*

water column (IWC, 2012). With respect to understanding whether entangling ropes and nets were in active use or not when entanglement occurred, it was noted that a large percentage of the materials removed are reported as being of 'unknown' origin and only in a few instances (e.g. less than 5%), are the materials determined to have been lost, abandoned or otherwise discarded, prior to entanglement. However, given a current review of gear loss and continued ghost fishing, in some regions it may account for up to 30% of entanglements (Mattila and Lyman, 2006). In addition, given the cryptic nature of the entanglement events and the general lack of reporting infrastructure, it is generally agreed that the numbers of entanglements are widely and severely under-reported. The 2010 Workshop therefore recommended capacity building on the topic, better data collection, and ultimately prevention. In response to the Commission's endorsement of this report and its recommendations, the USA seconded a technical expert (Mattila) to the IWC Secretariat to focus on advancing work on this topic.

Given the strong recommendation for capacity building, a second IWC Workshop was convened (IWC, 2013) to develop principles and guidelines for response to entangled whales, as well as a strategy and curriculum for capacity building. In the 18 months since that Workshop, the IWC entanglement response capacity building initiative has reached approximately 500 responders, managers and scientists, in 20 different countries. The capacity building curriculum includes exposure to techniques and methodologies for investigating the causes, scope and impact of large whale entanglements, including in marine debris, as well as current information on attempts to prevent it. During both conceptual and practical training, the consensus principles and guidelines are stressed, including human safety, animal welfare, and the collection of information about the whale and the entangling materials, which will ultimately be used to inform mitigation.

2.5 Microplastics

Cristina Fossi of the University of Siena reported that microplastics, plastic fragments smaller than 5mm, is an emerging issue for cetaceans. The impacts of microplastics on baleen whales that are potentially ingested by filter-feeding activity, are largely unknown.

Fossi presented a case study on the fin whale, *Balaenoptera physalus*, in the Mediterranean Sea, one of the largest filter feeders in the world. These whales feed primarily on planktonic euphausiid species. With each mouthful, fin whales can trap approximately 70,000 litres of water, and their feeding activities include surface feeding. They could therefore face risks caused by the ingestion and degradation of microplastics. Microdebris[4] can be a significant source of lipophilic chemicals (primarily persistent organic pollutants – POPs) and a source of pollutants such as polyethylene, polypropylene and, particularly, phthalates. These chemical pollutants can potentially affect marine organisms and are potential endocrine disruptors.

This study, supported by the Italian Ministry for the Environment, is the first evidence of the potential toxicological impact of microplastics in a baleen whale and suggests the use of phthalates as a tracer of the intake of microplastics through the ingestion of microdebris and plankton. The toxicological effects of microplastics on fin whales were studied comparing two populations living in areas characterised by different human pressure: the Pelagos Sanctuary (Mediterranean Sea, Italy and France) and the Sea of Cortez (Mexico). The work was implemented through four steps:

(1) collection/count of microplastics in the Pelagos Sanctuary (Mediterranean Sea);
(2) detection of phthalates in superficial neustonic/planktonic samples;
(3) the detection of phthalates in Mediterranean stranded fin whales; and finally
(4) the detection of phthalates and biomarker responses (CYP1A1, CYP2B, lipid peroxidation) in skin biopsies of fin whales collected in the Pelagos Sanctuary and Sea of Cortez.

A high presence of plastic particles with high concentration of phthalates (Di(2-ethylhexyl)phthalate or DEHP and Mono(2-ethylhexyl) phthalate or MEHP) has been detected in superficial neustonic/planktonic samples collected in the Pelagos Sanctuary areas that were investigated (mean value 0.62 items/m^3). As well, MEHP concentrations were detected (57.9ng/g) for the first time in blubber samples of five stranded fin whales collected along the Italian coasts. Finally, relevant concentrations of MEHP and elevated biomarker responses (CYP1A1, CYP2B, lipid peroxidation) were detected in the skin biopsies of fin whales collected in the Mediterranean areas in comparison to the specimens from whales in the Sea of Cortez. The results of this study support a strategy of using phthalates as a tracer of microplastics consumption in fin whales, and represent a warning signal for this emerging threat in baleen whales.

These preliminary investigations underscore the importance of future research on the detection of the toxicological impact of microplastics in filter-feeding species such as mysticete cetaceans, the basking shark and the devil ray. These results also underscore the potential use of these species in the implementation of Descriptor 10 (marine litter) in the European Union (EU) Marine Strategy Framework Directive as indicators of the presence and impact of micro-litter in the pelagic environment.

2.6 Closing the loop: repackaging plastic debris as a hazardous substance

Mark Browne, of the National Center for Ecological Assessment and Synthesis (NCEAS), University of California, Santa Barbara, suggested that the policies for managing plastic waste were out dated and threatened the health of people and wildlife. Plastic debris can physically harm wildlife and many plastics can be chemically harmful in certain contexts. In 2012, 280 million tonnes of plastic were produced globally, less than half of which was consigned to landfill or recycled. Yet in the USA, Europe, Australia and Japan, plastics are classified as solid waste, and are therefore treated in the same way as food scraps or grass clippings. If countries classified the most harmful plastics as hazardous, their environmental agencies would have the power to restore affected habitats and prevent more dangerous debris from accumulating. If current rates of consumption continue, the planet will hold another 33 billion tonnes of plastic by 2050, filling about 2.75 billion standard rubbish-collection trucks. This could be reduced to just 4 billion tonnes if the most problematic plastics (e.g. polyvinyl chloride or PVC, polystyrene, polyurethane, polycarbonate) are classified as hazardous immediately and replaced with safer, reusable materials in the next decade.

[4]Throughout this document the following definitions are used: microdebris refers to plastic particles smaller than 5mm and macrodebris to plastic particles greater than 5mm.

2.7 Overview of cetacean interactions with marine debris

Sarah Baulch, of the Environmental Investigation Agency (EIA), presented results from a literature review of published and unpublished data on debris interactions involving cetaceans. This review found that entanglement and ingestion interactions have been recorded in 46 cetacean species, equivalent to 53% of all cetacean species. The majority of records are from one-off stranding events, which represent a small but unknown proportion of interactions occurring unobserved at sea. Furthermore, there is much data that remains unpublished.

Baulch's review found that in the cases collated, items ingested were most commonly plastic (54%), with fishing gear comprising 20.7% and miscellaneous or unidentified items constituting the remainder (25.3%). Almost all of the entanglements in debris documented were caused by lost fishing gear (97%). The review indicated that ingestion of marine debris occurs in a large number of cetacean species (seven mysticete and 35 odontocete species) that employ a variety of foraging strategies at different levels of the water column. There appears to have been an increase in the number of cases reported per decade, with more than a seven-fold increase in the number of reported ingestion events in the last 50 years. Also, there has been an increase in the number of cetacean species that have been recorded ingesting debris. It is not clear to what extent the increase in records may be evidence of an increasing problem or whether it reflects increased detection and reporting rates. Notwithstanding the welfare concern of debris interactions at an individual level, there is a need to identify methods to determine whether there are population-level effects of marine debris ingestion and entanglement for cetaceans.

It was noted that another recent review came to similar conclusions, and also highlighted the possibility that deep-diving cetaceans (sperm whales and beaked whales) may be especially vulnerable to ingestion (Simmonds, 2012).

Discussion

The seminar concluded with a panel discussion that touched on the following topics:

- the legal requirements for monitoring and responding to marine debris vary around the world, and are also often complicated by a lack of capacity to enforce laws even if they exist;
- cooperation with other international organisations and existing frameworks was **encouraged**, including but not limited to: the Convention on Migratory Species (CMS) Resolution on Marine Debris, the UNEP/GPA Global Partnership on Marine Litter, UNEP Regional Seas Programme, MARPOL[5], the UN Food and Agriculture Organisation (FAO) and the Convention for Biological Diversity (CBD);
- the potential importance of fishing gear-marking strategies to the problem of derelict fishing gear;
- how local actions may relate to a global problem; and
- how countries might best develop partnerships to execute recommendations and strategies related to this issue.

In closing, Simmonds noted that these and other matters would be considered during the Workshop that would follow. It would focus on determining how to better understand the risks that marine debris poses to cetacean species and would also inform a second IWC Workshop on marine debris directed by the IWC's Conservation Committee, which will be concerned with addressing the threats posed by marine debris to cetaceans.

[5]MARPOL is the International Convention for the Prevention of Pollution From Ships (1973) as modified by the Protocol of 1978.

3. ENTANGLEMENT

3.1 Overview of papers relating to entanglement

3.1.1 Entanglement records in Italy

Podestá presented an overview of information from the Italian cetacean stranding network and a summary of entanglement records. The Italian Stranding Data Bank, managed by the University of Pavia and the Natural History Museum of Milan on behalf of the Italian Ministry of the Environment, collects and validates stranding data[6]. Data collection started in 1986 and continues today; each record in the database is geo-referenced and provides information about the event (location, species, sex, length, etc.) The records also capture information on samples collected and the institutes where samples are stored. The database is linked to the Cetacean Tissue Bank of the University of Padova, where samples collected from the stranded specimens are stored and available for research[7].

Podestá searched the Italian national database and summarised records of cetacean strandings that were related to entanglements in fishing gear over the last 11 years (2002-12). A total of 99 'bycatch' events were recorded, representing nearly 8% of the total strandings and affecting seven different species. Verified entanglements in fishing gear were reported for 36 cetaceans within the total number of bycatch recorded. The majority of the entangled animals were found dead (23), while 13 were found alive and were successfully released (Pace *et al.*, 2008). Nine of the live specimens were large cetaceans: eight sperm whales and one humpback whale, *Megaptera novaeangliae*. No information about whether entangling debris was active or lost fishing gear was available. Also, the source of entangling gear was often difficult to determine and in many cases was classified as 'unidentified fishing gear'.

Analyses of the data indicate that the number of entanglements were decreasing in the years considered, and represent a small percentage compared to the total number of strandings. Considering the bias in the data collection (different effort in different areas), Podestá stated that the number of entanglements has likely been underestimated in the considered period of time. Stranding data can be of help to report cetacean interactions with fishing gear, but dedicated studies are needed to analyse the problem in the whole Mediterranean area. Cooperation with researchers working on fisheries has to be improved in order to share data and information.

Podestá clarified that four entanglement cases involving sperm whales were determined to be in an active fishing nets, as opposed to lost gear, because the fishermen themselves contacted the Coast Guard for help. Podestá noted that fishing nets are not known to commonly wash up on the beaches as debris in Italy and that entangling gear is not retrieved in Italy for later analysis or archiving, primarily because people are not available to collect and do the categorisation.

DISCUSSION

In recognition of the importance of better understanding this issue, including the relative occurrence of derelict versus actively-used gear involved in cetacean entanglements, the Workshop **recommended** that all gear removed from cetaceans be retained, documented and detailed, archived, and analysed wherever feasible. Collection of entangling gear should not compromise human or cetacean safety.

[6]Data available online at *http://mammiferimarini.unipv.it*.
[7]See *http://www.mammiferimarini.sperivet.unipd.it*.

It was noted in relation to assumptions about the survival of released animals, that not all disentangled whales will survive, and that they are less likely to survive if released by untrained individuals, as untrained individuals often leave small, but lethal wraps of gear on the animal as it swims away. The recommendation for disentanglement teams to work with experts to determine the origin of the gear removed was noted as a component of the IWC principles and guidelines for proper entanglement response (IWC, 2013).

The EU has conducted research using Synthetic Aperture Radar (SAR) to successfully detect the presence of anchored gillnets after fishery management effort restrictions (Rosenthal and Lehner, 2011). SAR allows for remote detection of fishing effort without the need for traditional methods of recording effort, such as logbooks and vessel monitoring systems.

3.1.2 Overview of large whale entanglement records

Saez presented an overview of US west coast (California, Oregon, and Washington) large whale entanglement records and the trends in associated entangling gear types. Whale entanglements on the US west coast are reported from opportunistic on-water sightings, stranding records, and commercial fishery observers. Gray and humpback whales are the most commonly reported entangled large whale species. A switch in most common entangling gear types, from gillnet to trap/pot, is likely a reflection of management actions in California. Except for commercial fishery observer records, it is difficult to determine if the entangling gear was active gear or marine debris (lost gear) at the time of entanglement.

The co-occurrence of fixed gear commercial fisheries and large whales (blue, fin, gray, humpback, and sperm whales) off the US west coast was modelled to look for areas where, and months when, large whales are more likely to encounter gear and becoming entangled. Fishery effort for 11 fixed gear fisheries was modelled by combining fishery landings data with areas defined by common fishing depths. The co-occurrence model showed that the highest risk for blue, fin, humpback, and sperm whales was during the fall, and for gray whales the highest risk was in January and May. The Dungeness crab trap fishery had the highest co-occurrence scores/entanglement risk for all whale species. There are multiple confirmed entanglements of gray and humpback whales in the Dungeness crab trap fishery; however, there have been no recorded entanglements of blue whales in any type of fishing gear on the US west coast. Whale behaviour and morphology could possibly explain the discrepancy between the model results and what is in the entanglement records.

Saez noted that a Fixed Gear Guide was developed as part of a larger effort addressing the issue of marine mammal entanglements and to assist in classification of gear (active or lost)[8]. Photos, diagrams, and maps are used throughout the document in combination with written descriptions of gear, gear configurations, and management/regulations to characterise each fishery (Saez *et al.*, 2013).

DISCUSSION

The Workshop noted that microchips that can be scanned to identify origins of the material could be inserted into plastic; chemical markers can also be used. Gear guides should be considered locally applicable and subject to regular revision. It was asked if fishing gear was regularly dumped and, in the case of trawl gear because of its cost, this seemed unlikely. In other fisheries there are a variety of reasons for gear being lost and/or dumped (McElwee *et al.*, 2012; McElwee and Morishige, 2010).

In some fisheries, the value of catch is high enough to incentivise the fishermen to put out more gear than is needed. In such situations, discard occurs due to lack of capacity on the boat to haul the gear to port when some of it is full. The Workshop recognised that reduced fishing effort can result in greater profit-for-unit investment, while substantially reducing entanglement risk.

The Workshop **recommended** that fishery effort models should be coupled to lost gear recovery effort data to evaluate whether higher fishing effort is correlated with areas of higher densities of lost gear.

3.2 Review of the available marine debris entanglement data – consideration of species and data-types

3.2.1 Gear recovery in California and modelling impacts in Puget Sound, Washington, USA

Gilardi presented information on lost gear recovery efforts in California and also on a cost-benefit analysis for gear removal relating to loss of commercially valuable species in derelict nets in Puget Sound. The California Lost Fishing Gear Recovery Project, a programme of the UC Davis Wildlife Health Center, has been removing lost commercial and recreational fishing gear from California coastal waters since 2006. Lost gear is located and recovered by contract divers (commercial urchin harvesters), and either repatriated to original owners or disposed. Data on location, gear type, and number of entanglements or entrapments are recorded. To date, the programme has recovered more than 60 tons of gear and debris, and has documented more than 800 entanglements, including five small cetaceans and one pinniped.

The programme has also conducted research to better understand the population-level impacts of derelict fishing gear on marine species. A retrospective epidemiologic investigation of more than 12,000 intake medical records of gulls, pelicans and pinnipeds admitted to wildlife rehabilitation centres in California revealed that, depending on location and season, more than 10% of gulls and up to 4% of pinnipeds were impacted by fishing gear entanglement or ingestion injuries (Dau *et al.*, 2009).

In collaboration with the Northwest Straits Initiative, derelict nets in Puget Sound were monitored by divers over two-month periods to measure entanglement rates, in order to develop a predictive model for estimating total mortality caused by a net during its lifetime as derelict (Gilardi *et al.*, 2010). This model was then used to estimate the cost-to-benefit ratio for commercial fisheries of derelict gear removal, based on true costs and market values. This evaluation suggested that, regarding entanglement of Dungeness crab in derelict gill nets specifically, the cost-to-benefit ratio was 1 to 14.5. When the model was applied to grossly estimate total mortality of marine mammals in derelict gillnets in Puget Sound, and costs of gear recovery compared to costs to rehabilitate marine mammals impacted by oil spills, derelict gear removal was determined to be a highly cost-effective measure to mitigate anthropogenic impacts on marine mammals.

DISCUSSION

The Workshop **agreed** that lost gear recovery has saved thousands of animals, even ones that do not have a commonly

[8]The guide is a living document and available online at *http://www.swr.nmfs.noaa.gov/psd/fixed_gear.htm*.

associated monetary value. Combining government mandates to conserve endangered species and marine mammals with conservation of commercially valuable species makes a strong case for supporting lost gear recovery.

Although some people have considered lost gear as 'artificial habitat', recovery efforts result in the restoration of natural habitat and the removal of debris that will cause damage. The Workshop noted that the entanglement risk of man-made materials on the sea bed and other environmental consequences likely exceed the perceived benefits that items such as tires, toilets and traps may have by creating artificial habitat.

The Workshop **recommended** that when derelict fishing gear is removed from the marine environment, that a dedicated observer (biologist) is on board to collect data on the species, composition, and numbers encountered in the gear, as well as on the type and condition of the gear.

3.2.3 The work of the Consortium for Wildlife Bycatch Reduction

Werner reported the on-going research programme of the Consortium for Wildlife Bycatch Reduction, a group he directs that comprises members from US east coast fishing groups and academic institutions. The Consortium supports the investigation of innovative fishing techniques that can potentially reduce endangered species bycatch. The focus of the presentation was on several research projects the Consortium is undertaking to examine potential fishing gear modifications for mitigating large whale entanglements, in particular for the North Atlantic right whale (NARW), *Eubalaena glacialis*, an endangered species with an estimated global population of only 500 individuals. These projects are evaluating:

(1) ropes of different colour (and luminosity) to determine if NARWs show different avoidance behaviour;
(2) ropes with reduced breaking strength that are still durable enough for fishing;
(3) 'stiff ropes' that may have reduced entanglement properties because they are materially stiffened (e.g. hard lay ropes) or are under higher tension (such as in the northeastern portion of Maine where buoy lines tend to be stiffer, pulled taught by the opposing forces of flotation at the sea surface and weight of bottom gear, both exposed to high current and tidal forces); and
(4) rope-less fishing techniques, such as those that incorporate acoustic release technology to maintain buoy lines close to the sea floor until the time they are released to the surface for hauling.

In addition, given that testing of experimental gear with large whales is impractical, especially noting the need for statistically adequate sample sizes, the Consortium is supporting the development of a computer model to evaluate and test bycatch mitigation techniques with large whales.

Although these projects are still on-going, as a justification for the research into reduced breaking strength ropes, Werner presented the results of analysis of ropes retrieved from disentangled right whales showing evidence that breaking strength of rope is a factor affecting the likelihood that a large whale can break free upon entanglement in fixed fishing gear. In addition, he shared knowledge about a fisherman in Australia who has incorporated acoustic releases into his lobster fishing gear. These kinds of examples help inform what is possible in terms of practical fishing methods that can also reduce entanglements, but need to be evaluated within the local fishing context. Considering the potential of reduced breaking strength rope, its application is probably only suitable in areas that can use 'light duty' gear. Also, the appeal to an Australian lobster fisherman to use acoustic releases involves several unique local circumstances that include a high market price/kilo of product, a previous management action that reduced the number of fishermen in the fishery, and other factors. In the northeast US, lobster fishermen have raised their objections to using this technology by pointing out the high cost of the devices currently available on the market, and the increased probability of gear conflicts both within the fishery and with draggers.

The Consortium's research is directed at avoiding the incidence of whale entanglements in the first place, which Workshop participants acknowledged as the preferred solution to the problem of marine mammal entanglements in fishing gear. One concern was that gear modifications mandated by federal regulators in the US in response to whale entanglements (such as 'weak links' inserted between the top of a buoy line and the buoy, and groundlines attached to adjacent lobster traps that are negatively buoyant), whilst intuitively believed to reduce whale entanglements, have yet to produce scientific proof of their efficacy as deterrents. As such, they represent examples of often costly and perhaps even impractical modifications for fishermen that should be monitored to measure their effectiveness as entanglement deterrents and the consequences to fishermen.

These kinds of projects, involving collaboration among engineers, wildlife biologists, and fishers, highlight the advantages of engaging fishers as part of the solution to marine mammal entanglements. The idea for carrying out research into ropes with reduced breaking strength emerged from teams of fishermen and scientists who jointly studied gear retrieved from disentangled whales. Furthermore, it highlights that incentives exist for fishermen to modify fishing gear that reduce marine mammal bycatch, and that the problem can sometimes be solved without relying on new regulations enacted by government agencies.

The Workshop **recommended** that ideas for reducing cetacean entanglements and the occurrence of derelict gear should be generated in collaboration with fishermen, recognising that practical and sustainable bycatch solutions and reduction of loss of gear tend to emerge from partnerships between science and industry.

As well, the Workshop **recommended** that fisheries managers consider the influence that fisheries management schemes (e.g. ITQs, TACs, etc[9].) have on facilitating the incorporation of fishing methods that can be better for whales and that lead to a reduction of marine debris.

The Workshop also **recommended** that in fisheries where regulatory actions and agencies are unlikely to exert a strong influence over local fishing practices (such as in small-scale artisanal or non-industrial fisheries) the onus should be on collaborative research with fishermen. This should aim to identify practical solutions that provide local incentives to adopt alternative fishing methods that reduce the generation of marine debris and entanglement risk for cetaceans.

The Workshop also highlighted that prevention of entanglements is the preferred method, but stressed that concerted and well-funded research is required to evaluate fishing innovations for reducing marine mammal bycatch and generation of debris.

There are examples of programmes that are currently removing derelict fishing gear in different parts of the world.

[9]An ITQ is an Independent Transferable Quota and is part of a Total Allowable Quota (TAC). Both are typically set each season for each fished stock.

These projects provide immediate benefits to marine animals, including cetaceans, by removing gear that is a threat to entanglement and ingestion (McElwee and Morishige, 2010). The knowledge and experience from these on-going programmes could be beneficial to other countries that have not yet tackled the problem of derelict fishing gear.

The Workshop **recommended** that a programme is initiated through the IWC to provide an effective transfer of information and methods from on-going programmes to countries interested in beginning new derelict gear removal programmes and to stimulate the adoption of official programmes for removing fishing gear as debris. This could be modelled after the IWC's disentanglement training programme with guidance from the IWC's Scientific Committee and supported through the IWC.

The Workshop **recommended** that the IWC should identify effective programmes of derelict gear removal. Furthermore, the IWC should share knowledge gained on gear removal and its benefits.

It was noted that marine spatial planning and technological innovations might help to reduce conflicts between different maritime activities that may result in the creation of marine debris.

The Workshop discussed the effectiveness of management measures such as sinking ground line requirement and weak links. The NOAA Fisheries Atlantic Large Whale Take Reduction Team (TRT) has compiled a matrix to summarise the gear research that has been proposed and conducted to reduce entanglements of large whales in the Atlantic[10].

There was also a suggestion to revisit the feasibility of lipid-soluble rope for use in fisheries and other marine industries that rely heavily on the use of rope. The concept of lipid-soluble rope was not practical when originally researched in the past, but technological advances may make it possible today.

In some countries efforts are made to reduce bycatch, but rarely is it noted that sometimes these actions increase the amount of gear (marine debris) in the environment. This message should be shared with the next entanglement Workshop.

The Workshop **strongly encouraged** continued research and development into alternative fishing techniques, strategies to reduce the entanglement of cetaceans in active fishing gear, and validation of the effectiveness of existing fishing practices that lower the risk of entanglement incidence and severity. The Workshop **further encouraged** that the assessment of such alternatives in active fishing gear include evaluation of their potential to alter the contribution of marine debris in the environment and the risk of entanglement or ingestion by cetaceans.

Furthermore, the Workshop **recommended** that future efforts to both understand and mitigate cetacean entanglement should include participation from multiple stakeholders (e.g. manufacturers, fishers and other relevant ocean users).

3.3 Distinguishing active fishing gear entanglements from entanglement in marine debris

With regard to the issue of cetacean entanglement in man-made materials, a growing body of evidence indicates that the vast majority of entanglements occur in synthetic ropes and nets associated with fishing (e.g. Johnson *et al.*, 2005). Entanglements have been reported for most cetacean species in a wide variety of fishing gear, but predominantly in gear that is either drifting or anchored. While the relative entanglement risk posed by actively fished gear versus that posed by lost, abandoned or otherwise discarded fishing gear, is unclear, it is very clear that the solution to both can only be reached through full engagement with the manufacturers of fishing gear and the raw materials used to produce it, fishers and other involved parties.

A number of potential methods of distinguishing active gear from derelict gear were discussed. These included: gear marking; modelling fisheries activity, identifying geographic positions exhibiting high gear loss (through reporting and gear retrieval programmes), and using information on rates of gear loss to predict likelihood of gear being derelict; consideration of fouling organisms; engagement with fisheries to collate further information on potential methods of distinguishing active from derelict gear, as well as to identify key causes for loss or dumping of gear; and consideration of the number of different gear types (where multiple gear types are found on an animal they are likely to have been derelict at the time of entanglement).

With respect to gear marking, the Workshop **recommended** that every effort should be made to distinguish whether the entangling gear was active or derelict at the time of entanglement. Recognising the difficulty involved in this, the Workshop **recommended** further research to assist this process.

When considering the entanglement risk of debris: if gear is lost, there is an unknown period of time during which it may pose the same entanglement risk as active gear (McElwee and Morishige, 2010). Fishing gear, whether active or derelict, often lacks traceability to owner or fishery, and is comprised of materials and components designed to optimise fishing, but with the potential to injure or kill cetaceans.

The Workshop **recommended** combining existing fisheries knowledge and appropriate fishing techniques with applied research and innovation to engineer and utilise fishing gear that ideally is: (1) traceable; (2) generates less debris; and (3) causes fewer injuries and mortality to cetaceans.

It was suggested that the Workshop remain mindful of the idea of overall reductions of volume of man-made material in the ocean.

3.4 Pathology protocols: recommendation for diagnosis of entanglement and ingestion impacts of fishing gear and aquatic debris in cetaceans

In situ examination of entangling and ingested debris and associated traumatic injuries in live and dead animals is essential for revealing pathologic impacts of fishing gear and debris on cetaceans. Changes can include laceration, amputation, and constriction-related injuries externally, and/or, ileus, strangulation, ulceration, impaction, emaciation, and/or rupture internally. Evidence of chronic effects (e.g. emaciation) or prior trauma from entanglement and debris interaction, where material is no longer present, can also be obtained through careful clinical or post-mortem examinations by scientists and through subsistence harvest monitoring. In addition to the information provided for impacts assessment, this information will be beneficial for assessment of actual synthetic material/debris interactions (exposures) for cetaceans. Potential chemical exposure should be evaluated, and may or may not be accompanied by gross or histologic changes due to transfer of monomers, additives and sorbed priority pollutants from the plastic into the tissues (Rochman and Browne, 2013).

[10]Available at: *http://www.nero.noaa.gov/whaletrp/plan/gear/Gear%20Research%20Matrix_Oct%202010_final.pdf.*

The Workshop **recommended** the following diagnostic approach.

Evaluating possible impacts due to entanglement and ingestion impacts of fishing gear and debris should be done using a classical differential diagnostic approach when possible, to enable: (a) detection of trauma, chemical exposure and other sequelae related to exposure; and (b) analysis of their roles in contributing to morbidity and mortality in the context of other potential causes, such as infectious or non-infectious disease, nutrition, and other possible etiologies. In situations when a full differential diagnostic approach is not possible, efforts to document the presence of marine debris, both ingested and entangled, are still very important. Most efforts focus on macrodebris but efforts should also focus on microdebris. Efforts should be made to include the following components in the examination of all live and dead wild cetaceans as appropriate.

(1) Gross necropsy examination and report: description, sketches, images, measurements, collection and preservation of entanglement/debris, and affected body part(s). The entire gastrointestinal tract should be opened and examined. Standard cetacean necropsy protocols should be followed (Barco and Moore, In press; McLellan *et al.*, 2004; Pugliares *et al.*, 2007).
(2) Debris characterisation: material should be categorised as rope, net, floats, monofilament, braided line, hooks, packaging, cigarette butts, plastics and other anthropogenic material. Size, shape (image analysis of digital photographs), mass, volume, and polymer type if plastic (e.g. vibrational spectrometry) should all be recorded, and all evidence should be identified as to source using established techniques (Browne *et al.*, 2010) as practical and in collaboration with the relevant industries, to maximise the integration of data into these industries, such as plastics and fishing.
(3) Confirmatory diagnostics: further analyses as practical and indicated should be undertaken, such as histopathology, imaging, analytical chemistry, blood test and organ function tests, to document presence of and type of debris as well as possible impacts to the animals. It would be useful to provide resources to develop techniques to identify particles of plastic in the tissues of animals. Criteria for the assignation of degree of confidence of findings (e.g. quality of data) of entanglement or ingestion contributing to or causing morbidity and mortality have been recently published and should be applied (Moore *et al.*, 2013). Chain of Custody documentation should be maintained as required or possible.
(4) Training designed for specific countries and regions, and database maintenance would both enhance understanding of these problems.

3.5 Classification of debris types

The group noted that classifying marine debris is essential for understanding its sources, distribution, and impact on cetaceans. The Workshop **recommended** a two-part classification system to address this requirement. The first aspects should include characteristics adequate to understand the use, configuration, and other aspects of the debris while it is still in active use. Largely, these characteristics will map to the industrial function of the item – holding liquids, catching fish, providing buoyancy. The second aspect of the classification system should focus on characteristics of the item after it has left human possession and contribute to the harm the item might cause to cetaceans. For instance, this might include colour (i.e. visibility), flexibility, sharp edges, size, strength, density, site in water, flexibility, shape/aspect ratio, and a host of other aspects that affect its ability to harm cetaceans.

Currently there are projects to classify debris to a source in the Northwest Hawaiian Islands and Australia. Clean-up efforts are very labour intensive and expensive; therefore recent efforts in the Hawaiian Islands have focused more on removing gear. Local fishermen involved in lost gear recovery in California and on the US east coast have assisted in identifying a fishery and sometimes a specific fisherman. Fishermen may also be useful in determining active versus derelict gear in entanglement cases. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia has developed a cluster analysis of the physical origination sources of debris. Debris from commercial and recreational fisheries can be difficult to identify, especially if trying to trace to a certain area.

4. INGESTION

4.1 Papers relating to ingestion

Baulch presented an analysis of data collated on published and unpublished cases of debris ingestion from across the globe (1960-present). Ingestion of debris has been reported in the literature from 43 cetacean species, comprising seven mysticete and 35 odontocete species. The chances of detecting the ingestion of debris may be lower in mysticete species due to lower stranding and necropsy rates. Hence, the low number of mysticete species documented ingesting debris to date should not be taken as evidence that it does not occur. A number of studies (where sample size was >10) have assessed occurrence rates of cetaceans observed to have ingested debris. The occurrence rates of debris ingestion ranged from 2.2% in harbour porpoises, *Phocoena phocoena*, that stranded on the UK coast (Deaville and Jepson, 2010) to 31% in Franciscana dolphins, *Pontoporia blainvillei*, bycaught in Argentina (Bastida *et al.*, 2010). It was noted that publications have consistently showed high rates of debris ingestion in franciscana dolphins and given that these studies were based on animals captured as bycatch, ingestion of debris is unlikely to be over-represented as compared to strandings data.

Baulch presented maps showing where interactions have been reported. A relatively high number of cases have been reported in the US, Japan, Australia, South America, and parts of Europe, but records are lacking from Africa and Asia. Such differences in reporting rates between different regions are likely to influence perceptions of the severity, distribution and frequency of debris interactions at a global scale. Google fusion tables (Google forms and open data kit) were presented as a potentially valuable tool for collating global data in the future (see Fig. 1). Data collection forms can be designed and sent to stranding networks and responses can then automatically populate an online table. This would greatly facilitate data collection and collation and thereby aid understanding of the threat of marine debris. It was further emphasised that it would be important to collect information on rates of debris occurrence in animals necropsied (presence/absence) as well as rate and type of pathology (impact on animal) to gain a better understanding of the extent of the threat it poses to different species and populations.

Discussion

The Workshop noted that there will be low reporting levels for ingestion of debris in some areas, and that even where

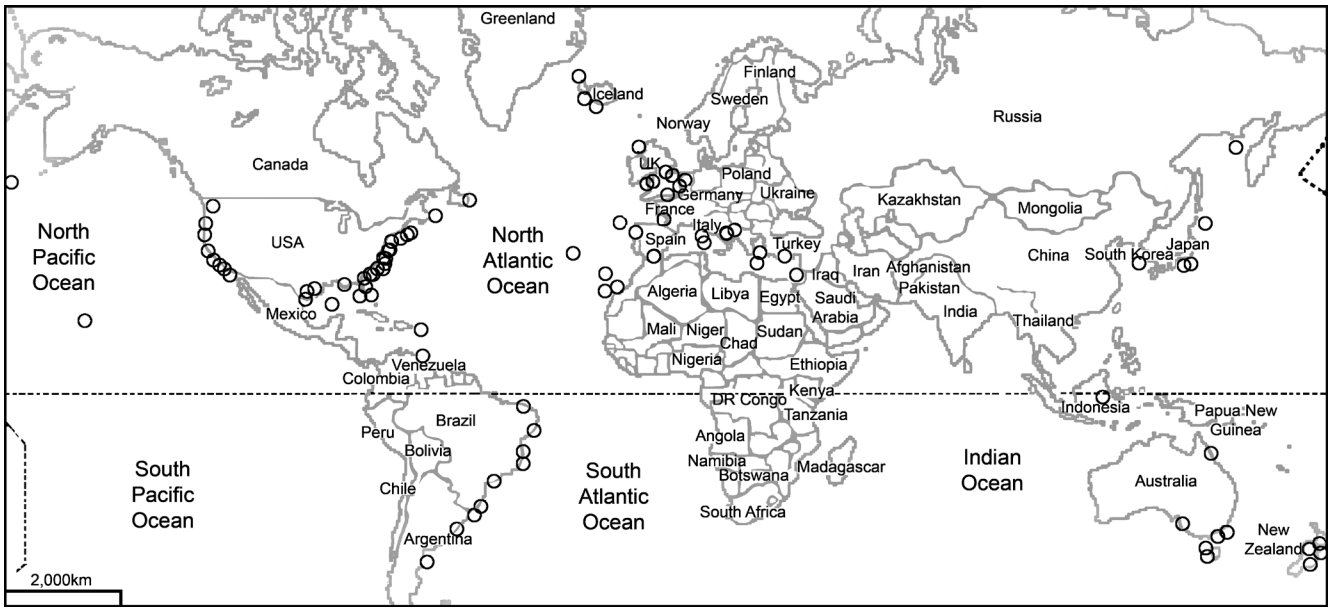

Fig. 1. Distribution of debris ingestion events reported in the literature (1960-2012).

data are collected, there may be poor accessibility to and collation of the data at a national and international scale. Possible formats for a global database were discussed, including the use of freely accessible databases such as that presented by Baulch, the IWC's Cetacean Emerging and Resurging Diseases (CERD) website, and the inclusion of this data within countries progress reports to the IWC.

Therefore, noting the poor coverage of global data on rates of debris ingestion, the Workshop **recommended** that where possible, full investigation of the gastrointestinal tract should be part of necropsy procedures. It also **recommended** that information on rates of debris occurrence in animals necropsied (presence/absence) as well as the rate and type of related pathology (impact on animal) should be collected in order to better understand potential population-level threats. Also, it **recommended** that data collected on debris interactions should be submitted to a global database, for which a standardised data form should first be designed.

As a first step, the Workshop **recommended** that rates of marine debris interactions with cetaceans be reported by IWC member countries, in the appropriate data fields within their National Progress Reports (e.g. stranding and bycatch), and that the data be recorded in such a way that it is available for future analysis. The Workshop also **recommended** that the Scientific Committee revisit the possibility of including a link to a marine debris reporting/data aggregation site on the CERD homepage at the upcoming IWC meeting or, if this was not viable for the Scientific Committee to recommend, an appropriate format for future data management.

4.2 Review of the available marine debris ingestion data

4.2.1 Case studies: Italy

Podestá reported the results of gastric analyses performed on stranded cetacean species in Italy, focusing on those where ingestion of marine debris had been documented. The most interesting case was of seven sperm whales that stranded together in 2009 (Mazzariol *et al.*, 2011). Gastric contents were examined in six of the seven sperm whales. Stomach contents consisted of cephalopod beaks and synthetic materials, including fishing gear and hooks, ropes and various plastic objects. No evident obstruction or perforation of the alimentary tract was noted, suggesting that marine debris was not the cause of death in these cases. Weight of synthetic materials varied from 9.5g in one individual to nearly 5kg in one of the stranded animals. Plastic was found in the stomachs of all six specimens and fishing nets, lines and one hook were found in two animals. Marine debris was documented in the stomachs of seven out of twelve additional sperm whale strandings recorded in the Mediterranean Sea (De Stephanis *et al.*, 2013; Roberts, 2003).

Among the other species studied, only two of 10 Cuvier's beaked whales, *Ziphius cavirostris*, stranded in Italy have been recorded to have plastic debris in their stomachs. Marine debris was not found in any of the 50 striped dolphins, *Stenella coeruleoalba* studied and only two of 24 bottlenose dolphins, *Tursiops truncatus*, had fishing net in their stomachs, most likely as a result of depredation on fishing gear.

The preliminary results support the idea, as reported in other papers (Evans and Hindell, 2004; Jacobsen *et al.*, 2010; Laist, 1997), that sperm whales seem particularly affected by marine debris ingestion. Small dolphins were never found with ingested plastic, and while some had fishing nets, these were probably linked to depredation. Podestá urged that more detailed studies on debris ingestion should be a priority for the whole Mediterranean area, which is highly polluted by plastic debris. Fossi noted that the problem of marine debris in this area is supported by the high occurrence of marine debris in the stomach contents of Mediterranean turtles (see also Garibaldi and Podestá, 2013).

DISCUSSION

It was noted during discussion that ingestion of marine debris is not always an accidental process for cetaceans and that depredation on fishing gear may result in ingestion of fishing gear. A Workshop on marine mammal bycatch in longline fishing gear sponsored by the Consortium for the Wildlife Bycatch Reduction and NOAA's Office of International Affairs is being held in October 2013[11]. It should be noted that ingestion of fishing gear due to depredation presents a different management problem to the passive ingestion of marine debris.

[11] *http://www.bycatch.org/node/796*.

The Workshop **recommended** that identifying the sources and fates of plastic debris would help improve and support Extended Producer Responsibility (EPR) initiatives by the manufacturer or distributor of the plastic. EPR is an effective tool for informing product design and could be used to raises awareness of the issue.

4.2.2 The structure of ziphiid stomachs

Yamada presented his research with collaborators, which finds that cetaceans, and especially ziphiids, may be particularly susceptible to ingesting plastic debris because of their stomach structure (Yatabe *et al.*, 2010). These studies were based on stranding data from Japan. Yamada introduced the anatomy of cetacean digestive tracts: the existence of connecting chambers was highlighted as a potential hindrance factor for the passage of non-digestible material, including debris, through the digestive tract (see Fig. 2.).

The number of connecting chambers varies between eight and 11 and the minimum diameter of the passage aperture between chambers is less than 15mm (Tamada, pers. obs.). The flow of digestive material into connecting chambers may be prevented when the main stomach is full. In ziphiids, the connecting chambers are divided into many smaller chambers, with more than 10 small chambers in some species (Mead, 2007), which may limit the passage of large items.

In necropsies of 80 stranded ziphiid carcasses, 73.8% of *Mesoplodon stejnegeri*, 50% of *M. ginkgodens*, 33.3% of *M. carlhubbsi*, 66.7% of *M. densirostris*, 100% of *Indopacetus pacificus* and 33.3% of *Ziphius cavirostris* had foreign substances in their stomachs. In most animals, quantities of foreign material in these stomachs were not seriously large; however some individuals had a huge volume of man-made debris that filled the main stomach. These animals would have suffered from the blockage of their digestive tract and may have been malnourished and lost body condition as a result, similar to the case of Inky, a pygmy sperm whale, *Kogia breviceps,*, treated at the National Aquarium of Baltimore (Stamper *et al.*, 2006). Yamada noted that debris had also been observed in finless porpoise, *Neophocaena phocaenoides*, rough-toothed dolphins, *Steno bredanensis* and spotted dolphins, *Stenella attenuata* stranded in Japan. Yamada also presented the results of acoustic research conducted by the National Research Institute of Fisheries Engineering.

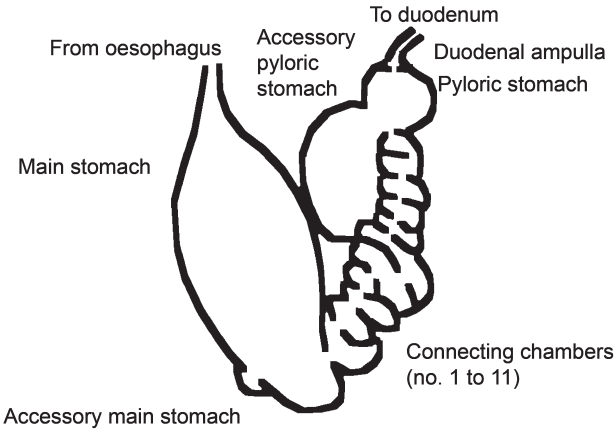

Fig. 2. Schematic illustration of the stomach of *Mesoplodon ginkgodens*.

DISCUSSION

During discussion it was noted that in addition to recording attributes of ingested debris, such as the weight, volume and type of debris, its size in relation to that of the digestive tract should be noted in different species, and that an index that quantifies or qualifies how full the stomach is would be useful. The issue of whether ziphiids were able to regurgitate synthetic materials ingested was raised. It is unclear whether this is possible. It was also noted that sub-lethal pathology can occur when the quantities of debris are lower and that this should also be investigated and noted in necropsies. Effects may include dietary dilution and reduced appetite with resulting reductions in body condition and other fitness-related pathology. While these may be less readily observed, it is important that such impacts are considered in cases of sub-lethal debris ingestion.

Moore noted that D-tags on beaked whales have been used to image the acoustic signature of their prey items at foraging depths up to 1,800m (Madsen *et al.*, 2005). With further information on the acoustic signature of plastic items versus prey items, it might be possible to establish whether and which debris items were being selectively ingested by cetaceans.

The Workshop **commended** the valuable work conducted by Yamada and colleagues and **recommended** further research in the following areas: obtaining acoustic information on how marine debris is perceived by cetaceans, which would help understanding of the causes of ingestion; determining the distribution of debris within the habitat of deep diving whales; and given the overall paucity of information on rates of debris ingestion in wild cetacean populations, non-lethal research and evaluation of strandings to measure rates of occurrence of debris ingestion and the pathological impacts would be valuable in a range of species and areas.

The Workshop noted and **expressed concern** regarding the high rates of debris ingestion in certain species (e.g. ziphiids, sperm whales and certain populations of franciscana dolphins). The Workshop **agreed** that, depending on severity, ingestion of debris is a welfare concern at an individual level. While it remains unclear whether there are any species or areas where it is a population- level concern, the conservation threat should be assessed in the context of the local population size, where even low mortality levels may be of concern.

The Workshop noted that the impact on cetaceans of entanglement and debris in the Arctic may increase as industries move into higher latitudes with climate change-driven ice recession opening up new areas for industrialisation. In this regard Reeves *et al.* (2012) noted that in 2009, the North Pacific Fisheries Management Council closed the Arctic Management Area (federal waters in the US Arctic) to commercial fishing. This area will be closed until more data are collected (largely absent at present), so that fishing can be conducted sustainably and with due concern for other ecosystem components. The Workshop **recommended** the benign collection of benchmark data on the impacts of marine debris on cetaceans in this area at the earliest opportunity.

4.3 Recommended pathology protocols

The Workshop's recommended pathology protocols are given at Item 3.4.

4.4 Categorisation of ingested debris types

See Item 3.5.

4.5 Toxicological effects of plastic additives

Panti presented information on the toxicological effects of plastic additives on cetaceans. The assessment of toxicological risk in marine mammals requires the development of sensitive biomarkers to evaluate the exposure to plastic additives, such as bisphenol A (BPA) and phthalates. BPA and phthalates are widely distributed in the marine environment, acting as agonists or antagonists for endocrine receptors. To propose new gene expression biomarkers in cetaceans Panti and collaborators have developed an *ex vivo* approach (organotypic cultures), exposing cetacean skin biopsies to increasing doses of mixture of contaminants. Organotypic cultures collected from fin whales, killer whales, sperm whales and bottlenose dolphins were exposed to increasing concentrations of BPA and phthalates. Two potential biomarker genes were selected, the peroxisome proliferator-activated receptors α and γ (PPAR α and γ), which belong to a superfamily of ligand-dependent nuclear receptors that regulate physiological processes of lipids homeostasis, inflammation, adipogenesis, reproduction, etc. The mRNA levels of the two PPARs were quantified in response to the two different treatments in the four species. The results revealed that the BPA and phthalates treatments induce the expression of the genes PPARα and PPARγ, showing a dose-response trend. Based on these results, the gene expression biomarkers were also measured in skin biopsies from free-ranging Mediterranean fin whales and bottlenose dolphins from Mediterranean Sea and Sea of Cortez. The study was carried out in order to validate the *ex-vivo* approach, but more importantly, to assess the potential exposure of the two species to plastic additives. Due to the up-regulation of the PPARγ gene (an early warning signal), both fin whales and Mediterranean bottlenose dolphin appear to be exposed to plastic additives. These data represent the first evidence of emerging contaminant exposure in free-ranging fin whales and bottlenose dolphins, suggesting the potential use of these diagnostic markers as an early warning signal of exposure to plastic released compounds in marine mammal monitoring.

Panti noted that their research currently focuses on mysticetes and that there is a need to develop a suite of specific biomarkers. There are unresolved questions regarding the relative rates of leaching of contaminants from microplastics versus macro-debris. Initial research suggests that in cases of macro-debris ingestion, there is no evidence of phthalate exposure and this is borne out by research in sea turtles, and stranded sperm whales along the Italian coast, that presented with macro-plastic debris in their stomachs.

The Workshop recommended that further work on surface filter feeders, particularly the North Atlantic right whales, should be undertaken. As surface feeders, right whales may be exposed to high quantities of microplastics in the surface microlayer. The Workshop also commended the work of researchers at the University of Sienna and **encouraged** further work of this kind.

By 2050, an extra 33 billion tonnes of plastic is expected to be added to the planet (Rochman and Browne, 2013). This material enters and persists in environments from the poles to the equator and down to the depths of the sea. Slow degradation into smaller particles means that microplastics have been accumulating in the environment (Browne *et al.*, 2007; 2010; 2011; Thompson *et al.*, 2004). Once ingested by animals, such microplastics can accumulate within the guts of organisms where it can be engulfed and stored by cells (Browne *et al.*, 2007; 2008). This provides a feasible pathway for microplastic to transfer sorbed contaminants, constituent monomers and additives into the tissues of animals and affect physiological processes that sustain health (Teuten *et al.*, 2007; 2009). At least 78% of priority pollutants listed by the EPA and 61% listed by the European Union are associated with plastic debris (Rochman and Browne, 2013). While there are established techniques for quantifying other contaminants in tissues of cetaceans, strikingly, there is still little information on the uptake and toxicological consequences of microplastics (e.g. endocrine disruption). Preliminary research suggests fin whales (Fossi *et al.*, 2012) may contain large quantities of phthalates (potentially derived from microplastic) with possible alterations to the expression of genes associated with endocrine disruption.

DISCUSSION

The Workshop expressed concern regarding the potential impact of microplastics and made the following **recommendations** with regards to further research:

- develop and validate the use of direct (vibrational spectroscopy) and indirect (e.g. contaminants associated with plastic: phthalates, PCBs, PBDEs) measures of ingested microplastic in baleen whales;
- examine whether ingested micro- and nano-plastic can transfer into the food chains of cetaceans;
- evaluate the use of established biomarkers of exposure to assess the toxicity of microplastics, including endocrine disruption; and
- conduct laboratory and field experiments to investigate the bioavailability and toxicity of priority pollutants and additives from microplastic.

It is also important that future research on the uptake and toxicological impacts of microplastics in filter-feeding species of mysticetes includes both species with intense surface feeding activities (e.g. right whales) and species with feeding related to the sediment (e.g. grey whales).

The Workshop also noted that baleen whales and other large filter feeders should be considered in national and international marine debris strategies (e.g. Descriptor 10 [marine litter] in the EU Marine Strategy Framework Directive) as critical indicators of the presence and impact of microplastics in the marine environment.

In conclusion, the Workshop agreed that ingestion and inhalation of marine debris may sometimes be lethal, that sub-lethal pathology may also occur, and that intake of debris is a problem, both as an individual welfare concern and potentially for some populations and species. Therefore, the Workshop encouraged further non-lethal research on the individual and potential population-level impacts of ingestion of debris and, noting the promising research on biomarker development, the group **recommended** further work in this field.

5. THE DISTRIBUTION OF DEBRIS

5.1 Request for papers relating to investigating the distribution of marine debris

Known marine debris databases were described with the caution that not all will have geo-referenced locations and may not pertain exclusively to cetaceans. The Marine Debris Monitoring and Assessment Project (MDMAP) is expanding the use of standardised shoreline survey protocols and building our understanding of debris types and abundances across geographies. The efforts of the MDMAP partner organisations, including volunteer coordination, field surveys, and data submission, are critical for this type of large-scale data collection. The many shoreline monitoring teams have uploaded their survey data to the *md-map.net*

database. A pending NOAA Marine Debris Monitoring Tech Memo will be outlining protocols for monitoring marine debris. An additional source of a long-term database comes from the Norwegian survey and derelict gear removal programme, which has been systematically removing derelict fishing gear from their waters from 1983 to the present time.

5.2 Modelling approaches to identify spatial overlap between cetaceans and harmful debris

Wilcox presented three projects on risk analysis for marine debris impacts on wildlife. The first focused on derelict fishing gear impacts on marine turtles. This project involved modelling the spatial overlap between drifting gear and marine turtles as a proxy for entanglement risk. The model was validated against both known tracks of drifting gear and data on locations where turtles were entangled and stranded. The model was able to make accurate predictions of catch. Based on the analysis it was possible to identify cost effective areas in which to conduct surveillance and recovery of abandoned gear. The second two projects involved analysing the spatial overlap of marine debris more generally, with either marine turtles or seabirds, respectively. In this case, the researchers used a global model of marine debris distribution, based on oceanographic drift patterns and population density. This was overlain with species distributions to predict relative encounter rates for species as a measure of risk. These predictions were then compared to literature data on stomach contents as a measure of plastic ingestion. The comparison revealed that consideration of species ecology was an important component of making accurate predictions, but in general encounter rates were a reasonable predictor of ingestion rates. It was suggested that this approach could be used to make predictions of relative entanglement or ingestion rates for cetaceans, although it is important to be aware of the limitations of the large-scale analyses in making local predictions.

DISCUSSION

Risk analysis provides a framework for complex problems. Simple encounters appear to be a good measure of risk and models help with making informed decisions (e.g. where to do surveillance or interceptions). It was noted that the ecology of the species concerned is also important in the analysis and that traits are useful for making predictions. The solutions are complex and incentives and alternative income sources are going to be a powerful tool (especially for developing nations). For example, derelict fishing gear has been turned into art, or used fishing rope has been turned into doormats. In addition, risk analysis models potentially could reduce management costs. Debris density plots with vertical aspects (layers of debris) were also discussed with potential benefits from the analysis. Further applications of risk analysis can be extended to other fisheries (besides 'ghostnets'), which would be beneficial to numerous regions (e.g. Brazil's marine debris problems with active and derelict longlines).

Potential projects will be looking at a global dataset of fisheries spatial data overlaid with range maps of marine mammals. However, caution should be used regarding known entanglement events due to the limited number of known events as well as the caveat that the comparison may apply to small cetaceans, but not necessarily to large whales due to the ability to drag gear for longer ranges.

The Workshop **recommended** an increase in the usage of theoretical global models that help identify locations where there is greater potential for interactions of cetaceans with debris.

The Workshop also **recommended** engagement with international aid agencies and international financial institutions (such as the World Bank) involved in the development of fisheries management in developing countries to ensure they take into account the impacts to cetaceans from unintended consequences of the various types of gear being brought into communities as an economic development strategy.

DeForce presented the work of the Sea Education Association (SEA), which has been collecting data on floating plastic debris for more than 25 years. These data are typically collected on six-week long educational research cruises as part of the undergraduate SEA Semester programme. From the data collected on the research cruises, the longest and most extensive data set on floating plastic debris in the open ocean was published in 2010 (Law *et al.*, 2010).

In 2010, the Plastics at SEA: North Atlantic Expedition set out to document for the first time the easternmost extent of plastic accumulation in the North Atlantic and measured the highest concentration of plastic debris ever recorded (26 million pieces/km^2) and found that high plastic concentrations extend at least as far as the middle of the Atlantic Ocean. To expand our knowledge of how plastic marine debris is affecting the ecosystem, the Plastics at SEA: North Pacific Expedition set sail from San Diego to Hawaii in Oct 2012. This cruise sampled not only the concentration of plastic but also micro/macro organisms growing on plastic, plastic submerged in the water column due to wind (Kukulka *et al.*, 2012), environmental persistent organic pollutants, and surveys for potential tsunami debris. This research programme continues, and plastic concentrations from 11 years of data collected by SEA in the North Pacific subtropical gyre are currently being analysed for publication.

In reference to microorganisms on marine debris, several sources of health biomarkers were discussed by the Workshop, including research on microorganisms on whales, and research of barnacles on sea turtle carapaces. One future line of investigation could be investigating the correlation of mean sea state and plastic distribution. Another project could be applying gear degradation assessment technology to gear removed during disentanglement. A potential collaboration on the filtration of baleen whales and plastics density/buoyancy/shape was also mentioned.

Mindful of emerging technologies such as deep DNA sequencing, the Workshop **recommended** that the scientific community continue to use novel approaches to support further research on the interaction between cetaceans and marine debris.

Drinkwin presented an overview of Washington State's Derelict Fishing Gear Database. This database is used to collect and store data on derelict fishing gear: debris locations, and the species and habitats documented to be impacted by the debris. In particular, most of this data relates to the Northwest Straits Initiative's Derelict Fishing Gear Program in Puget Sound, an inland sea in Northwest Washington, but also includes data from Oregon and British Columbia. The Initiative's programme has removed over 4,400 derelict fishing nets and more than 2,900 derelict crab pots from Puget Sound since 2002. The removal protocols include an on-board biologist on every removal vessel documenting and cataloguing data about the gear removed, the species found entangled, and the habitat it is affecting. The state-wide derelict gear database operates on a Structured Query Language (SQL) web platform. It is accessible through the internet to approved users. The database includes all data

related to removal efforts of derelict fishing gear as well as the locations and disposition of reported gear. Data retrieval is partitioned between confidential data (not available to the public) and non-confidential data. Access to non-confidential data is routinely approved for researchers, resource managers, and interested citizens. Through an Access™ interface, the uploaded data are quality checked before officially being entered into the database for retrieval. The data can be queried in multiple ways and may be exported for spatial display and analysis.

The requirement that fishermen report lost nets was addressed, referencing the requirement of reporting based on recent implemented laws in the state of Washington, USA. A point was raised regarding using existing marine debris databases frameworks and the possibility of cloning pre-existing frameworks to maintain consistency. A short discussion pertained to the active versus passive participation in providing marine debris data to a central database. The utilisation of technology, in particular sonar, was discussed and it was determined that the expertise of the sonar operator is very important in correctly identifying gear. In the continuation of discussion of database programs, several participants have provided several references of field database programs (see below), which will reduce the error of data transfer from paper format as well as provide a unique identifier for each entry and forces the entering of a complete data form. The participants also recognise the difficulty in identifying and retrieving derelict gear in deep water.

The Workshop **recommended** the promotion and utilisation of existing database frameworks and protocols with the aim of establishing a centralised database for a comprehensive picture of global marine debris impacts on cetaceans.

5.3 The application of quantitative field sampling techniques to investigate prevalence of marine debris in cetacean habitats, including seas

The Workshop **recommended** a general broadening of cetacean boat-based surveys to include marine debris data collection.

6. POPULATION LEVEL IMPACTS OF MARINE DEBRIS

The Workshop noted that a significant amount of information on entanglement exists and can be cross-referenced from past IWC efforts. Welfare concerns related to cetacean entanglement in active fishing gear and marine debris have been well recognised by the IWC following publication of the extended time-to-death of chronic entanglement in right whales (Moore *et al.*, 2006). Recent publications have reinforced this concern (Moore and Van der Hoop, 2012; Moore *et al.*, 2013).

Recent research indicates that North Atlantic right and humpback whales have lower apparent survival after entanglement than other cetacean species (Knowleton *et al.*, In prep; Robbins and Knowleton, 2012; Robbins and Landry, 2012). The number of observed entanglement deaths has the potential to impact population viability (Glass *et al.*, 2012; Van der Hoop *et al.*, 2012). In the case of North Atlantic right whales, research suggests that reproductive rates are also impacted by entanglement (Knowleton *et al.*, In prep). The degree to which marine debris *per se* is responsible for individual and population-level entanglement impacts is an important issue that requires further study.

Several welfare concerns related to the ingestion of marine debris in cetaceans were recognised. Evidence of significant gastrointestinal impaction and other damage following the ingestion of debris as described by Yamada and reviewed by Baulch in this Workshop suggest that there is a welfare concern for ingestion comparable to entanglement, especially for sperm and beaked whales. While it was noted that several of the Workshop presentations and background information papers contributed to the current state of research in this area, the group **recommended** additional research to further detail both the physical and toxicological/physiological impacts of debris ingestion.

The Workshop group recognised the significant impact that marine debris can have on cetacean welfare and **recommended** that additional research be undertaken to further evaluate the impacts of ingested debris on cetacean welfare and population health.

Modelling of debris 'tracks' was noted to be of potential use in cetacean marine debris interaction estimations. There was discussion of the potential application of fishing net track models which are currently being applied in sea turtle debris interaction studies, to cetaceans. This modelling considers the path of debris that the animal encounters as well as general distribution of debris, and uses this information to make projections that may be applicable to stock assessment. These models would allow estimation of the number of animals dead but not recovered/seen. Knowledge of the 'floating characteristics' of cetaceans is considered critical to these models and it was noted that the UK has performed research on drifting body information that could inform these models.

The Workshop **recommended** additional investigation into the applicability of debris track modelling with particular emphasis on the scaling up of models from the regional level to a level that would benefit stock assessment and allow the determination of population level impacts.

7. CETACEANS IN FRESHWATER HABITATS

Most of the information considered at the Workshop related to cetaceans in the marine environment, but it was noted that the threats posed by man-made debris applied equally to freshwater cetaceans. Evidence from studies of river dolphins (e.g. *Inia geoffrensis* and *Sotalia fluviallis*) indicates that debris, including derelict fishing gear and actively fished gear, occurring in freshwater habitats can entangle or become ingested by cetaceans, with both lethal and sub-lethal effects (Iriarte and Marmontel, 2011) . In comparison with marine cetaceans, freshwater species tend to occur within more contained bodies of water often downstream of, or adjacent to, large urban areas that are a major source of debris within these aquatic habitats.

The Workshop **encouraged** further research into the impacts of man-made debris on freshwater cetaceans, as well as effort to mitigate the threats to these animals, some of which are amongst the most endangered of all cetaceans.

8. OVERARCHING EVALUATION OF DATA AND RECOMMENDATIONS

The application of science-based information can often be sensitive, especially considering that this information will be utilised by, and potentially impact the lives of, a diverse group of stakeholders. Thus, science-based information must be objective, transparent, and of high integrity. This requires appropriate structures (e.g. databases, networks) and personnel (e.g. scientists) to maintain the integrity

of data in terms of its acquisition, analysis, storage, and maintenance. The Workshop **recommended** that these structures and personnel should be well-established in order to create and develop the best science-based approaches and/or solutions.

The Workshop group strongly supported augmented datasharing and encouraged improved coordination with respect to marine debris data and research. The group **recommended** that marine debris interactions with cetaceans be reported by IWC member countries, in the appropriate data fields within their National Progress Reports (e.g. stranding and bycatch), and that the data be recorded in such a way that it is available for future analysis.

8.1 Recommendations for future research and priorities

- The Workshop **agreed** that the overall goal of any marine debris-related research endeavour should be designed to help build risk assessment model(s) and address the issues raised in the risk models, which can be applied to other cetacean species with different geographical ranges.
- The Workshop **encouraged** debris sampling when conducting cetacean research at sea and the reporting of these results to relevant groups such as the IWC.
- The Workshop **recommended** that the IWC promote research on debris-related impacts from fisheries and **encouraged** that data reported via fisheries be collected in a format more amenable to stock assessment and risk assessment analyses (i.e. via FAO guidance).
- The Workshop **recommended** that industry partners be involved in marine debris prevention, research and response to ensure success in reducing marine debris impacts on cetaceans; and
- In the context of addressing global marine debris impacts on cetaceans, the Workshop **recommended** that the IWC utilise existing national and intergovernmental platforms for responding to the issue.
- The Workshop **encouraged** governments and industry to support all the research identified by this Workshop (and the Workshop noted that none of its recommendations would require cetaceans to be taken).
- The Workshop found that:
  (a) entanglement of whales can involve peracute under-water entrapment, chronic debilitation, impairment of mobility, chronic infection, and ultimately death;
  (b) recent findings concerning both the welfare and conservation impacts of entanglement have brought the topic to the attention of both the IWC's Whale Killing Methods and Associated Welfare Issues Sub-Committee and its Conservation Committee;
  (c) the extent to which marine debris may contribute to whale entanglements is not fully understood; and
  (d) lost gear recovery has saved thousands of animals, even ones that do not have a commonly associated monetary value.
- The Workshop therefore **recommended** that ideas for reducing large whale entanglements and the occurrence of derelict gear be generated in collaboration with fishermen, recognising that practical and sustainable solutions to minimise bycatch tend to emerge from partnerships between science and industry.
- The Workshop **recognised** the influence fisheries management schemes, e.g. Individual Transferable Quotas (ITQs), Total Allowable Catches (TACs), etc. have on facilitating the incorporation of fishing methods that can be better for cetaceans and that lead to a reduction of marine debris.
- The Workshop **recognised** that it may be difficult to exert influence over small-scale artisanal or non-industrial fisheries and, as such, the onus should be on collaborative research with fishermen to identify practical solutions that provide local incentives to adopt alternative fishing methods.
- The Workshop highlighted that fact that, while prevention of entanglements is the preferred approach, concerted and well-funded research is required to evaluate fishing innovations for reducing marine mammal bycatch.
- The Workshop **recommended** the collection of small-scale commercial and artisanal data on total global distribution of fisheries effort extrapolated from global catch, as it was noted that there are limitations to the data that FAO collects. In addition, it was noted that estimates of gear loss from relevant fisheries would be very helpful toward understanding the relative risk of active versus derelict gear.
- The Workshop **recommended** that fishery effort models should be coupled to lost gear recovery effort data to see if increased effort is correlated with higher densities of lost gear.
- The Workshop **encouraged** the IWC-supported entanglement prevention Workshop to review and incorporate appropriate recommendations from the marine debris Workshops into their report, and underlined the importance of understanding how both Workshops' recommendations will impact each other.
- The Workshop found that:
  (a) the distribution of marine debris is dependent on the distribution of sources (e.g. urban areas, tourist beaches, shipping routes, fishing grounds) and oceanographic processes, with, for example, coastal marine areas receiving sewage, having 250% more microplastic than those not receiving sewage (Browne *et al.*, 2011);
  (b) greater than 60% of priority pollutants are found sorbed to plastic debris at concentrations that may be hundreds of times that found in sediments and millions of times that occurring in seawater (Rochman and Browne, 2013), likely causing greater impacts to cetacean species living in areas adjacent to large human populations;
  (c) there is minimal understanding of the extent of exposure of plastics ingested by cetaceans and the impact that such exposure has on fitness;
  (d) all cetaceans must use the upper water-column and penetrate the surface to breathe; and
  (e) low density microplastics (e.g. polypropylene) and concentrated lipophillic pollutants may become airborne (Wallace and Duce, 1978) and be available for inhalation above the air-water interface for risk of inhalation.
- Therefore, using existing expertise within and external to the IWC, the Workshop **recommended** that the IWC Scientific Committee evaluate the risks of ingestion and inhalation based upon: (1) the spatial distribution of microplastics and macro debris; and (2) the feeding strategies and location of feeding areas of cetaceans, and that the Scientific Committee prioritise studies of those cetacean that are likely at greatest risk of ingesting or inhaling macro- and micro- debris and associated pollutants (Fossi *et al.*, 2012). The Workshop thus

recommended that the initial focus of research be on three species of filter-feeding whales: the North Atlantic right whale, the fin whale in the Mediterranean Sea, and the gray whale in the eastern North Pacific.

- Assessment of the impact of ingested debris on the welfare and fitness (e.g. contaminants and biomarker responses) of cetacean populations should also be explored, including translocation and storage of microplastic in the tissues of whales (Browne *et al.*, 2008). The Workshop noted that additional research is needed on sub-lethal effects of ingested debris.
- The Workshop identified the following **priority mitigation measures.**

Entanglement

Since both active and derelict gear are largely responsible for cetacean entanglements, focus should be to mitigate the impacts of both of these sources on cetaceans. The Workshop **recommended** a consideration of how different managerial regimes affect (i.e. facilitate or hinder) the feasibility of implementing actions, regulatory or otherwise, intended to reduce the risk of entanglement to cetaceans, maximise the return of lost viable gear to fishers, and avoid the introduction of derelict fishing gear into aquatic environments. These actions include:

(1) targeting reduction of fishing effort;
(2) modifying of fishing gear;
(3) developing a response system to respond to and retrieve lost gear; and
(4) implementing time-area closures and marine spatial planning.

Ingested debris

As impacts are largely dependent on species group, we strongly recommend research that allows prioritisation of relevant cetacean populations as data does not exist at this time to allow this. The group **encouraged** modelling approaches that examined the relationship between marine debris 'hot spots' and information on distributions, feeding strategies and mortality rate data already collected by the IWC and other organisations. The group also **recommended** the determination of hazard function of specific debris with subsequent connection with the modelling data.

9. THE IWC RESPONSE

9.1 Work being undertaken by other IGOs

9.1.1 Europe's response to marine debris

De Ruiter presented a summary of efforts addressing the debris problem in Europe.

Information on debris in European seas is very scarce. The CleanSea project started in 2013 and its aim is to assess distribution, fate and impact of marine litter, with 17 international parties involved. OSPAR[12] Beach Litter Monitoring has been conducted in nine European countries since 2002. On average, volunteers collect 700 litter items per 100m of beach. Ropes, nets, balloons and bottle caps are found most commonly along the beaches that are monitored. Research has shown that >90% of all northern fulmars, *Fulmaris glacialis*, have an average of 30 pieces of plastic in their stomach (J.A. Van Franeker, IMARES, pers. comm.). The northern fulmar is an indicator species for the Marine Strategy Framework Directive.

The OSPAR Convention is the current legal instrument guiding international cooperation on protection of the northeast Atlantic marine environment. The Helsinki Commission (HELCOM) works to protect the Baltic Sea's marine environment from all sources of pollution through intergovernmental co-operation. ASCOBANS is the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas. A working group on marine debris formed in 2012. The aim of the Marine Strategy Framework Directive (MSFD) is to achieve good environmental status of the EU's marine waters by 2020. The MSFD Task Group Marine litter aims for a measurable and significant decrease (10%/year on coastlines) in the total amount of litter in the environment by 2020. NGOs (European Environmental Bureau, Marine Conservation Society, Surfrider Foundation, Birdlife Sweden, LPN, Bund, North Sea Foundation, Seas At Risk (SAR)) advised the MSFD on a stronger aim: a 50% reduction in 2020, compared to 2012 and problem solved within one generation: by 2038 (MSFD GES Technical Subgroup on Marine Litter, 2011).

In Norway, the Directorate of Fisheries organises retrieval surveys of gill nets annually since 1980. Within the Kommunenes Internasjonale Miljøorganisasjon (KIMO) project Fishing for Litter in the UK, Baltic and Netherlands, fisherman are provided large bags to remove litter from the sea. Within the Netherlands a group of divers remove ghost nets from shipwrecks. The Surfrider Foundation organises beach clean-ups worldwide. The Marine Conservation Society organises beach clean-ups with thousands of volunteers: they do litter surveys, published a Good Beach Guide and have campaigns on specific items, such as balloons and plastic bags. The North Sea Foundation focuses on tackling the problem at the source, with lobbying, beach surveys (OSPAR) and several campaigns, such as Beat The Micro Bead, Coastwatch (education) and MyBeach (awareness).

9.1.2 CMS/UNEP presentation

Thiele provided an overview of the Convention on Migratory Species (CMS) including its organisational structure, legal framework, and cetacean specific agreements and activities, including ASCOBANS, ACCOBAMS[13], the Pacific Islands Cetacean Memorandum of Understanding (MOU), the Western African Aquatic Mammals MOU, the Global Programme of Work on Cetaceans, and the Resolution on Marine Debris. The presentation included ideas for strengthened collaboration and opportunities for future engagement. In summary, there are 119 parties to CMS, across the globe, and species are listed in either Appendix I (endangered) or II (unfavourable status). A total of 15 cetaceans are listed in Appendix I and 43 cetaceans listed in Appendix II. The Pacific Cetacean MOU was negotiated in collaboration with the Pacific Regional Environment Programme (SPREP) and includes an action plan that mirrors the Secretariat of SPREP regional Whale and Dolphin Action Plan, illustrating a successful model of streamlined efforts between CMS and existing regional agreements. Similar MOUs could be created in other regions, provided funds and capacity to implement are provided.

CMS Resolution 10.4 on Marine Debris[14] highlights the negative impacts of marine debris on migratory species, whether caused by ingestion, entanglement and habitat degradation. It calls for the identification of hotspots where

[12]The Convention for the Protection of the Marine Environment of the North-East Atlantic.

[13]Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic area.

[14]*http://www.cms.int/bodies/COP/cop10/resolutions_adopted/10_04_marinedebris_e.pdf.*

marine debris accumulates and originates, encourages Parties to develop and implement their own national plans of action to address this problem, and to report available information on the amounts, impacts and sources of marine debris within their waters in their national reports. Because so much of the Workshop's conversation included reference to bycatch and entanglement, Thiele also shared CMS Resolution 10.14 on Reducing Bycatch from Gillnets which calls for national assessments of the risk of bycatch arising from gillnet fisheries and urges the implementation of best practice mitigation measures tailored to each particular situation.

Thiele presented an overview of UNEP's Global Initiative on Marine Litter, including the Regional Seas Reports and Assessments on Marine Litter, the Fifth International Marine Debris Conference, 20-25 March 2011[15] and respective conference outcomes. Major conference outcomes included the Honolulu Strategy and the Honolulu Commitment, the Global Partnership on Marine Litter (GPML), which was launched at the 3rd Intergovernmental Review of the Global Programme of Action (GPA), and associated online tools such as the Marine Litter Network which was created to help track progress on the implementation of the Honolulu Strategy. The Global Environment Facility Scientific and Technical Advisory Panel (GEF/STAP) produced a workshop summary report (STAP, 2011).

Another example of the growing global attention to marine debris is a specific reference to it made at the UN Conference on Sustainable Development ('Rio+20') (A/66/L.56, para. 163). UNEP's Regional Office of North America together with the Natural Resources Defence Council (NRDC) convened a Marine Litter Workshop on 'Legal, Policy and Market-Based Approaches to Prevent Marine Litter at the Source.' Lastly, a technical report commissioned by the Convention on Biological Diversity (CBD) and GEF/STAP called 'Impacts of Marine Debris on Biodiversity' played an important role in informing the 11th CBD Conference of Parties decision to formally recognise the impacts of marine debris on marine and coastal biodiversity (Section I, para. 25-27). These activities provide just a snapshot of what is happening globally. It is important for the IWC to build on the existing platforms and information-gathering efforts of institutions like UNEP and others so as not to be duplicative in its good efforts to address marine debris impacts on cetaceans specifically.

DISCUSSION

The discussion that followed considered ways to better include developing countries in the IWC's conservation and management activities, and the relevance of the West African Marine Mammal MOU was noted along with the other CMS daughter agreements and MOUs that relate to cetaceans. Thiele on the behalf of CMS encouraged support from IWC on capacity building efforts in the area of marine mammal disentanglement and training strategies.

The Workshop noted the availability of numerous Regional Seas Marine Litter Assessments and UNEPs Global Initiative on Marine Litter.

A participant noted that there were many international frameworks and conventions during the presentation, but not much information on status of implementation. Thiele noted that the Global Partnership on Marine Litter will help track these efforts in the future and pointed out that money and collaboration are needed to get action on many of the initiatives that had been discussed.

[15] *http://www.5imdc.org*.

It was noted that the Fifth International Marine Debris Conference in Honolulu (5IMDC) had recognised a globally accepted definition of marine debris and the Workshop **recommended** that this discussion about comparisons between marine debris terminology might be considered by the next IWC Workshop on marine debris.

9.1.3 GESAMP structure

The Workshop noted that the Transboundary Waters Assessment Programme (TWAP; a Large Size Project of the Global Environmental Facility[16]) included two components relevant to the interests of the Workshop participants: (i) mapping the distribution of plastics in the open ocean; and (ii) describing the distribution of persistent, bio-accumulating and toxic compounds in beached plastic resin pellets (linked to the International Pellet Watch Programme[17]), based on Large Marine Ecosystems. Responsibility for completing these components lies with the Joint Group of Experts on Scientific Aspects of Marine Protection[18] (GESAMP), an inter-agency body of the United Nations comprised of independent scientists working under the direction of UNESCO-IOC. In addition, GESAMP has a working group on 'Sources, fate and effects of micro-plastics – a global assessment', running from 2012-15 that receives support from several UN Agencies, NOAA, Plastics Europe and the American Chemistry Council. GESAMP welcomes closer collaboration with IWC on the effects of plastics on cetaceans, including the potential impacts of micro-plastics on baleen whales.

DISCUSSION

Discussion followed on the types of collaboration being sought by GESAMP. It was clarified that, secondary to budgetary constraints, GESAMP was looking for collation and analysis of existing literature/data only and that they would not be gathering new data on priority contaminants.

9.2 Proposals for future actions by the IWC and opportunities for intergovernmental collaboration

Brockington commented upon the strategic opportunities for the IWC to engage in the marine debris issue. He recalled that the Commission's Conservation Committee had discussed marine debris at its meetings in 2011 and 2012, and that the welfare concerns associated with entanglement of large whales had been considered separately through the Welfare sub-Committee. Following these discussions the Commission had established an intersessional programme of working to develop applied research and management actions to reduce the impacts of marine debris on cetaceans.

At the international level there is an absence of a single overarching agreement or Convention dealing with the issue of marine debris. The lack of a central document led to calls for increased partnership working between intergovernmental organisations (IGOs), and this was especially relevant for the IWC. Accordingly, the IWC may wish to form partnerships with IGOs in the following categories:

(1) Fisheries management organisations, including for example FAO and CCAMLR;
(2) Multilateral environmental agreements, e.g. CMS, CBD, UNEP;
(3) Regional Seas agreements; and
(4) other Conventions competent in the management of debris including for example MARPOL and the Basel Convention.

[16] *http://www.twap.iwlearn.org*.
[17] *http://www.pelletwatch.org*.
[18] *http://www.gesamp.org*.

In addition to greater interlinkages with other IGOs, partnerships working with the full range of stakeholders including industry groups, NGO observer organisations and national governments would also be essential to progressing action on marine debris.

Brockington noted that the IWC was in a key position to contribute scientific knowledge on the extent and severity of the impacts of debris on cetaceans through the work of its Scientific Committee. This knowledge base could be further enhanced by expansion of national government progress reports to include actions taken to measure and mitigate the impacts of debris on cetaceans. With knowledge as a basis for action, the IWC possessed considerable strategic opportunities for creating partnerships to progress action on marine debris

DISCUSSION

The Workshop suggested an exchange of personnel and information between the IWC and other IGOs (i.e. UNEP/CMS). It was noted that the IWC presently maintains observer status at several Conventions and with regard to interacting has recently expanded its activities into new partnership actions on entanglement and other human impacts in the Caribbean and South Pacific, for example the UNEP Caribbean Environment Programme concerning Specially Protected Areas and Wildlife (UNEP-CEP-SPAW), South Pacific Regional Environment Programme (SPREP), Permenant Commission for the Pacific (CPPS), etc. It was also noted that this mechanism seems to work best when IWC brings its particular expertise to a joint activity. It was noted that IWC and CMS has an existing collaborative agreement. An inquiry as to mechanisms for reporting into UNEP/CMS was made: specific recommendations and suggested mechanisms such as participating in meetings and respective working groups (i.e. the CMS Aquatic Mammals Working Group) were shared.

A number of intergovernmental organisations including ICES, NOAA, CCAMLR and the North Pacific Marine Science Organization (PICES) were identified as potentially important in future collaborative efforts.

It was noted that, in addition to the second Workshop on marine debris, there is an Entanglement Prevention Workshop being planned by IWC, and it was **recommended** that the Marine Debris Workshop coordinate with them on recommendations and cross-Workshop impacts of recommendations.

The unique strengths of the IWC's Scientific Committee were mentioned, including its range of expertise, experience with environmental threats and regular Annual Meeting cycle.

The Workshop encouraged IGOs with overlapping mandates to work together collaboratively on common goals.

It was noted that the identification of priorities by the IWC Scientific Committee could potentially help NOAA prioritise the marine debris work it funds, and help local governments to more fully recognise the marine debris problem and implement response activities, acknowledging the current lack of funding and infrastructure. The CMS resolution on marine debris was noted[19].

The Workshop **agreed** that a brief document summarising priority recommendations for potential funders was a good idea and stressed that they ideally should be prioritised, brief and feasible.

[19]*http://www.cms.int/species/pacific_cet/pacific_cet_bkrd.htm.*

9.3 Recommendations for the 2nd IWC Workshop on Marine Debris

- The Workshop **recommended** that the Second Marine Debris Workshop perform a careful review of recommendations from this Workshop in order to determine if they were acted upon and, if not, identify the factors related to the failure of implementation.
- The Workshop **encouraged** greater outreach to the public and scientific community; the next Workshop is urged to carefully consider its audience and how best to engage.
- The Workshop also **recommended** increased engagement with intergovernmental bodies and industry (plastics, fisheries etc.) prior to and during the next Workshop, and better representation/good engagement with representatives from developing countries. This would bring increased presence from those involved in non-industrial/artisanal fisheries, which were felt to be an underrepresented component of the marine debris problem at the current Workshop (include a session specific to this problem). Related to this, conveners of the next Workshop should seek additional funding in order to be able to provide support to participants from developing countries.
- The Workshop recognised the utility of the IWC web portal and **encouraged** the further use of portal and development of an updated bibliography of material relevant to the next Workshop, including mitigation. It was also noted that it will be provided in ample time for review by attendees.
- The Workshop **recommended** that the turtle modelling work currently performed by CSIRO be presented at the second Workshop.
- The Workshop noted the significant challenges in communicating scientific information about the impact of marine debris on cetaceans, with interactions typically occurring far removed from the lives of most people. There is an urgent need for scientists to relay information about the detrimental impacts of marine debris to a variety of audiences, including decision-makers, industry officials/representatives, policymakers and the public. Thus, the Workshop **recommended** dedicating significant time and resources at the next Workshop to develop effective communications strategies to address this need. Consideration could also be usefully given to educational programmes for adults and children.
- Consideration should be given to reviewing programmes that are currently removing derelict fishing gear in different parts of the world. These projects provide immediate benefits to marine animals, including cetaceans, by removing gear that is a threat to entanglement and ingestion. The knowledge and experience from these on-going programmes could be beneficial to other countries that have not yet tackled the problem of derelict fishing gear.
- The Workshop **recommended** that a programme be initiated and supported through the IWC that would provide an effective transfer of information and methods from on-going programmes to countries interested in beginning new derelict gear removal programmes and stimulate the adoption of official programmes for removing fishing gear as debris. This could be modelled after the IWC's disentanglement training programme with guidance from the IWC SC and supported through the IWC.
- The Workshop acknowledged that natural but catastrophic climatic or seismic events (e.g. hurricanes/

typhoons, earthquakes, tsunamis) can result in pulses of tremendous amounts of debris into the ocean. The Workshop **recommended** that the IWC support a globally applicable but scale-able contingency plan for assessing impacts of such events on cetaceans, which offers member states guidance on mitigation options.

10. CONCLUSION: PRIORITY RECOMMENDATIONS

Given that legacy and contemporary marine debris have the potential to be persistent, bioaccumalative and lethal to cetacean populations and represent a global management challenge, and entanglement in and intake of active and derelict fishing gear and other marine debris have lethal and sub-lethal effects on cetaceans, the Workshop **agreed** that marine debris, and its contribution to entanglement, exposures including ingestion, and associated impacts, including toxicity, is both a welfare and a conservation issue for cetaceans on a global scale.

Therefore, the Workshop **recommended:**

- research and experimentation to develop and evaluate the efficacy of alternative fishing practices, including innovative methods, gear and management regimes, because fishing gear, both active and derelict, is a major cause of injury and mortality in cetaceans;
- microplastics, their associated chemical pollutants and microbes, and macrodebris ingestion should be prioritised for research because they represent a potentially significant but poorly understood threat to cetacean populations; and
- that, while governments, industry groups and organisations are making progress to address the threat of marine debris on local/regional scales, due to the migratory nature of cetaceans; these efforts should be advanced globally.

11. CLOSE OF MEETING

All recommendations included in this document were reviewed and agreed before the Workshop closed and a small editorial team (consisting of Simmonds, Gilardi, and Landrum) was appointed to tidy up the text before it was submitted to the IWC Scientific Committee.

Simmonds thanked everyone for their contributions and especially the rapporteurs for their hard work.

He also thanks the IWC Secretariat team who had done so much to make the Workshop a success, including Julie, Sandra, Brendan, Jessica and Kate. He also thanked Michael Moore for the kind invitation to use the excellent WHOI facilities at no charge and Andrew Daly and Michael for the support they provided during the meeting. Simmonds was thanked for chairing the meeting and at 16.20 on 17 May 2013 he brought the gavel down and closed the meeting.

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Annex A

List of Participants

Sarah Baulch
Environmental Investigation Agency/ member of UK delegation to IWC Scientific Committee
SarahBaulch@eia-international.org

Ginny Broadhurst
Director of the Northwest Straits Commission, USA
broadhurst@nwstraits.org

Simon Brockington
Executive Secretary, International Whaling Commission, UK
simon.brockington@iwc.int

Mark Anthony Browne
NCEAS Post-doctoral Fellow, National Center for Ecological Analysis and Synthesis, University of California, Santa Barbara, USA
browne@nceas.ucsb.edu

Leandro Cortese Aranha
Instituto Brasileiro Do Meio Ambignte e Recursos Naturais Renovaveis, Brazil
Leo_aranha@yahoo.com.br

Emelia DeForce
WHOI and SEA 'Emelia DeForce', USA
edeforce@hotmail.com

Marchien De Ruiter
North Sea Foundation and Chair of ASCOBANS Working Group on Marine Debris, Netherlands
m.deruiter@noordzee.nl

Joan Drinkwin
Director of the Northwest Straits Foundation's Derelict Fishing Gear Removal Program, USA
drinkwin@nwstraits.org

Maria Cristina Fossi
Professor, University of Siena, Department of Physical, Earth and Environmental Sciences, Italy
fossi@unisi.it

Kirsten Gilardi
UC Davis Wildlife Health Center, USA
kvgilardi@ucdavis.edu

Chris Wilcox
Senior Research Scientist, Marine and Atmosphere Research Division, CSIRO, Australia
chris.wilcox@csiro.au

Christy Hudak
Associate Scientist, Provincetown Center for Coastal Studies, USA
chudak@coastalstudies.org

Peter Kershaw
Principal Research Scientist based at the Centre for Environment, Fisheries and Aquaculture, UK
peter.kershaw@cefas.co.uk

John Kieser
Environmental Manager Coastal Provinces and International Coastal Cleanup Coordinator-Plastics, SA, South Africa
John.Kieser@plasticssa.co.za

Scott Landry
Provincetown Center for Coastal Studies, USA
sclandry@coastalstudies.org

Jason Landrum
Fellow with the American Association for the Advancement of Science (AAAS), lead scientist with the Marine Debris Program, USA
jason.landrum@noaa.gov

Laura Ludwig
Project Director for Marine Debris, Provincetown Center for Coastal Studies, USA
lludwig@coastalstudies.org

Milton Marcondes
Brazilian Humpback Whale Institute, Brazil
milton.marcondes@baleiajubarte.org.br

David Mattila
Technical Adviser, Entanglement Response and Ship Strike Reduction, IWC Secretariat
david.mattila@iwc.int

Charles (Stormy) Mayo
Provincetown Center for Coastal Studies, USA
c.mayoiii@comcast.net

Michael Moore
Woods Hole Oceanographic Institution, MA, USA
mmoore@whoi.edu

William Nuckols III
Principal of W.H. Nuckols Consulting
will@whnuckolsconsulting.com

Cristina Panti
Post-doctoral Fellow, Department of Physical, Earth and Environmental Sciences, University of Siena, Italy
panti4@unisi.it

Tom Piper
KIMO International
tom.piper@kimo.shetland.org

Michela Podestá
Curator, Vertebrate Zoology Dept. (Mammals), Museo di Storia Naturale di Milano, Italy
michela_podesta@hotmail.com

Jooke Robbins
Provincetown Center for Coastal Studies, USA
jrobbins@coastalstudies.org

Cheryl Rosa
Deputy Director, US Arctic Research Commission, USA
crosa@arctic.gov

Teri Rowles
Coordinator, Marine Mammal Health and Stranding Program, NOAA-NMFS, USA
teri.rowles@noaa.gov

Lauren Saez
Contractor with Ocean Associates for NMFS, Southwest Regional Office, USA
lauren.saez@noaa.gov

Mark Peter Simmonds
Workshop Convener, UK
mark.simmonds@sciencegyre.co.uk

Monika Thiele
Convention on the Conservation of Migratory Species (CMS), Focal Point for North America and UNEP
monika.thiele@unep.org

Nancy Wallace
NOAA Marine Debris Programme Director and Division Chief, USA
nancy.wallace@noaa.gov

Mason Weinrich
Provincetown Center for Coastal Studies, USA

Tim Werner
New England Aquarium, USA
twerner@neaq.org

Tadasu Yamada
National Museum of Nature and Science, Japan
yamada@kahaku.go.jp

OBSERVERS

Regina Asmutis-Silvia
Whale biologist and Executive Director, WDC (USA)
regina.asmutis-silvia@whales.org

Andrew Daly
Administrator, WHOI, USA
adaly@whoi.edu

Michelle Evans
Australian Government Department of Sustainability (DSEWPue), Australia
Michelle.evans@environment.gov.au

Annex B

Agenda

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   - 1.2 Procedural matters
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   - 5.3 The application of quantitative field sampling techniques to investigate prevalence of marine debris in cetacean habitats, including seas
6. Population level impacts of marine debris
7. Cetaceans in freshwater habitats
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   - 9.2 Proposals for future actions by the IWC and opportunities for intergovernmental collaboration
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Report of the IWC Workshop on Mitigation and Management of the Threats Posed by Marine Debris to Cetaceans

Contents

CHAIR'S EXECUTIVE SUMMARY

The Workshop was held in Honolulu from 5-7 August 2014. Thirty-four participants from ten countries attended, including several from the Pacific region. The United Nations Food and Agriculture Organisation, the United Nations Environment Programme and its Convention for Migratory Species were all represented, as were relevant industry bodies and a number of non-governmental organisations concerned with marine debris.

The primary objectives of the workshop were to: (i) explore how the IWC can engage with the existing international and regional mitigation efforts concerning the management of marine debris; (ii) determine how best to ensure those efforts are informed by the growing understanding of the cetacean-specific impacts of marine debris; and (iii) advise on how best the IWC can lead/engage with action in regions where marine debris has the greatest potential impacts on cetacean populations.

The workshop reviewed initiatives from across the world to address marine debris in general and entanglement of cetaceans in particular, which was viewed as the greatest threat to these animals. These initiatives ranged from high-level agreements between countries to address the issue, to efforts in the field to remove materials directly from the seas and recycle or burn it for energy, to efforts to disentangle whales and other cetaceans snared in netting. The IWC is already highly active in this field and held a workshop on the assessment of marine debris impacts on cetaceans in May 2013 at the Woods Hole Oceanographic Institution [link] and also has a programme of work focused on responding to entangled whales. This initiative was begun by Norway, in partnership with Australia and the USA, and has included workshops in Maui in 2010 and Provincetown in 2011.

Important international initiatives have included *inter alia*:

(a) the 5th International Marine Debris Conference: Waves of Change; Global Lessons to Inspire Local Actions, from which came the 'Honolulu Strategy; A Global Framework for the Prevention and Management of Marine Debris' and Honolulu Commitment;

(b) The 2012 'Manila Declaration', which referenced the Honolulu Strategy and strongly endorsed UNEP GPA's mandate to continue its work on marine litter including the recommendation to create the Global Partnership on Marine Litter (GPML)[1] to promote implementation of the strategy;

(c) The formal recognition of the issue of marine debris at the inaugural UN Environmental Assembly Ministerial Meeting in June 2014;

(d) SPREP's new work on stranded cetaceans and programme of work with the IWC; and

(e) calls for action to reduce the incidental capture of whales in fishing gear at the UN General Assembly (UNGA) and by the Committee on Fisheries (COFI), most recently at its thirty-first session in Rome 2013.

In addition, the **Convention on the Conservation of Migratory Species of Wild Animal (CMS)** has a new Resolution on marine debris proposed for adoption at its conference of parties in November 2014 and the workshop also took note of the 'Untangled' symposium hosted by World Animal Protection (WAP) in Miami 2012.

The workshop received information about a number of topics from the assembled experts and it discussed these and generated a number of recommendations which are outlined below. The focal topics discussed included fishing gear marking, using practices in the USA as an example; potential gear modifications; methods for identifying debris hot spots; modelling approaches; work conducted on other species (principally the work of CSIRO in Australia on risk analysis for ingestion and entanglement in seabirds and turtles); debris ingestion; ALDFG; the role and responsibilities of MARPOL; the Nofir project for recycling fishing gear in Norway and elsewhere; the NOAA Marine Debris Programme and the Hawaii Marine Debris Action Plan; the Korean Gear Buyback Programme; the European Healthy Seas Initiative; the Philippines Net-Works programme; Ghost-Nets Australia; WAP's new Sea Change initiative; and the exemplary outreach work by Northwest Straits Foundation, UNEP and NOAA.

Conclusions and Recommendations

The Workshop **emphasised** that the issue of marine debris, while important for cetaceans, was a major environmental issue in its own right that was already the subject of a number of important international and national initiatives and that there is a need for a coordinating body to help bring these initiatives together. Any lack of strong evidence of quantified impacts for some cetacean species for some debris types at present should not preclude efforts to remove existing debris and prevent future accumulation in the marine environment. It also **agreed** that from an animal welfare perspective, the absolute number of cetacean entanglements and the associated suffering and times to death are unacceptable, irrespective of population level effects.

[1] *http://www.stapgef.org/stap/wp-content/uploads/2013/05/STAP-CBD-TS67-Debris-F-WEB.pdf*

The Workshop **agreed** that the IWC's primary contribution should be to ensure that cetacean-related issues are adequately represented within existing initiatives and that its strong scientific and other expertise is made available in collaborative efforts.

It **strongly recommended as the highest priority** that the IWC and its Secretariat work together with the Secretariats of the other major IGOS and RMFOs relevant to this issue to ensure consistency of approach, synergy of effort and exchange of information to develop appropriate mitigation strategies that recognise that (a) prevention is the ultimate solution but that (b) removal is important until that ideal is realised.

It also **recommended** that individual IWC member countries collaborate with such initiatives and that the IWC continues to highlight issues surrounding marine debris and cetaceans.

The Workshop also **recommended** that every effort is made to work with fishing, other relevant industries and NGOs as appropriate.

The Workshop also **recommended** that the IWC (and other IGOs) encourage their member states to review national level implementation of MARPOL Annex V and other conventions relevant to marine debris reduction. The IWC should **encourage** its members to prioritise the strategic use a range of measures to improve marine and terrestrial waste management, including national legislation and policy, stakeholder partnerships, industry training schemes and economic tools aimed at reducing public consumption of key types of debris such as packaging waste.

The workshop also made specific recommendations for collaboration with IMO (section 8.1.1) and SPREP (8.1.2) and **endorsed** the research recommendations from the previous IWC workshop on marine debris (IWC, 2013) and the recent Scientific Committee meeting (IWC, 2015 in press), including incorporation of data on marine debris into IWC national progress reports in a standard format and development of a global IWC entanglement database.

In addition the Workshop **recommended** that:

(a) a concerted effort be made to collect data using a standard approach that will allow a better assignation of entanglements;
(b) the IWC **encourages** COFI to complete its work on gear marking;
(c) the IWC **encourages** disentanglement and stranding teams to collect detailed information on entangling gear/material that is removed from whales, and on marine debris present in the immediate environment;
(d) the IWC Scientific Committee explores ways of combining estimates of oceanic debris and information on cetaceans to identify priorities for mitigating and managing the impacts of marine debris on cetaceans;
(e) the IWC continues to support and develop its disentanglement network, and carefully considers incorporating the issue of all marine debris into the initial training programme component of the disentanglement training. It **stresses** the importance of involving the local fishing communities in the training;
(f) the IWC promotes and shares the model of expert training/capacity building into existing marine debris initiatives including the Global Partnership on Marine Litter as well as at the national level;
(g) the IWC Secretariat examine ways in which it and its member nations can most effectively communicate the workshop's recommendations to the relevant target audience(s), including considering highlighting the IWC's work on the impacts of marine debris on cetaceans at meetings of other IGOs e.g. the forthcoming COFI in 2016; and
(h) the IWC develops improved methods to **encourage** its member nations and others to provide the marine debris related data discussed in this report and to provide progress reports on their work on marine debris as part of their national conservation reports.

Finally, the Workshop **endorsed** the forthcoming IWC workshop (anticipated March-April 2016) on prevention of the incidental capture of cetaceans. It **agrees** that this should incorporate entangling debris as well as in-use gear. It **reiterates** the importance of ensuring participation of experts from industry and relevant IGOs especially FAO and the Workshop **encouraged** all members and non-members of the IWC to take advantage of the IWC disentanglement network especially in those regions where entanglement represents a threat at the population level (e.g. Western Pacific, Eastern South Atlantic, and Arabian Sea).

1. INTRODUCTORY ITEMS

The Workshop was held at the Ala Moana Hotel, Honolulu from 5-7 August 2014. The list of participants is given as Annex A.

1.1 Welcoming comments

Mark Simmonds, Workshop Convenor, welcomed participants to the meeting, and thanked them for persevering in the face of Hurricanes Iselle and Julio.

Nancy Wallace welcomed everyone to Hawaii on behalf of the hosts, NOAA. She was pleased that the Workshop had a good mix of experts from many different areas to discuss the issue of marine debris. She hoped that the experience of all of these people should bring some strong recommendations from the meeting, which will be taken forward to the IWC meeting in Slovenia. This is the second IWC marine debris workshop and she hoped that this one will follow the good work of the first.

Greg Donovan welcomed and thanked the participants on behalf of the IWC. He was especially pleased that so many experts from a variety of backgrounds were able to attend. The Workshop would not have been possible without the financial and practical assistance of a number of organisations in addition to the IWC. As well as thanking NOAA for hosting the meeting, he thanked Ocean Care, World Animal Protection, EIA, Humane Society International, NOAA, the US Marine Mammal Commission and the Government of the United Kingdom for financial assistance.

He emphasised that the issue of marine debris and cetaceans is multi-dimensional and that the IWC recognises that dealing with it requires considerable co-operation amongst intergovernmental organisations, governments, industry and non-governmental organisations. In terms of the contribution of the IWC to this effort, he noted two important areas. The first is the expertise residing within its Scientific Committee, especially in the context of: (a) modelling populations and human activities to determine priorities for action from a conservation perspective; (b) evaluating potential and actual mitigation measures; and (c) long-term monitoring of cetaceans. The second area concerns the welfare of individual animals independently of the conservation status of the population to which they belong; at present the IWC has focussed on entanglement in fishing gear.

He stressed that the present Workshop was aimed at trying to develop: (1) practical conservation and management actions based upon the available evidence; and (2) mechanisms to improve the scientific basis for action where this is lacking. Clearly the Workshop cannot solve the many issues surrounding this issue now but in the time available it is important to try to develop a framework and strategy to focus multidisciplinary international efforts in the future.

1.2 Appointment of Chairs and rapporteurs

The overall Chair was confirmed as Mark Simmonds. Several participants led the discussions for different topics as indicated under the relevant Agenda Items. Cooke, Donovan and Mattila were appointed as rapporteurs. It is important that the report is completed in a timely manner for presentation to and consideration by the IWC at its meeting in September. It was clarified that the report of the Workshop was a report of the discussion of the participants; the views and recommendations it contains are not necessarily those of their institutions or organisations. Of course the relevant bodies may endorse the completed report if they choose.

1.3 Objectives of the Workshop

The Workshop will:

(a) explore how the IWC can engage with the existing international and regional mitigation efforts concerning the management of marine debris;

(b) determine how best to ensure those efforts are informed by the growing understanding of the cetacean-specific impacts of marine debris; and

(c) advise on how best the IWC can lead/engage with action in regions where marine debris has the greatest potential impacts on cetacean populations.

The Workshop will also provide advice to the IWC with respect to a possible future Conservation Management Plan (CMP) for future work on marine debris.

1.4 Adoption of Agenda

The adopted agenda is given as Annex B. A list of acronyms used is given as Annex C.

1.5 Available documents and list of acronyms

Documents were distributed in advance of the meeting and made available on the One Drive online system. A list of documents made available to the Workshop and/or cited in this report is given as Annex D.

1.6 Review of previous IWC work

1.6.1 Overview of the first IWC workshop on marine debris and review of progress of recommendations

The IWC Scientific Committee's sub-committee on environmental concerns has been receiving information on entanglement and ingestion of marine debris for several years. The issue has been growing in importance in recent years, led by such people as David Laist, a participant at the present workshop. Simmonds provided an overview of the report of the first IWC workshop on marine debris which was held at the Woods Hole Oceanographic Institution in May 2013 (IWC, 2014a). Thirty-eight participants from eight countries had attended.

In summary, Simmonds concluded that the Woods Hole workshop was successful and had identified the scale of the marine debris problem and the need for improved international cooperation. The issue of microplastics was particularly mentioned. The workshop had recommended that industry should be involved in solving the issue and had made a number of recommendations that were endorsed by the Scientific Committee (IWC, 2014b, pp.18-19).

The first day of the Workshop included a public seminar consisting of keynote presentations which illustrated the ways in which debris and cetaceans interact, including the long lingering deaths that can result from entanglement, and a growing realisation that ingestion of plastics (including microplastics) may be a significant problem, and several approaches to evaluating the risk this problem might pose (e.g. Wilcox *et al.*, 2013). It was noted that 280 million tonnes of plastic were produced globally, less than half of which was consigned to landfill or recycled. If current rates of consumption continue, the planet will hold another 33 billion tonnes of plastic by 2050. The keynote presentations also highlighted the need for improved international cooperation.

The first Workshop identified the potentially significant impact that marine debris has on both cetacean habitat and the animals themselves through interactions both with macrodebris (such as fishing gear, plastic bags and sheeting) entanglement and ingestion and through microplastics (such as plastic particles added to cosmetics and the pellet form of raw plastics) and their associated chemical exposures through ingestion or inhalation. While ingestion and inhalation of marine debris may sometimes be lethal, sub-lethal impacts may also occur with long-term negative consequences. Intake of debris may be a problem, both as an individual welfare concern and potentially for some populations and species. More research was encouraged and it was recommended that industry partners be involved in marine debris prevention, research and response to ensure success in reducing marine debris impacts on cetaceans.

The first Workshop made many recommendations and concluded that the IWC Scientific Committee should evaluate the risks of ingestion and inhalation based upon: (1) the spatial distribution of microplastics and macro debris; and (2) the feeding strategies and location of feeding areas of cetaceans. It also recommended that the Scientific Committee prioritise studies of those cetaceans that are likely at greatest risk of ingesting or inhaling macro- and microdebris and associated pollutants (e.g. Fossi *et al.*, 2012).

The IWC Scientific Committee reviewed the workshop report at its May 2014 meeting and endorsed its recommendations (see IWC, 2014c), including its recommended pathology protocol and the full Scientific Committee **agreed** that:

> (1) legacy and contemporary marine debris have the potential to be persistent, bioaccumulative and lethal to cetaceans and represent a global management challenge; and
>
> (2) entanglement in and intake of active and ALDFG (abandoned, lost or otherwise discarded fishing gear) fishing gear and other marine debris have lethal and sub-lethal effects on cetaceans.

The Committee had strongly agreed that marine debris and its contribution to entanglement, exposures including ingestion or inhalation, and associated impacts, including toxicity, are welfare and conservation issues for cetaceans on a global scale and a growing concern.

The Committee had recommended that the Commission and the Secretariat take prompt action to help better understand and address this growing problem, including:

> (1) providing data on rates of marine debris interactions with cetaceans into the national progress reports and supporting the second marine debris Workshop (which will have mitigation and management as its focus);
>
> (2) strengthening capacity building in the IWC entanglement response curriculum and adding information on marine debris;
>
> (3) building international partnerships with other relevant organisations and stakeholders including an effective transfer of information about on-going research and debris-reduction and removal programmes and the international and national marine debris communities;
>
> (4) developing programmes to remove ALDFG gear and schemes to reduce the introduction of new debris; and
>
> (5) incorporating consideration of marine debris into IWC conservation management plans where appropriate and to consider making it the focus of a plan in its own right.

It was noted that the national IWC Progress Reports now include reporting of data on marine debris, entanglement and ingestion, which could be used as the beginning of a wider marine debris database. The issue of CMPs is discussed under Item 8.

1.6.2 Overview of previous IWC whale disentanglement workshops (Maui 2010; Provincetown 2011)

Mattila provided an overview of two recent IWC workshops on the topic of large whale entanglement that can occur wherever fishing gear and whales overlap. He noted that, almost since its inception, the IWC had recognised the need to understand and quantify whale bycatch, through the work of its Scientific Committee. Recently, the Commission's Working Group on Whale Killing Methods and Associated Welfare Issues has recognised the sometimes severe welfare issues that can be associated with whale entanglements, as the average time to death for an entangled North Atlantic right whale was estimated to be six months (Moore *et al.*, 2006). Given this, Australia, Norway and the USA proposed a workshop, hosted by NOAA in Maui, in 2010, which looked at the scope and impacts of the entanglement issue, as well as what countries were doing in response, including rescue programs and consideration of euthanasia (IWC, 2012). That workshop agreed that the issue was both a conservation and animal welfare issue; that it occurs wherever whale distribution overlaps with rope and net fisheries; and that, given its cryptic nature and most country's lack of reporting infrastructure, it is often severely under-reported. The workshop reviewed existing euthanasia/rapid killing techniques and developed a decision tree for responding to reports of entangled whales. It also produced several recommendations, including the following three priorities: (1) building capacity for entanglement response in countries where it does not exist; (2) encourage better and more widespread data collection; and (3) work toward preventing entanglements.

In order to follow up on the first workshop's success and recommendations, Australia, Norway and the USA proposed a second workshop, hosted by the Center for Coastal Studies in Provincetown, MA, in 2011 (IWC, 2013). That workshop focused on: updating new information; developing consensus principles and guidelines for safely responding to entanglements; developing a strategy and curriculum for capacity building on the issue; and the formation of an expert advisory group to the IWC. All of these goals were accomplished and the consensus 'principles and guidelines' can be found in English, French and Spanish on the IWC's website[2], along with information about a recent capacity building and the members of the expert group. To date, the IWC, with support from the USA (NOAA), UNEP-CEP-SPAW, SPREP, CPPS, World Animal Protection and other NGOs, along with the support of many of the countries for which training occurs, has provided the capacity building training for over 350 participants in approximately 18 countries. A key driver of the work is the need to emphasise the danger to humans of well-intentioned disentanglement attempts by non-trained persons.

In discussion, it was noted that the IWC's capacity building initiative requires that it is undertaken with the approval (and often financial or in-kind support) of the country in which training is taking place. Fisheries, Marine Parks or Environment agencies are often involved in the programme. The trainees, who are chosen by the respective government in light of certain criteria may be a mix of natural resource personnel, eco-tour operators, fishers, Navy personnel, scientists, etc. With respect to targeting fishers specifically, it was noted that as an individual fisher rarely encounters an entangled whale, they would often prefer to call the 'experts' when necessary. Entanglement can create economic hardship, as whales can destroy gear resulting in the need for gear replacement and lost fishing time. This may be particularly true in artisanal fisheries in developing countries.

The entanglement workshops both emphasised that prevention and mitigation is a far better solution than disentanglement. However, in smaller populations, e.g. North Atlantic right whales, disentanglement is still important as each individual counts towards the population or species survival. Until there is a preventative solution, people will attempt to release entangled whales, whether it is an artisanal fisher trying to recover his gear, or a well-meaning member of the public. This can have serious negative results for both the rescuer and the whale.

It was noted that the IWC approach to entanglement training has been very successful. It was suggested that the same approach might be replicated for capacity building about marine debris, involving interested people in different countries in the same way to develop national or regional marine debris prevention, removal and general outreach programmes. This is discussed further under Item 8.4.

The present Workshop noted a number of components that a broader marine debris related capacity building programme might contain: (a) establishment of an expert steering committee to guide the development of a national or regional initiative; (b) provision of support staff by national or other concerned international or non-governmental organisations to support training; (c) a compilation and review of relevant literature; (d) identification of successful models and methods already available and the reasons for their success; (e) preparation of curricula and advice for trainers; and (f) holding workshops to train, advise, or otherwise assist staff of national or regional agencies and organisations.

It was noted that in some countries (e.g. USA) fishers are required to have basic equipment on board for releasing protected species when they become entangled. This is particularly true for small cetaceans and turtles, but the guidance does include minimal suggestions when large whales are encountered. While this may correctly emphasise safety it may often lead to an 'incomplete' disentanglement with negative consequences for the whale and future disentanglement efforts by trained personnel.

[2] *http://iwc.int/best-practice-guidelines-for-entanglement-response*

It was further noted that most documented cases where the material that entangles whales can be determined, involve a wide variety of passive fishing gear that is in use (as opposed to ALDFG), including pots, traps, gillnets, longline, etc. Any rope, net, or other material that can 'wrap', which is suspended in the water column is a potential threat.

1.7 Overview of relevant recent non-IWC meetings

1.7.1 Overview of the 2012 'Untangled' global symposium hosted by WSPA (now WAP) in Miami.

Bass described the 'Untangled' report, and the symposium hosted by World Animal Protection (WAP) in December 2012[3]. The report reviewed and synthesised the available published and grey literature describing and quantifying the impact of marine debris on animals, and the symposium provided more than 60 experts in marine debris monitoring and mitigation efforts with a platform to discuss priority problems as well as to propose effective solutions. The solutions identified for the priority problem of ALDFG included the following approaches: legislative (e.g. education/enforcement of MARPOL Annex V, regulatory controls on over-setting of traps); technological (e.g. gear modifications, gear marking); social (e.g. training fishers on safe and humane disentanglement techniques for seals, turtles etc. and/or making them aware of trained disentanglement experts to call upon in the case of entangled whales); and economic (e.g. fishing for litter/nets schemes, low-cost loans to replace gear more regularly, involvement of the seafood retail sector in meeting some of the costs of mitigation measures, and net deposit/net buy-back schemes).

Each of the three study areas has problems associated with it. Solutions talked about at the symposium included: creation of global entanglement networks; involving marine users; lobbying for fishery best practice to be made law; and the creation of local training networks. It is important to involve fishing communities at all levels. Legislation could be improved. Technology to enable animals to escape and to track missing gear could be used. Training for fishers in how to release entangled animals could be expanded. It was noted that any solutions have to work economically for fishers.

The Sea Change campaign came out of this symposium (see Item 3.1.2.8).

1.7.2 Overview of UNEP, CMS, and CBD activities on marine debris

To further help put the work of international conventions and inter-governmental organisations into context, Thiele presented a short overview of some of the global agreements and progress in addressing marine debris over the last three years. In 2011, UNEP and NOAA hosted the 5th International Marine Debris Conference: *Waves of Change; Global Lessons to Inspire Local Actions* (Honolulu, HI) which brought together 500+ experts in marine debris from around the world and across stakeholder groups—from practitioners to policy-makers, to scientists and academia, and from the private sector to the arts community. Outcomes included the *'Honolulu Strategy; A Global Framework for the Prevention and Management of Marine Debris'* and the complementary *Honolulu Commitment.* In January 2012, at the Intergovernmental Review of the Global Programme of Action for the Protection of the Marine Environment from Land based Activities (GPA) in the Philippines, government representatives of 64 countries and the European Commission signed the 'Manila Declaration' which referenced the Honolulu Strategy and strongly endorsed UNEP GPA's mandate to continue its work on marine litter, including the recommendation to create the Global Partnership on Marine Litter (GPML)[4] to promote implementation of the strategy.

During 5IMDC (20-25 March 2011, Honolulu, Hawaii) a workshop was hosted by the Scientific and Technical Advisory Panel (STAP) of the Global Environment Facility (GEF) which brought together industry experts and scientists to work on defining solutions for addressing plastics in the marine environment (see the report on '*Marine Debris as a Global Environmental Problem; Introducing a solutions based framework focused on plastic*[5].') This report was formative in getting the Global Environment Facility (GEF) to incorporate the issue of marine debris, particularly plastics and the emerging issue of microplastics as a priority in their GEF6 Funding Strategy.

Another positive global advancement of the marine debris issue was reached at the UN Conference on Sustainable Development (known as Rio+20), hosted in Rio de Janeiro in June 2012. The final Outcome Document called '*The Future We Want*'[6] specifically referenced marine debris and implementation goals of the Honolulu Strategy, which further strengthened UNEP's mandate to work on this important issue. Most recently, at the inaugural UN Environmental Assembly Ministerial Meeting in June 2014, the issue of marine debris was formally recognised in a new UNEP Resolution. This resolution on marine plastic debris and microplastics welcomes the work undertaken by the IWC on assessing the impacts of marine debris on cetaceans and the work of UNEP and CMS and *inter alia* encourages Governments and the private sector to promote the more-resource-efficient use and sound management of plastics and microplastics and encourages Governments to take comprehensive action to address the marine plastic debris and microplastic issue through, where appropriate, legislation, enforcement of international agreements, provision of adequate reception facilities for ship-generated wastes, improvement of waste management practices and support for beach clean-up activities, as well as information, education and public awareness programmes.

[3] The Untangled report and symposium proceedings outlining the full suite of priority problems and proposed solutions can be downloaded at *www.worldanimalprotection.org/sea-change.*
[4] *http://www.stapgef.org/stap/wp-content/uploads/2013/05/STAP-CBD-TS67-Debris-F-WEB.pdf*
[5] *http://www.stapgef.org/stap/wp-content/uploads/2013/05/STAP-CBD-TS67-Debris-F-WEB.pdf*
[6] *http://www.unep.org/rio20/*

UNEP's Regional Office for North America, in partnership with the Natural Resources Defense Council, has also built on outcomes of 5IMDC by working on marine plastic pollution from an upstream, preventative approach, investigating policy and legal solutions that include private sector engagement on topics such as Life-Cycle Management and Extended Producer Responsibility (EPR)[7].

Thiele gave a presentation about the Convention on Migratory Species (CMS) providing a short overview about the treaty and specific recommendations for addressing marine impacts on marine migratory species emanating from a 2014 Marine Debris Assessment Report that was commissioned by the CMS Scientific Council, in response to CMS Resolution 10.4 on Marine Debris which was adopted at COP10. COP11 will take place in Quito, Ecuador this year from 4-9 November and a new resolution on Marine Debris Management will be proposed. Participants are invited to participate and send in proposals for side events that might help raise attention and support for CMS marine debris efforts.

As background, the IWC and CMS formalised a partnership arrangement in 2001 which established a framework for consultation and information sharing between the Conventions and national institutions of respective contracting parties. She suggested that it might be timely to update and renew that MoU. While the present IWC workshop is focused on marine debris and impacts on cetaceans, CMS works to address marine debris impacts across all affected migratory marine species (marine mammals, seabirds, marine turtles, sharks) covered in CMS Appendix I or II.

The CMS Marine Debris Assessment (2014) was conducted to review marine debris across three major categories: (1) information gaps in management of marine debris impacts on migratory species; (2) commercial vessel best practices; and (3) effectiveness of public awareness and education campaigns. Outcomes of this three-part report have been used to shape a new resolution on marine debris management which will be considered at COP11 (UNEP/CMS/ScC18/Doc.10.4/Rev.2). Major outcomes and recommendations from the report were shared for IWC consideration.

Major outcomes from Report I included: establish monitoring programmes using standardised methods to assess the prevalence of debris that may have impacts on migratory species; identify sources, pathways and distribution of such debris; assess impacts and population level effects on migratory species; implement cost-effective measures for the prevention of debris; apply targets within national marine debris management strategies with national reporting obligations to COP; encourage prioritisation of research into the effects of microplastics; and explore of linkages with other biodiversity-related agreements via multilateral working groups (e.g. IWC Scientific Committee, CBD, IMO, FAO). The report also recommended that CMS establish a marine debris working group to develop the Convention's marine debris work.

Priority recommendations from Report II on commercial vessel best practices included: close gaps in international legislation such as MARPOL Annex V concerning fishing vessel exemptions based on vessel size; address the issue of ALDFG building on the Honolulu Strategy and the FAO Code of Conduct for Responsible Fisheries; encourage the use of market based instruments to deter commercial ships from disposing of garbage at sea; encourage the promotion of ship operator awareness measures; invite UNEP to continue its leading role in coordinating stakeholder engagement and implementation of best practices; and encourage the shipping industry to support these measures.

Report III on public awareness campaigns recommended the following actions to CMS: encourage Parties to refer to existing successful campaigns to promote positive responses especially behavioural change; collaborate with other organisations and industry on awareness campaigns; evaluate awareness campaigns to determine success and identifying improvements for future campaigns.

Thiele noted that recommendations relevant to the IWC included: promote synergies between international bodies (e.g. CMS, Regional Seas Conventions, CBD, IWC, IMO, FAO, ISO) and more specifically to consider the creation of an inter-convention working group; create innovative partnerships and stakeholder engagement opportunities to address marine debris across key industries; improved research to better understand and prioritise problems and serve as a scientific information platform; and identify upstream preventative measures to keep waste from entering the marine environment.

Thiele also took the opportunity to reference activities of the new CMS-Abu Dhabi office, represented by Ms. Donna Kwan. The Office was set up under the Environment Agency of Abu Dhabi (EAD) which provided funding and technical support to coordinate the MoU on the Conservation and Management of Dugongs and their Habitats throughout their Range; the MoU on the Conservation of African-Eurasian Migratory Birds of Prey and to provide support to conserve other regionally important marine species (e.g. marine turtles, inshore dolphins, sharks, large cetaceans). Marine species entanglement in fishing gear is well known issue, but not well documented with the exception of dugongs in UAE or sea turtles in Oman. CMS Abu Dhabi welcomes support from the IWC to better understand other types of marine debris impact on species beyond dugongs and sea turtles in that region. Such knowledge would help inform the regional policy and regulatory framework as well as management and decision frameworks in the region.

Meanwhile, UNEP administers the **Convention on the Conservation of Migratory Species of Wild Animal (CMS)**, which has a new Resolution on marine debris currently under review and proposed for adoption at CMS COP11 (Ecuador,

[7] *http://rona.unep.org/about_unep_rona/marine_litter/index.html*

4-9 November 2014). This Resolution builds on the direction of CMS Resolution 10.4 on Marine Debris (adopted at COP10 in 2011), but with more focus on the management aspects, drawing from recommendations presented in a three-part assessment report CMS produced on: (1) Knowledge Gaps in Management of Marine Debris; (2) Commercial Marine Vessel Best Practice; and (3) Recommendations for Public Awareness & Education Campaigns.

In absence of a CBD representative at this IWC Workshop, Thiele shared some updates from the CBD decision on marine debris. This decision emanated from recommendations in a technical progress report delivered to the Parties (shared at SBSTTA 18 May 2014), which officially noted: *"CBD recognizes marine debris is an increasing threat to marine and coastal biodiversity..... Entanglement or ingestion by birds, turtles, fish and marine mammals is well documented and has shown to be fatal to a number of species... Analysis of best practices and experiences in mitigating the impacts of marine debris on biodiversity would help to inform global policy making"*

Thiele noted that in support of CBD Aichi Biodiversity Targets 8 and 10, a formal decision was made at CBD CoP11/Decision18 that addressed impacts of marine debris on marine and coastal biodiversity. The Decision formally requested the CBD Executive Secretary to collaborate with Parties, other Governments, relevant organisations and indigenous and local communities to: (a) provide info on the impacts of marine debris on marine and coastal biodiversity and habitats; (b) compile and synthesise submissions as input to an expert workshop; and (c) organise an expert workshop to prepare practical guidance on preventing and mitigating the significant adverse impacts of marine debris on marine and coastal biodiversity and habitats that can be applied by Parties and other Governments (Dec 2014). She suggested the IWC might consider participation at this December workshop to relay the outcomes of the present workshop and to help ensure synergies with the IWC.

In discussion it was noted that the activities and recommendations from these UN bodies and reports are largely aimed at a high level, i.e. at governments. One participant inquired about examples of actual implementation on the ground of some the recommendations. While it was acknowledged that these UN recommendations are generally aimed at designing global frameworks for implementation by national governments, convention parties, and on the ground partners (e.g. NGOs, academia, stakeholders), and that implementation can seem like a slow process when dealing with inter-governmental agencies, it was noted that there are some good examples of uptake and implementation on a region to region basis. For example, the Regional Seas Programs have adopted marine debris monitoring and response recommendations with OSPAR having just announced the first new Marine Debris Management framework[8].

1.8 Conclusions and recommendations

The Workshop welcomed information on IWC and non-IWC initiatives. It stressed that the global reach of stakeholders focusing on the marine debris issue reinforces the importance of the IWC collaborating with other organisations and initiatives on this issue (see Item 8.1).

2. OVERARCHING ISSUES

2.1 Clarifying marine debris terminology

Wallace briefly outlined the NOAA legal definition of 'marine debris':

Marine debris is defined as any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment.

The Workshop **agreed** to use this as a working definition for the present report, noting that UNEP uses the word 'litter' to mean the same thing as 'debris'. It was noted that for practical purposes, macrodebris can be considered to be anything over 5mm whilst microdebris is anything under 5mm.

It was noted that with respect to fishing gear a number of different terms have been used to distinguish fishing gear that is being used (operationally active) by fishermen and gear that has been abandoned, lost or otherwise discarded. It was agreed that for the present report, the former would be called 'both commercial and other active fishing gears' or COAFG and the latter would be called 'abandoned, lost or discarded fishing gear' or ALDFG. It was noted that use of the term 'active' by itself can be ambiguous since it could be interpreted as mobile fishing gear such as trawls and dredges.

In addition, it was noted that 'wet-stored' gear (gear stored in the water rather than hauled and stored on land during non-fishing seasons) did not fit any of the descriptive gear categories of actively fished, abandoned, lost or discarded gear types. Depending on the regional use of wet storage, the possibility that it should perhaps be considered a separate category was raised although the point was also made that the legal ownership of the gear resides with the holder of the fishing license for such gears and while it might not be operationally active for the target species, it was still operationally active with potential for ghost fishing and entanglements.

In order not to confuse the general concept of bycatch used by FAO (see Item 3.1.1.1), it was **agreed** to use the term 'incidental capture' when referring to cetacean entanglements in fishing gear.

[8] *http://www.ospar.org/content/news_detail.asp?menu=00600725000000_000023_000000*

2.2 Improved data collection (including retention/identification of gear from cetaceans)

Saez gave a presentation on gear marking (i.e. labelling gear so that it is identifiable to some degree that may range from individual fisherman to gear type) and experiences from the USA in this regard. As identified in the previous workshop, data collection from entangling gear is an important factor for identifying and understanding the source. If the gear is traceable, it can first be classified as fishing gear or non-fishing gear, and then further studied to understand the factors leading to the entanglement. Traceability allows for more informed management that may reduce the risk of entanglements before they happen. In the case of fishing gear, traceability to the fishermen through gear marking can provide information on where and when the gear was set, if it was COAFG or ALDFG, which fishery (commercial or recreational), and provide insight on the gear configuration. Gear identification creates an opportunity for communication with the fisherman, who can provide useful information for 'real-time' entanglement response as well as long-term solutions. If possible, gear should be collected for further analyses (IWC, 2013).

As an example of the merits of gear marking, Saez noted that the California, Oregon and Washington Dungeness crab trap fisheries, the largest trap fisheries off the US west coast, marks individual traps as part of a trap limit system. Fishermen are allowed to apply for replacement tags for up to 10% of their trap allotment. Through this system, the state fishery management can quantitatively measure the (reported) trap loss. These may not be 'problem' fisheries with the highest gear loss, but marking through a trap limit system provides an example of a way gear loss can be tracked.

Saez also reported on a recent whale entanglement in California that highlights the information that can be gleaned with traceable gear marking. On 30 June 2014, a highly degraded humpback whale fluke was found off San Clemente Island in southern California wrapped in commercial fishing line and five fishing buoys. The buoys were marked with commercial fishing license numbers and also California Dungeness crab buoy tags. The gear markings allowed for contact with the owners of the two sets of gear, through the California Department of Fish and Wildlife. The fishermen stated that they had set their gear off the San Francisco area and had lost their gear at the end of March or April. The fluke was found over two months later and approximately 360 n.miles south of the original gear set location. The buoy tags were industry initiated and implemented in California in 2013 as part of a trap limit system.

She noted that whilst gear marking is used by fishermen to locate their gear, in order for others to be able to identify gear to the fishery, there needs to be some form of standard marking that is searchable. Ideally, there will be a central location where data is held. In terms of development of a lost or found fishing gear reporting system or structure, there are existing models available (e.g. fish tagging studies and reporting of caught tagged fish[9], or pinniped tag databases that allow researchers to look up sizes and colours of tags observed on pinnipeds) that should be investigated before a system is built from the ground up.

The Workshop **welcomed** information of this national initiative. It encouraged similar schemes, especially for fisheries for which it was known or suspected that large whale entanglement is a risk. In discussion, it was **agreed** that there are considerable advantages in gear marking from a cetacean incidental capture perspective. For example it allows important information on incidental capture and factors related to gear including: gear types, loss rates of the various gear types, the persistence of ghost gear by type as a threat in the water column, and the origin of ALDFG. This information is particularly important in assisting in quantifying incidental captures by gear type and in assisting with developing mitigation measures and priorities.

The Workshop noted that the issue of gear marking was one that was being taken up by the fishing sector and fisheries management for their own purposes. The topic has been under consideration by FAOs Committee on Fisheries (COFI) from a fisheries management perspective including deterrence/detection of IUU fishing activity.

It was suggested that that even a 'low-tech' gear marking scheme in combination with examinations of gear removed from whales might be particularly important to resolve three key questions: (1) the region in which gear is set; (2) the fisheries from which the gear came (e.g. traps vs gillnets); and (3) the part of fishing gear from which it came (e.g. buoy lines vs. groundlines between traps). Related issues that could be considered, included placing simple generic marks (e.g., painted or tape bands of specific colours or colour combinations) at strategic points on fishing gear; this is quite different from gear tagging (which includes placing coded information in more sophisticated formats on gear to identify individual fishermen). Consideration should also be given to appropriate intervals for marks to be placed. For example, typical lengths of line found on and removed from entangled whales would suggest intervals of every 30 to 40m. Marks would need to be broad enough (e.g. 30cm or 1ft long) to be visible from boats 100m or more away or from aerial photographs of entangled whales. Such a system is currently being developed by the National Marine Fisheries Service for trap and gillnet fisheries along the US east coast to improve information on the sources of lines removed from North Atlantic right whales and humpback whales.

Rather than trying to make any specific recommendations here, however, it was **agreed** that probably the most productive approach was for the IWC to participate in relevant IGO fisheries discussions to raise awareness on the merit of gear marking to reduce the incidental capture of cetaceans (see the recommendation under Item 8.2.1). Technical details on implementation of a gear marking scheme are beyond the scope of the present workshop. The Workshop **proposed** that appropriate IWC experts participate in any future IGO workshops on gear marking to ensure that issues surrounding

[9] *https://www.vasaltwaterjournal.com/report_tagged_fish.php. http://www.fishtag.info/index.htm*

cetacean entanglement are adequately addressed. The Workshop also **agreed** that the matters of compliance and reporting are extremely important, either separately or as part of discussions surrounding any future scheme or schemes.

The Workshop **agreed** that although there is clear value in a standardised global marking system, it was important to recognise that approaches that may be appropriate in developed large scale fisheries may be impractical or economically infeasible in artisanal fisheries or fisheries in the developing world. Similarly, the value of a centralised global database (or perhaps regional databases) for gear and the reporting of lost gear was recognised. However, it was again **agreed** that this was beyond the scope of the IWC.

A recommendation on gear marking can be found under Item 8.2.1, whilst the reporting of ALDFG is considered under Item 3.1.1.3.

On the more generic issue of determining the origin of floating or drifting ALDFG, the Workshop noted that studies of prevailing oceanographic conditions can be valuable as shown in the studies by Hardesty and Wilcox (2011) and Wilcox *et al.* (2013) off northern Australia.

2.3 Identifying hotspots of debris (geographically, temporally and within the water column)

2.3.1 Technological data collection e.g. use of Synthetic Aperture Radar, deep sea surveys

The Workshop briefly considered the use of technology to detect ALDFG and other large marine debris. This could be useful, for example in detecting areas where gear and other debris might collect in order to focus clean-up work[10].

The Workshop noted that the logistical difficulty (in terms of cost and asset access) of accessing open ocean areas with aerial or vessel surveys, have meant that use of satellite sensors provides a valuable potential opportunity for targeted detection attempts in remote areas. Satellite sensors can offer both broad coverage and increasingly fine resolution; commercially available high-resolution visual and multispectral data can be in the 0.5-5m range. However, satellite detection and identification of debris type has proved to be difficult given the diversity of debris objects in size, shape and colour, as well as limitations of snapshot satellite data in reliably differentiating debris from active vessels, sea-state features, or floating aquatic vegetation.

ALDFG nets provide additional challenges in detection. A primary difference between detecting nets and other debris is that nets present a very dynamic and generally small target at the surface with the majority of the net underwater. The portion of the net that is at the surface is typically awash, and non-contiguous (with water showing through the holes in the mesh). With the highest resolution commercially-available satellite data being 0.5-5m per pixel, identifying individual solid objects from a few pixels is challenging. Taking into account that nets do not reliably present a solid, contiguous target at the surface, reliable detection and identification of nets is a further challenge. There have been two *in-situ* detection tests to evaluate the capability of multiple satellite sensors (SAR, multi-spectral and panchromatic visual) to detect nets deployed from vessels off Hawaii, first in 2006 and again in 2012 but neither was successful in identifying nets in satellite collected data thus far. In the Ghostnet Project, satellite data was used to detect oceanographic features (e.g. ocean current convergence zones or straits) that had the potential to aggregate debris, such as nets, which were later overflown as part of an aerial survey collecting visual/photographic data.

NOAA and other groups are continuing to evaluate and pursue methods to expand and improve both detection of debris and modelling of likely debris accumulation areas on shore and in the open ocean. Improvements in these capabilities can help build our understanding of ALDFG gear behaviour and inform prioritisation of efforts to address its impacts.

The Synthetic Aperture Radar (SAR) system is an airborne system that can be used to produce images at sufficient resolution to identify large debris. However it is an expensive process and experimental use by NOAA found that it was most useful if other means were used to narrow down the area to search. Other potential technologies referred to included use of reflectance micro-Fourier-transform infrared spectroscopy to detect microplastic concentrations and a new type of passive sonar (Subsea Asset Location Technologies or SALT) originally developed for military use. It was also noted that side-scan sonar can detect ALDFG under the proper environmental conditions (e.g. flat bottom with low natural variability).

2.3.3 Modelling approaches (e.g. cetacean and debris (lost gear/other debris) co-occurrence; fishing effort modelling)

One of the important areas of expertise of the IWC Scientific Committee is the use of modelling in a management context that takes inevitable scientific uncertainty explicitly into account. Donovan briefly introduced the work of the Committee in this regard, noting that there are the following major broad uses in a management context: (1) population modelling used to examine the status of whale populations and predicting future trajectories in the light of known and projected human activities and taking uncertainty explicitly into account (in effect these can also be considered risk analyses); (2) habitat and spatial modelling to examine geographical and temporal density distributions of populations for comparison with similar models of actual and potential threats to determine high risk areas ('hot spots'); and (3) a combination of

[10] A special issue of *Marine Pollution Bulletin* (Vol.65, Issues 1–3, 2012) edited by K. McElwee, C. Morishige and M. Donohue was dedicated to 'At-sea Detection of Derelict Fishing Gear'

modelling approaches to evaluate the effectiveness of actual and potential mitigation measures. In all cases, modelling approaches can be valuable in highlighting priorities for future data collection.

Models are a valuable tool to: (1) assess status as a means of determining population level priorities; (2) examine uncertainty by considering plausible scenarios consistent with available data; (3) identify which data gaps are most important in a management context; and (4) develop hypotheses and predictions arising out of those that can be tested by the collection of targeted data. Experience has shown that the relationship between models and data is an iterative process – initial models may be based on relatively few data and highlight which data gaps are important in a management context. It is important to note that these initial modelling efforts with poor data are rarely suitable as the basis for management. However, they have great value in allowing focussed data collection such that more refined models can be developed and the range of management implications narrowed to allow more targeted management actions with a sound scientific basis.

In terms of data requirements, the types of information required for human activities and cetaceans are broadly similar, e.g. overall abundance and trends, density and abundance at appropriate geographical and temporal scales, movements and behaviour, etc.

With respect to the determination of higher risk areas or 'hot spots', it is important to recognise that the mobility of cetaceans (and their prey) means that it is rarely if ever sufficient to base relative density maps on one or two years' data given natural variation. Spatial and habitat modelling is a valuable tool but requires good data sets including information on potential explanatory variables if it is to be used in a predictive manner. Donovan noted that this matter was discussed thoroughly at the recent IWC workshop on ship strikes, and the present Workshop noted the general conclusions and recommendations made there with respect to the strengths and weaknesses of modelling high risk areas (IWC/65/CCRep01, item 5.1.1.3) for human induced stressors and cetaceans; caution was urged over using simple range maps for cetaceans (and human activities) when identifying high risk areas as these can be highly misleading if the data limitations are not carefully considered and explained.

An important modelling area that requires further development relates to the question of synergistic and cumulative effects of stressors. Donovan noted that the recent IWC Arctic workshop discussed this in more detail (IWC/65/Rep07[11]) and has made a recommendation that the Scientific Committee consider holding a co-hosted workshop or workshops with appropriate stakeholder participation on identifying and evaluating threats to cetaceans from human activities including: (a) data and analytical requirements (both for cetaceans and human activities) for identifying high risk areas to cetaceans at the correct geographical and temporal scales; (b) evaluation of non-direct threats to cetaceans at the population level including chemical pollution, noise, climate change etc. and (c) methods to examine synergistic and cumulative effects of a range of actual and potential threats at the population level. He noted that this work would be extremely important in the context of assessing high-risk areas and priorities with respect to marine debris.

2.4 What can be learnt from other species (e.g. risk analyses for seabirds and turtles by CSIRO)

Wilcox introduced the work of CSIRO on risk analysis for ALDFG entanglement impacts on turtles, ingestion of debris by turtles and ingestion of debris by seabirds. He presented a range of approaches that can be applied in contexts from well-known data-rich systems to systems where there is little or no existing data. The research is motivated by existing Australian national policy on the threat posed to wildlife by debris, and the need to assess the magnitude of the threat.

One of the primary approaches used is to model the overlap between species range and purported threats (i.e. ALDFG or debris). They used this overlap to estimate the exposure of species to the pressure (i.e. debris). These exposure estimates were then included in a statistical model that related records of entanglement or ingestion to exposure, along with other important factors such as foraging strategy, species, or other factors. Using this validated model, they then predicted expected ingestion or entanglements at a range of scales from single taxa within a regional sea to globally across 188 seabird species.

Wilcox then discussed research to infer impacts at the population or higher level of organisation, such as the number of individuals killed, from the preliminary models of risk. He presented two approaches. The first approach used observed catches of marine turtles in ALDFG to estimate the catch rates of the gear. Using experimental results on the length of time dead turtles remained in nets and a regional oceanographic model to estimate the paths of ALDFG, the number of turtles killed was estimated from the catch rates. The second approach used 'expert elicitation' to assess the expected population impact (fraction of animals affected multiplied by chance of lethal, non-lethal, etc. effects). In this analysis, a statistical model was used to control for bias introduced by individual respondents. This approach has been applied using a semi-quantitative questionnaire covering seabirds, turtles, and marine mammals. While not completed at this point, he stated that when finalised, the analysis will provide semi-quantitative estimates of population scale impact from the 20 most common marine debris items found in coastal clean-ups.

He suggested that these approaches could be applied to cetaceans, using spatial and temporal overlap as a measure of exposure to a pressure, parameterising a model of threat using this exposure and observations on either entanglement or ingestion, and based on these predicting areas, populations, or other segments that are at high relative risk of debris impacts. In the context of data-poor situations, a staged approach using semi-quantitative approach like expert elicitation,

[11] *http://iwc.int/iwc65docs*

and then moving to more in-depth analysis in situations identified as high-risk. An important consideration is to provide advice to policy makers in the short term, recognizing the inherent uncertainties, while pursuing more in-depth analysis in the fullness of time.

2.5 Future work on high risk areas and populations

A number of methods for ecological risk assessment (ERA) of entanglement, injury and mortality of cetaceans in marine debris are available for the continuum of data-deficient to data-rich regions and species. Risk assessment can move from qualitative to more quantitative methods progressively, with subsequent levels focusing on species or regions, identified from preliminary screening, as being of high risk. In this way, the less rigorous risk assessments, which have a relatively high degree of uncertainty, may provide a useful tool to consider large numbers of populations or sites, and then prioritise those populations or sites deemed to be relatively vulnerable for more in-depth data collection and/or analysis.

Relatively high-quality surveys of debris densities in the Western Atlantic and Eastern Pacific are available currently; more sparse data from all ocean basins and from each of the major oceanic gyres. Some participants stated that modelling efforts have expanded these limited data to provide more reliable estimates of relative debris densities globally and less reliable absolute densities. They also believed that similarly, for fisheries and other sources of specific types of debris, there are either global-scale data on distribution and density, or reasonable proxies that can be used to describe the pressure.

The Workshop **requests** that the IWC Scientific Committee considers ways of combining estimates of oceanic debris and information on cetaceans to identify priorities for mitigating and managing the impacts of marine debris on cetaceans. One approach to consider would be using a semi-quantitative ERA method with the available data on fisheries, cetaceans and cetacean-marine debris interactions to provide preliminary estimates of high-risk locations or species, and to identify situations and/or populations that should be high priorities for additional data collection, more detailed analysis and/or immediate mitigation and management. The results from any analyses should of course, explicitly account for uncertainty in the underlying data, such that fisheries, NGOs and IGOs understand the scientific basis for any recommendations that may be made and the need for adaptively managing as new data become available.

3. DEVELOPING MITIGATION APPROACHES

Discussions under this section were chaired by Chopin and Bass.

3.1 Abandoned, lost and discarded fishing gear (ALDFG)

3.1.1 Overview of existing legislation, agreements and strategies to tackle ALDFG by UN agencies

3.1.1.1 MINIMISING THE INCIDENTAL CAPTURE OF WHALES IN COMMERCIAL FISHERIES – AN FAO PERSPECTIVE

Chopin provided an overview of FAO's work relevant to the issue of marine debris and cetaceans. He noted that the term 'bycatch' includes the incidental catch of whales, seabirds, turtles and other non-target species by fishing gears and has been addressed in FAO's Code of Conduct for Responsible Fisheries[12] and more recently in FAO's International Guidelines for bycatch management and reduction of discards[13] which were endorsed by the Committee on Fisheries in 2011. The term 'incidental catch' as used by FAO in fisheries refers to that part of the catch which was not originally targeted, but was caught anyway. An example of the use of terminology can be found in FAOs International Plan of Action for reducing incidental catch of seabirds in longline fisheries[14].

Chopin informed participants that calls for action to reduce the incidental capture of whales in fishing gear has occurred at the global level in the UN General Assembly (UNGA) and in the Committee on Fisheries (COFI), most recently at its 31st session in Rome 2013. Calls have also been made by Governments and NGOs for measures to reduce the incidental capture of whales in fishing gear. The incidental capture of whales in commercial fisheries may adversely affect the profitability of fishing operations as a result of gear damage and loss of fish catch. Some whale species that become entangled in ALDFG through a process known as 'ghost fishing' may contribute to a significant loss of biodiversity.

Chopin proposed that if the IWC wishes to minimise the incidental capture of whales in commercial fisheries, it may consider:

(a) promoting and raising awareness on incidental capture of whales in global and regional fora addressing fisheries management, policy and biodiversity conservation;
(b) broader use of reliable and cost-effective bycatch mitigation technologies;
(c) harmonised and improved bycatch data collection protocols (including logbook data reporting) to identify spatial and temporal entrapment hotspots;
(d) the use of effective gear marking to identify ownership and to increase gear visibility;
(e) encouraging the reporting of lost fishing gear and locations of whale entrapments;
(f) development of best practices to minimise incidental capture and safe release of whales from fishing gear;

[12] *http://www.fao.org/docrep/005/v9878e/v9878e00.htm*
[13] *http://www.fao.org/fishery/nems/40157/en*
[14] *http://www.fao.org/fishery/ipoa-seabirds/en*

(g) capacity-building within fishing communities to facilitate safe release of whales caught incidentally in fishing gear;
(h) ALDFG removal from the aquatic environment and safe disposal; and
(i) involving experienced fishing masters and crews in bycatch mitigation experiments.

Chopin noted that his role in the workshop was to provide guidance on various technical options to reduce the incidental capture of whales. He stressed that FAO was not advocating any particular option. He also emphasised that solutions need to be tailored to specific problem fisheries and take into account, practicality, safety, cost effectiveness and would work best when the fisheries sector is fully engaged. The Workshop **welcomed** the technical guidance from FAO at the meeting.

It **agreed** that the most effective approach to reducing the incidental capture of cetaceans in all fishing gear would be through co-operation with FAO, RFMOs and the fishing sector. Recommendations relevant to this appear under Items 8.1 and 8.6.

The Workshop **suggested** the IWC Secretariat, in cooperation with others such as UNEP, CMS and CBD, bring the issue of incidental capture of marine mammals to the attention of the UNGA and/or COFI. Consideration should also be given to multi-agency funding proposals to support mitigation actions. Other suggested areas that might be appropriate for future co-operation included relevant aspects of gear-marking, removal of ALDFG, development of guideline documents, holding of joint expert workshops, databases of lost gear, sharing of fishing effort data, links between biodiversity and livelihood, mitigation measures and the harmonising of data recording.

3.1.1.2 MONITORING AND MANAGEMENT OF ALDFG WITHIN REGIONAL FISHERIES MANAGEMENT ORGANISATIONS AND OTHER INTERGOVERNMENTAL ORGANISATIONS

Gilman presented an overview of draft findings from a study on the topic intergovernmental governance of ALDFG (Gilman *et al.*, In prep). He noted that ALDFG can cause substantial ecological and socioeconomic problems. Over the past decade there has been increasing international recognition of the need for multilateral efforts to effectively address the transboundary problems resulting from ALDFG including ghost fishing. Ghost fishing by ALDFG removes both target and non-target species of fish and shellfish, as well as species with relatively low fecundity such as seabirds, sea turtles, marine mammals and elasmobranchs, some of which are endangered, threatened or protected. Ghost fishing is most problematic in passive fishing gear such as gillnets and pots. Used worldwide primarily by coastal, artisanal, small-scale fisheries, about a fifth of global marine fisheries landings comes from gillnet fisheries.

To benchmark regional measures for monitoring and mitigating ALDFG and ghost fishing from marine capture fisheries, an assessment was made of ALDFG-related data collection protocols and conservation and management measures (CMMs) of regional fisheries management organisations and intergovernmental organisations (IGOs) that can adopt fisheries conservation and management measures that are binding on their members. Ten of the 19 assessed IGOs manage fishery resources captured in an active gillnet or trammel net fishery.

Study findings highlight opportunities for improved regional monitoring of ALDFG. Approximately half of the IGOs have logbook or observer data collection protocols for information on ALDFG with large variability in the information collected by each IGO. Harmonising ALDFG data collection protocols where they are in place, and filling gaps for those IGOs lacking procedures to collect this information, would contribute to improved monitoring of ALDFG in regional marine capture fisheries.

Findings identify opportunities to improve regional management of ALDFG and ghost fishing. For example, seven of the 19 IGOs lack binding measures to prevent and remediate ALDFG and associated ghost fishing. IGOs with measures in place are making use of a small subset of available tools. Of 18 categories of measures to prevent and remediate ALDFG and manage ghost fishing, only half are used by the 19 IGOs. Measures prohibiting the use of gillnet and trammel net gear in part or all of the IGO's area of competence, in part, to reduce ghost fishing, was the most commonly employed measure. Gear marking to identify ownership and to increase passive surface gear visibility was the second most commonly used measure. Both forms of gear marking contribute to reducing ALDFG. Measures requiring the possession onboard of equipment to retrieve ALDFG, and to report lost gear that they could not retrieve, which contribute to remediating ALDFG, was the third most commonly used measure to manage ALDFG.

RFMO/As could tap a broader suite of complimentary methods to prevent and remediate ALDFG and associated ghost fishing. In particular, spatial planning measures designed to separate passive and mobile gear sectors to avoid gear conflicts and concomitant gear loss, a leading cause of ALDFG in some areas, could be beneficial in mitigating ALDFG in some fisheries.

In discussion it was noted that the different international bodies and organisations assign different levels of priorities to this issue; recommendations from the IWC and others may assist in increasing attention and thus priorities. This should form part of the work envisioned under Item 8.1. This could include the provision of data on ALDFG by associated whale research platforms (e.g. the IWC POWER cruise already collects data on marine debris and other cetacean cruises and platforms of opportunity such as whale watching vessels could also be encouraged to do so). It was noted that an important method to raise issues within RMFOs was to submit documents to their scientific bodies.

3.1.1.3 IMO - MARPOL ANNEX V

In light of a representative from the IMO being unable to attend the workshop, in consultation with IMO Bass provided the workshop with a review of the role and responsibilities of the IMO with respect to ALDFG. The summary noted that MARPOL Annex V requires signatory nations to provide adequate port reception facilities for accepting garbage (including ALDFG) generated by ships. It was noted that the Global Integrated Shipping Information System (GISIS) website[15] provided and managed by the IMO provides a database of garbage management facilities searchable by port and waste type, it did not appear to allow specific identification of those ports and waste management providers that accept (and/or recycle) end-of-life fishing gear.

The Workshop noted that many port reception facilities did not accept fishing gear and that this was a problem, but also heard several presentations referring to increasing efforts to equip ports with dedicated fishing gear disposal provisions (e.g. Nofir and the Healthy Seas Initiative). The Workshop considered that knowledge of where end-of-life fishing gear could be responsibly disposed of (ideally free of charge) could - if combined with education outreach - reduce incidence of gear discards.

In discussion, it was noted that loss of fishing gear which poses a 'significant threat to the marine environment and navigation' is supposed to be reported to the IMO under MARPOL V, although there is no definition of 'significant'; without this or some accepted guidance on what comprises a 'significant threat', reporting is low. It was also noted that the Australian Maritime Safety Authority (AMSA) tracks large floating debris that may be a hazard to navigation. In general, the Workshop **agreed** that many local, regional or national voluntary reporting schemes have not been successful, and that even 'mandatory' reporting such as that under MARPOL appears to be poor.

A recommendation relevant to IMO and MARPOL is given under Item 8.1.1.

3.1.1.4 UNEP (HONOLULU STRATEGY AND GPML)

See Item 3.2.1.2.

3.1.2 National and regional plans for prevention and recovery of ALDFG

3.1.2.1 NORWAY

Ruud gave a presentation on the Nofir[16] project for recycling fishing gear in Norway. This project has successfully created a profitable national system for collecting and recycling discarded fishing equipment and this is now being extended across other European countries (thus far Iceland, Denmark and parts of the UK). In part this has been possible because of the large size and number of nets. Nofir is also trying to expand into southern Europe and Turkey.

Norway has a very long coastline and an important fishing sector. Large-scale fisheries include trawl nets, gillnets and aquaculture. The latter is expanding rapidly using much bigger cages which present a large disposal problem when they require replacing and are predominantly comprised of plastics. Fisheries waste, particularly old nets, is not welcome at waste facilities as it entangles the machinery, such that old gear either went to landfill, was dumped at sea or was burnt. There is a particular problem in Norway with steel wires on the sea bed which can snag gillnets, etc.

An important component of the Nofir project is that it collects discarded gear for free; selling the valuable plastic contents of the gear pays for the disposal of net components (including other types of plastics) that cannot be recycled or are less valuable as well as collection of the more remote debris. Net dismantling and processing is carried out in a plant in Lithuania. The Norwegian Directorate of Fisheries collects and recycles discarded gear, including in remote places such as Svalbard.

Some of the challenges of the project include transport, laws and regulations regarding hazardous waste since copper is used on the nets as an antifouling agent and the general difficulties in dismantling and recycling (plastics recycling is complex). In addition effort is needed to increase awareness of the problem for the fishing sector as well as to improve the ability to make a profit from the enterprise.

The Workshop **welcomed** the news of this successful project although it was noted that in some countries (e.g. South Africa), present laws state that all fisheries waste must go to landfill.

3.1.2.2 USA

Wallace summarised the various examples of marine debris mitigation covered by the NOAA Marine Debris Program[17] for ALDFG, the mission of which is to identify and solve the problems of marine debris through research, prevention and reduction.

She presented examples of work done by the NOAA Marine Debris Program in Alaska, the West Coast, Great Lakes and Southeast regions of the United States. In Alaska, debris is removed from very remote areas with very small populations and presents many challenges related to removal and disposal. More than 50% of debris is fishing related and most of that gear is not local.

[15] *http://gisis.imo.org*
[16] *http://www.nofir.no/*
[17] *http://marinedebris.noaa.gov/*

The West Coast Governors' Alliance has identified marine debris as a priority issue. One of the goals of the marine debris strategy is to reduce the amounts and impacts of ALDFG through loss prevention, gear modification to prevent impacts if fishing gear is lost and surveys for its removal. Two specific examples of projects are the Northwest Straits Foundation removal of ALDFG nets in Puget Sound and the Sea Doc Society's California Lost Fishing Gear Recovery Project in California where fishermen remove lost gear through a buy-back programme.

NOAA will be funding a new prevention effort in the Great Lakes. In Wisconsin, partners will be interacting with 100 anglers at sport shows on net safety, developing videos, a website and will be working with fishermen in workshops to reduce the amount of gear lost.

The Florida Marine Debris Action Plan is in the planning and development phase. Initial ideas to minimise impacts from ALDFG are to decrease the cost for fishing licenses for people who complete training, establish a fund for emergency response to remove and dispose of ALDFG and limit the amount of effort so that less traps are deployed every year.

NOAA also supports the Fishing for Energy project around the United States. Fishermen can dispose of gear free of cost and it is transported to waste-to-energy facilities and converted to energy. To date 2.5 million pounds of ALDFG have been converted to electricity through this project. NOAA is also funding projects related to gear modifications to lessen the impacts of ALDFG.

In summary, Wallace stressed that not all debris is local and that prevention is better than removal. However, solutions should be local and organisations should work with local partners using local expertise.

3.1.2.3 HAWAII MARINE DEBRIS ACTION PLAN

Koyanagi and Godenzi presented the Hawaii Marine Debris Action Plan. This project is a community-led cooperative effort with Schnitzer Steel and Covanta Energy – the debris is incinerated to generate electricity with incineration, producing 8-10% of Oahu's power needs, although marine debris comprises a relatively small component of the incinerated waste[18].

The first goal of the Plan is to reduce the backlog of marine debris. More than 700 tonnes of debris have already been removed from the northwestern Hawaiian Islands but it is an ongoing problem (50 metric tonnes 'reappeared' in 2012-2013). Challenges from this area are the distances between islands and atolls, physical characteristics of atolls making it impossible to use large ships. Surveys are conducted by pairs of free-divers and tow-boarders, and they also carry out the removal of found fishing gear in the coral. Free-diving is a good way to do this as there is good visibility and shallow water. Scuba is used occasionally for debris that is too deep or large. Shoreline removal operations are also carried out. This is to prevent shore-based animals like monk seals and nesting turtles from becoming entangled. Almost all of the gear is from non-Hawaiian fisheries. Collection is expensive and at present NOAA is paying for the removals from reefs but there is pressure on this funding after next year.

The collected waste is sent to be incinerated at Waste-to-Energy H-POWER: Honolulu Project of Waste and Energy Recovery. Ninety percent of the rubbish generated on Oahu is burned and steam-turbines generate 8-10% of Oahu's power needs. Their new Mass Burn Technology boiler can accept larger pieces of marine debris. The older boilers required material to be cut into pieces. A workshop will be held next week with Covanta Energy, NOAA, and Schnitzer Steel to revise the guidelines for Acceptable Waste to allow for more types of marine debris and larger sizes. Emissions from the plant are very tightly controlled.

The background to the Nets to Energy Program was the Clean Oceans Initiative started in 1999 in Hawaii with partners Covanta Energy, NOAA and Schnitzer Steel. It has now been renamed Nets to Energy and can be found across the USA. Old gear can be deposited in free-to-use bins and is then incinerated. This project is not quite cost-neutral, but provides a valuable community service. There is considerable community goodwill with private companies involved with bin collection, transport, processing, and finally incineration for energy.

The second goal of the Plan is prevention and a workshop was held in 2014 to develop a 2-year action plan, share experiences and discuss gaps in knowledge.

In discussion, it was noted that there are a number of valuable features of this community driven programme that might be applicable elsewhere including in developing countries, and indeed some companies are looking into this. Factors that need to be taken into account include cost-benefit analyses (e.g. small populations may not generate enough waste to burn or to justify the cost of a plant, even with outside ALDFG; availability of landfill sites may also affect decisions; recycling and reduced use of plastic goods is preferable) and local legal frameworks.

3.1.2.4 SOUTH KOREA

Hogan summarised information on the Gear Buyback Program which was initiated in 2003 by the federal Ministry of Maritime Affairs and Fisheries and implemented in 51 locations throughout South Korea. The premise was that the government would 'buy' any ALDFG fishing line, rope, or net that the fishing fleet located and brought back to port in the course of their standard fishing operations, at the cost of approximately US$10 per 100 litre bag. The collected gear was then taken to energy plants for incineration and the program costs were shared between local and the central

[18] *http://www.covanta.com/facilities/facility-by-location/honolulu.aspx*

government. Between 2007 and 2011, almost 200 fishing vessels, representing 1,814 participating fishermen participated in the program, yielding 700 tons of ALDFG. Unfortunately the program was discontinued in 2013 for two primary reasons: (1) some of the fishermen were stuffing their household trash into the bags, for the payments; and (2) some fishermen lost interest in the program when sorting the items became too tedious and the payment was no longer sufficient to retain their interest.

3.1.2.5 WESTERN EUROPE (HEALTHY SEAS)

Hogan reported that the Healthy Seas initiative is a consortium of the following European companies and NGOs that collect debris from the North, Adriatic, and Mediterranean Seas, and convert it into consumer products:

(a) European Centre for Nature Conservation (ECNC)
(b) Aquafil (manufacturer of nylon netting)
(c) Star Sock (sock company and licensee)
(d) Nofir (collects discarded fishing gear across Europe – see Item 3.1.2.1)

Healthy Seas recovers fishing nets and regenerates them into ECONYL ® yarn, which is then turned into new products including socks, carpets and swimwear. Since 2011, they have collected 16,000 tonnes and converted it into new polymers and yarn. Each month, the Aquafil plant in Slovenia processes 400-500 tonnes of fishing nets; 40% of total volume of input into the factory. Currently the majority (80%) of their input nets are from aquaculture rather than ocean fisheries, although this is changing. In 2013 alone, a total of 14 diving trips courtesy of a network of 60 volunteer divers yielded 20 tonnes of nets recovered. At the beginning of August 2014, a new pilot project began in Ancona (Italy) where more than 250 fishing boats began to collect ALDFG nets, and to take divers out for collection at the sites of shipwrecks and reefs. A similar pilot is now being scouted in Catalonia, Spain.

3.1.2.6 PHILIPPINES (NET-WORKS)

Net-Works is a partnership initiative between the Zoological Society of London (ZSL, a conservation NGO), Aquafil (nylon net recyclers), and Interface (carpet company). The premise is for the communities living in the Danajon Bank of the Philippines to collect and sort nets, which are a major entanglement hazard and threat to the reef and its ecosystem. ZSL coordinates the collection efforts and payment structure through the creation of community banks, Aquafil then processes the netting into yarn, and Interface buys the yarn to make carpet tiles, fulfilling their company mission of a closed-loop supply chain. Since June 2012, 9,000 kilos of discarded fishing nets have been converted to carpet tiles; 892 local fishers and their families collect fishing nets in exchange for payment; for every 2.5 kilos of nets collected, villagers receive enough money to buy 1 kilo of rice.

This project, which actively pursues a role for the private sector continues to succeed, by assigning a commercial value and price point to the 'product' of marine debris.

3.1.2.7 AUSTRALIA

Gunn presented Ghost Nets Australia (GNA). Originally, this programme focused on social reform through managing an environmental issue. This was achieved by building alternate livelihoods for 32 local indigenous communities across northern Australia enabling the removal of ghost nets (>90% of the marine debris) from over 3,000km of coastline, raising awareness internationally and providing ongoing maintenance of the issue.

The data the rangers were trained to collect covered the magnitude of the problem and the difficulties in being able to prevent it, with less than 9% of the gear being of Australian origin. As this lead to many unanswered questions, in 2009 the programme joined with CSIRO to help research the source and impacts of the nets further.

Once the geographical source of the nets was identified as being the Arafura Sea, both GNA and CSIRO partnered with the Arafura Timor Seas Ecosystem Action (ATSEA) programme in Indonesia to explore the causes, drivers and possible solutions for ALDFG in the region through workshops with local fisheries. The initial reaction was a denial that the problem originated in their fisheries. However, once an open dialogue was created it was found that most of the gear was abandoned due to interaction with the sea floor and gear conflict. The main drivers for this are over-capacity; there are too many boats especially from IUU fishing which is three times greater than legal fishing. The more vessels there are the more ALDFG in an area.

Solutions developed in the workshops fell into three major categories: education; technical (boat-based); and regulation. Boat-based technical solutions were prioritised. In 2014, many of the regulatory prevention strategies that resulted from the workshops with the Arafura fishing industry were adopted by the Ministry of Marine Affairs and Fisheries, Indonesia in their first regional fisheries management plan (FMP 719).

Currently, GNA is working on an improved net identification system that focuses on identifying the use of the net rather than where it was manufactured, or flag of the vessel, as this should provide the information needed to locate specific fishing industries with which to work directly on further prevention measures.

3.1.2.8 WAP SEA CHANGE

Bass provided an overview of WAP's Sea Change campaign, and the development of the Global Ghost Gear Initiative to tackle ALDFG. The campaign's core aim is to catalyse replication and expansion of effective solutions in order to create a global, measurable decrease in the volume of fishing gear being abandoned or lost in the oceans, and in order to create a measurable increase in the volume of ALDFG removed from the marine environment. A primary stakeholder group for

the campaign is the seafood retail industry, with a goal of working with retailers to encourage and enable them to help promote and support ghost-gear mitigation policies and practices within their fishery supply chains. A key tool to facilitate the better sharing of essential information and data on the issue is the development of the Global Ghost Gear Initiative (GGGI), an alliance of governments, industry, intergovernmental and non-governmental organisations, with a shared commitment to both better understand and tackle the problem of ghost fishing gear. More information about the Initiative, including the process to register interest, and attend the GGGI's first round table meeting in November 2014, can be found on the WAP website[19].

3.1.3 Facilitated panel discussion – strengths, weaknesses, opportunities and threats

The Workshop thanked all presenters and **commended** the ALDFG reduction and removal initiatives underway. It **encouraged** continuation, replication and expansion of such effective initiatives. It welcomed the development of cross-sectoral partnerships to address ALDFG, including the Global Partnership on Marine Litter and the Global Ghost Gear Initiative. The Workshop also **emphasised** the importance of focusing on reduction and prevention efforts as the most sustainable, long-term solution to the problem of ALDFG. In developing such initiatives it emphasised the importance of examining why some projects fail as well as why others succeed. Key factors include cost-effectiveness (including determining 'true' costs), social awareness and the importance of community and local involvement along with industry.

3.1.4 Data needs and recommended research actions to inform longer term management strategies for impacts of ALDFG on cetaceans

3.1.4.1 DIAGNOSING ACTIVE VERSUS ABANDONED, LOST OR DISCARDED (ALDFG) FISHING GEAR ENTANGLEMENT

Lyman and Smith introduced this topic. Currently, even in regions with disentanglement networks and specialists who can identify gear removed from whales, less than 50% of the materials can be identified to a particular fishery. It is even more difficult to determine if the rope and net removed from whales was COAFG or ALDFG when the whale encountered it. However, while the impacts to the whales may be the same, many of the management/mitigation strategies may differ depending on whether the gear was encountered as ALDFG or COAFG.

In many regions, COAFG rather than ALDFG is perceived as the primary threat to large whales. For example, ALDFG was strongly indicated in only 4.2% (n=237) of total large whale entanglement cases reported in Alaska and Hawaii since 1999, however the value for Hawaii alone was higher at 9%.

Whilst marine debris, by its very nature (e.g. fragmented or degraded), is more difficult to positively identify, the Workshop **agreed** that more effort should be put toward not only identifying gear as ALDFG vs COAFG, but also whether it was abandoned, lost, discarded or wet-stored. Ultimately, the different gear types may pose similar threats, but the source of that threat is still necessary for effective management and prevention. Use of a suite of data indicators will be required including: amount/degree and type of fouling; degradation/age (e.g. UV damage determined visually and through breaking strength); multiple gear types entangled together; gear markings that provide additional temporal/ spatial information; the health of the animal or other impacts of the gear.

Since large whales may carry the gear for long periods of time and over large distances, there are challenges in interpreting these indicators. For instance, gear found with heavy fouling on a large whale, may have been encountered as ALDFG already fouled, or could have been COAFG that became fouled while it was on the animal over a long period of time. However, looking at the totality of the indicators, and with a greater sample size over time, a probability matrix may eventually be developed much like has been done recently in arriving at serious injury determinations in the USA for large whales impacted from ship strikes and entanglement. It was **agreed** that this issue should also be considered by the IWC entanglement expert group at its next meeting, and at the forthcoming IWC Workshop on prevention of entanglement to be held in March-April 2016.

A recommendation relevant to this issue is given under Item 8.2.1.

3.1.4.2 IDENTIFYING 'PROBLEM' FISHERIES WITH HIGH RATES OF GEAR LOSS

The Workshop noted that wherever gear (especially passive or static gear) and large whales are found together, entanglements are likely. It noted that the 2010 IWC Workshop on entanglement had summarised the available information from IWC national progress reports from 17 countries between 2003 and 2008 (IWC, 2012).

Entanglements were reported for 15 gear types (using ISSCFG categories[20]) including seines, trawls, gillnets and entangling gear, traps, hooks and lines, aquaculture and shark control gear; eleven species of large whales were involved.

Participants at the Workshop provided some additional information:

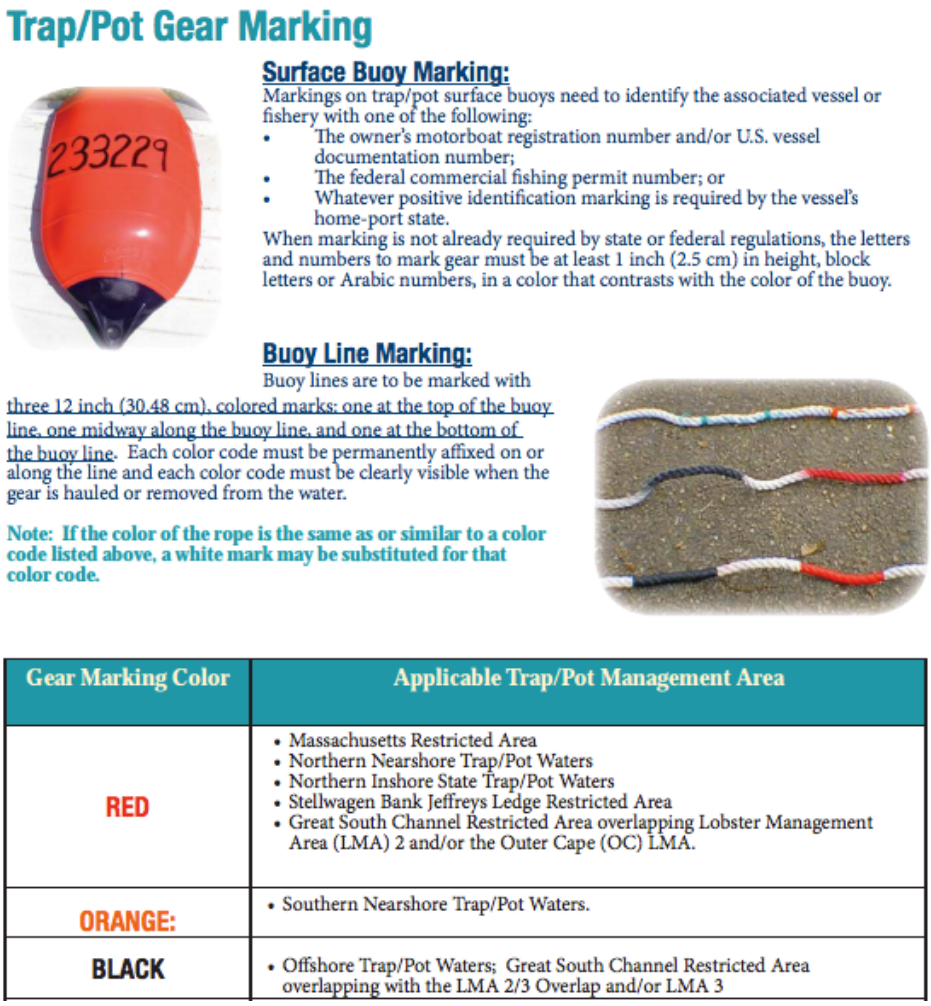
(a) the US Atlantic coast take reduction schemes (right, fin, humpbacks) have focussed on pot and gillnet fisheries.
(b) in South Africa, static fishing gear is the major cause of large whale entanglement (Meyer *et al.*, 2011), especially the types associated with the West Coast rock lobster industry and the large-mesh gillnets that are set off the coast of KwaZulu-Natal to reduce shark attacks.

[19] *www.worldanimalprotection.org/sea-change*
[20] And see *http://www.fao.org/fishery/cwp/handbook/M/en*

(c) in South Korea, analyses of entanglements found that common minke whales were primarily entangled in three types of gear: set nets, pots and gillnets (Song *et al.*, 2010).

In the USA, right, fin, sei, and humpback whales are protected through legislation requiring fisheries with known interactions to be identified and managed in order to minimise the seriousness and lethality of the fishing gear interactions with these endangered and threatened large whales. These fisheries are identified from efforts including: fisheries observers on fishing vessels; gear investigations of gear removed from entangled whales through disentanglement efforts; entangling gear removed from beached whales; and mandatory reporting of marine mammal and fishing gear interactions, as well as lost fishing gear. Fisheries identified as those that have had high occurrences of previous interactions with endangered and threatened large whales are included in discussions with government fishery managers on the state and federal level, researchers, and whale biologists in order to develop fishing gear and practice modifications to minimize the seriousness and lethality of those interactions. As part of these collaborations, the Atlantic Large Whale Take Reduction Plan (ALWTRP) has been developed and has come to require specific gear markings to ensure that fisheries with high levels of interactions are identified and managed appropriately. Effective marking of fishing gear is thought to inform fishery managers as to the fisheries origin of the gear found and removed from entangled marine mammals. Both trap/pot gear and gillnet gear is required to be appropriately marked along the U.S. Atlantic coast. An excerpt from quick reference guide for the Northeast U.S. Trap/Pot Gear Guide is shown in Fig. 1[21].

Additionally, it is critical that whatever efforts developed are monitored after implementation in order to determine if fishing gear and technique modifications are effective and/or need to be altered. A monitoring plan was developed to determine if the fishing gear identification and mitigation efforts implemented have been effective in the US Atlantic fisheries[22].



Trap/Pot Gear Marking

Surface Buoy Marking:

Markings on trap/pot surface buoys need to identify the associated vessel or fishery with one of the following:

- The owner's motorboat registration number and/or U.S. vessel documentation number;
- The federal commercial fishing permit number; or
- Whatever positive identification marking is required by the vessel's home-port state.

When marking is not already required by state or federal regulations, the letters and numbers to mark gear must be at least 1 inch (2.5 cm) in height, block letters or Arabic numbers, in a color that contrasts with the color of the buoy.

Buoy Line Marking:

Buoy lines are to be marked with three 12 inch (30.48 cm), colored marks: one at the top of the buoy line, one midway along the buoy line, and one at the bottom of the buoy line. Each color code must be permanently affixed on or along the line and each color code must be clearly visible when the gear is hauled or removed from the water.

Note: If the color of the rope is the same as or similar to a color code listed above, a white mark may be substituted for that color code.

Gear Marking Color	Applicable Trap/Pot Management Area
RED	• Massachusetts Restricted Area • Northern Nearshore Trap/Pot Waters • Northern Inshore State Trap/Pot Waters • Stellwagen Bank Jeffreys Ledge Restricted Area • Great South Channel Restricted Area overlapping Lobster Management Area (LMA) 2 and/or the Outer Cape (OC) LMA.
ORANGE:	• Southern Nearshore Trap/Pot Waters.
BLACK	• Offshore Trap/Pot Waters; Great South Channel Restricted Area overlapping with the LMA 2/3 Overlap and/or LMA 3

Fig. 1. Excerpt from the 2014 US Northeast Trap/Pot Gear Guide Marking Requirements as part of the Atlantic Large Whale Take Reduction Plan

[21] More information regarding the required gear marking scheme along the US Atlantic coast can be found at: *http://www.greateratlantic.fisheries.noaa.gov/Protected/whaletrp/*

[22] *http://www.greateratlantic.fisheries.noaa.gov/whaletrp/reports/5a_ALWTRP%20Monitoring%20Strategy.pdf*

As noted under Item 2.2, gear marking would be invaluable in helping to determine what types of COAFG and ALDFG pose a higher risk for large whale entanglement.

3.1.4.3 ASSESSING IMPACTS OF ALDFG AT THE INDIVIDUAL AND POPULATION LEVEL

A key difficulty in assessing the effects of ALDFG at the individual and population level relates to the difficulty noted above in separating out COAFG and ALDFG entanglements. For entanglements in general, it was noted that there may be a reporting bias associated with where effort is located (e.g. coastal species more often reported) and for species that float after death. As summarised in the 2010 entanglement workshop (IWC, 2012) scar studies looking at survivors show a high rate of entanglement ranging from 20-80% of the overall populations affected, with 8-33% for the North Atlantic right whale population entangled at least briefly each year e.g. Knowlton *et al.* (2012) and estimated mortalities of 2-4%. That is sufficient to be a threat to the recovery of endangered populations such as gray whales in the western North Pacific, some populations of right whales (e.g. North Atlantic right whales, North Pacific right whales, southern right whales in the southeastern Pacific) and Arabian Sea humpback whales.

3.1.4.4 IDENTIFYING ALDFG CETACEAN ENTANGLEMENT HOTSPOTS

The Workshop only briefly discussed this issue. The potential use of sonar and satellite technology (see Item 2.3.1) to map the distribution of ALDFG and identify hotspots was noted along with the limitations of this approach at present. Data collected through fisheries log book data may also provide useful information on rates of gear loss in different fisheries and regions but there is a lack of consistency in the extent and type of data collected in different fisheries and regions to truly identify hotspots. It was noted that the population of bowhead whales in the Bering-Chukchi-Beaufort Seas was a case for which lost gear has been identified as the most likely source of entanglement, due to spatial but not temporal overlap with the relevant fishery (Citta *et al.*, 2013).

The Workshop noted that the identification of ALDFG hotspots (both in terms of where the gear is lost and where entanglements occur) is complicated by the lack of reporting of gear in the water (although some schemes exist, see Item 2.3) and the fact that animals can tow gear great distances. Difficulties in determining whether entanglements involved COAFG or ALDFG are discussed under Item 3.1.4.1. The value of modelling approaches was discussed under Item 2.3.3 and a recommendation relevant to this issue is given under Item 8.2.3.

3.1.4.5 GEAR MODIFICATIONS (ROPE TENSIONING OR WEAK-LINKS) AND NEW GEAR DEVELOPMENT

Gilman summarised efforts within FAO (Gilman *et al.*, In prep) and elsewhere on gear technology methods to reduce ghost fishing by derelict gillnets and trammel nets. He noted that increasing gillnet filament diameter, modifying the weaves (e.g. using multi-monofilament instead of single monofilament), using larger floats on the top rope and heavier weights or lead-core on the bottom rope, and infusing compounds can make the net stiffer (increase net tension), reducing the likelihood of entangling large organisms.

He noted that efforts to make nets more detectable, such as through net colour, thicker twine diameter and attaching corks or other visual markers within the net, has in some cases been shown to effectively reduce bycatch rates of marine mammals and turtles. Similarly, attaching materials such as thick polyester rope and chains to fishing nets, and infusing nylon nets with metal compounds such as barium sulphate and iron-oxide has the potential to reduce cetacean captures either because the materials increase acoustic reflectivity when using echolocation, increase the net's visibility or the infused metals increase twine stiffness.

He also reported on the use of less durable materials (e.g. thinner net twine diameter and weaker material) to produce a breaking strength that allows large organisms to break free of the gear and escape which might reduce ghost fishing mortality. Gear technology has been developed to reduce the duration of the fishing power of ALDFG via designs that employ degradable materials (e.g. degradable FADs have been designed; degradable cotton fibre is still used in some gillnet fisheries; attaching floats using biodegradable materials has been trialled in a demersal gillnet fishery; degradable escape mechanisms are required in some trap fisheries). Degradable escape panels and cords can be used to reduce ghost fishing by traps, and are required in some fisheries. Synthetic gear materials have been developed that can be broken down by microbes and ultraviolet light. Simulated ALDFG demersal gillnets constructed of multifilament twine have been observed to have a shorter duration of fishing efficiency than gillnets constructed of monofilament twine.

Acoustic pingers and alarms and illuminating nets with chemical or battery-operated lightsticks might reduce bycatch but would likely be ineffective methods to reduce ghost fishing mortality once the energy source has drained.

In discussion, the Workshop noted the following:

(1) care needs to be taken that a solution to one problem does not create a new unexpected problem, e.g. making it easier for whales to break free of gear using weak links may increase debris amounts and thus ghost fishing, and use of degradable gear (e.g. that being developed in South Korea) may increase microplastic debris;

(2) possible solutions must take into account the resources of local fisheries and involve gear producers; and

(3) this topic will form a key part of the forthcoming IWC workshop on the prevention of entanglement in March-April 2016.

3.2 Other marine litter: macrodebris and microdebris

3.2.1 Overview of existing legislation and strategies to tackle marine litter (non-ALDFG)

3.2.1.1 INTERNATIONAL LAWS AND AGREEMENTS (BASEL CONVENTION, UNGA RESOLUTIONS A/RES/60/30 AND A/RES/63/111 ON OCEANS AND THE LAW OF THE SEA: INTRODUCTION TO EXISTING INTERNATIONAL INSTRUMENTS

Baulch presented an overview of the international legislation related to marine debris. International legislation has been in place for over 25 years, with the objective of reducing terrestrial and marine sources of marine debris. However, there is mixed evidence regarding its success and oceanic sampling indicates that the problem has persisted or worsened (Derraik, 2002; Rochman *et al.*, 2013).

MARPOL Annex V is the international instrument that prohibits dumping of garbage at sea. The recent significant improvements in the provisions of Annex V were noted, as well as efforts by the IMO to standardise reporting of vessel waste disposal and its development of guidelines on what constitute adequate Port Reception Facilities. However, Baulch noted that there remain significant problems in the implementation and enforcement of Annex V, including a lack of mechanisms by which to verify compliance, particularly in those vessels below the tonnage limit requirements for Garbage Record Books. This tonnage limit means that 99% of the global fishing fleet is excluded from the mandate to have a Garbage Record Book or Garbage Management Plan, and there is therefore no mechanism by which to monitor compliance (Sherrington *et al.*, 2014c). It has therefore been recommended that commercial vessels of all sizes should be required to have a garbage management plan and a garbage record book and that national authorities could provide a training programme as part of licensing procedures to improve compliance (Sherrington *et al.*, 2014c). Enforcement authorities have highlighted that violations are almost impossible to detect and prosecute successfully and that fines are often low compared to the potential cost saving of discarding waste illegally.

The variation in adequacy and cost of port waste reception facilities (PRF) has been highlighted as a particular disincentive to compliance within the marine sector (Sherrington *et al.*, 2014c). Provision of adequate PRF by countries and implementation of a no-special-fee system, where the costs of offloading waste are included into general port fees were essential measures to remove any incentive to dump waste illegally. With regards to international instruments aimed at preventing terrestrial sources of marine debris, whilst there is no binding international agreement, the valuable role of the various UNEP partnerships (GPA, GPWM, GPML), as well as the work being developed by CMS, IMO and CBD was identified, noting the importance of such frameworks for prompting coordinated regional action, including through the UNEP Regional Seas Programme and associated conventions. Legislative reform to remove barriers to compliance and mandate high waste management standards in marine and terrestrial industries is key to improving waste management, as are other voluntary measures, such as multi-stakeholder partnerships, education programmes, extended producer responsibility schemes and market based strategies. The latter can include measures to incentivise responsible waste management within industry sectors, as well as item-specific levies and bans (e.g. on single use bags, microplastics, beverage containers) which aim to change public use and behaviour and have often been highly successful at reducing waste generation.

In discussion it was noted that while there are often good legislative frameworks in place that are aimed at preventing marine debris, their success has been hindered by poor implementation at national level, inadequate enforcement capacity and a lack of national programmes aimed at incentivising compliance and good waste management practices within industry. More information on levels of compliance would be helpful. It was also noted that the reform of MARPOL Annex V reform has recently been concluded.

3.2.1.2 UNEP REGIONAL SEAS PROGRAMMES AND GPA

Savelli reported on the UNEP Regional Seas Programme and the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA). There are 18 Regional Seas Conventions and Action Plans with more than 143 member countries. Conventions provide regional legal frameworks and are in many regions supplemented by Protocols. The GPA is a non-binding intergovernmental mechanism covering 9 source categories when established in 1995, one of which is marine litter. Global Partnership on Marine Litter (GPML) launched during the United Nations Conference on Sustainable Development, Rio + 20 in June 2012, is a voluntary open-ended partnership for international agencies, governments, businesses, academia, local authorities, non-governmental organisations and individuals. This launch complemented paragraph 163 of the Rio outcome document 'The Future We Want' which committed to take action by 2025 to achieve significant reductions in marine debris to prevent harm to the coastal and marine environment. Besides being supportive of the Global Partnership on Waste Management, the GPML seeks to protect human health and the global environment by the reduction and management of marine litter as its main goal, through several specific objectives.

UNEP provides the Secretariat for the GPML in line with the mandate received in the 'Manila Declaration on Furthering the Implementation of the GPA', and leads on the focal area on land-based sources of marine litter. FAO and IMO lead the focal area on sea-based sources of marine litter.

The GPML is initially guided by the 'Honolulu Strategy, which provides a global framework for prevention and management of marine debris' and works as a 'coordinating forum' for all stakeholders working in the area of marine litter prevention and management, thereby assisting stakeholders to complement each other's efforts. Various activities are ongoing at global, regional, national and municipal levels including:

(a) support for the internationalisation of the 'beat the microbead initiative';

(b) support for the 'Valuing Plastic' publication;
(c) in collaboration with FAO, a desk review/study of technologies and methodologies used to remove ALDFG from the marine environment;
(d) the development of methods to 'Estimate the Efficiency and Duration of Ghost Fishing, Estimates of Derelict Gear, Estimates of Megafauna Ghost Fishing Mortality, and Regional Fisheries Management Organization Management Measures'; and
(e) review and analysis of national and regional legal and policy frameworks for selected countries/regions where recovery and clean-up missions have been successful, including in Norway, the USA, and Australia and Korea and others.

The GPML has also supported the development of regional, national and municipal marine litter action plans as well as a demonstration project in Samoa.

3.2.1.3 UNEP/CONVENTION ON MIGRATORY SPECIES (CMS) ACTIVITIES

See Item 1.7.2.

3.2.1.4 SPREP REGIONAL ACTIVITIES

Donoghue and Haynes reported on the activities of the SPREP and commented that the workshop was very timely to assist SPREP in its work. SPREP is the regional intergovernmental organisation responsible for the coordinated management and conservation of the environment of the Pacific Islands. It is composed of 21 Pacific Islands Countries and Territories (American Samoa, CNMI, Cook islands, FSM, Fiji, French Polynesia, Guam, Kiribati, Nauru, New Caledonia, Niue, Palau, PNG, RMI, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu and Wallis and Futuna) and 5 'metropolitan' members (Australia, France, New Zealand, UK and USA) with interests in the region. The SPREP region is approximately 98% ocean and coastal seas and covers some 38 million km^2, over 10% of the global ocean, most of which is contained within the EEZs of members.

Two of SPREP's four work Divisions (Biodiversity and Ecosystem Management, and Waste Management and Pollution Control) have a direct interest and mandate for improving regional management of marine debris. Marine debris has been a problem in the region for some years, and the other regional agencies with responsibilities for monitoring and managing fishing activities (Secretariat for the Pacific Community, SPC, and the Forum Fisheries Agency, FFA) have been collecting some data on an opportunistic basis. However, SPREP has only recently been able to devote resources to assessing the significance of this issue, through the following programmes that have been initiated within the last year:

(a) A postgraduate student (Ms Ana Markic) is being supported by SPREP to undertake a PhD at Auckland University to assess the provenance and distribution of marine debris in the SPREP region and its impact on marine wildlife.
(b) In association with the South Pacific Whale Research Consortium, SPREP has recently launched a web-based programme to report stranded whales and dolphins (*http://apodstrandings.org*). It is hoped that this will encourage a better rate of reporting of strandings than has occurred in the past and result in a larger number of necropsies to determine whether debris was potentially a causative factor in any given stranding event;
(c) SPREP has begun collaborations with the IWC to improve the level of training and the amount of data reported from the region. Very recently, Mattila conducted a training event in whale disentanglement with officials and NGOs from Tonga and Vanuatu, and has left behind a specialist kit for future use.

Fundamentally, SPREP is not a research agency, but a co-ordinating body that relies on developing collaborations with technically skilled parties with a shared interest. SPREP appreciates the invitation to this workshop and the opportunity to participate in future collaborations with the IWC, government agencies and institutions, and NGOs with an interest and experience in addressing the growing problem of marine debris and its impacts on the marine environment, and on cetaceans and other iconic marine wildlife of the Pacific Islands.

A number of recommendations were developed from the discussion that followed this presentation and can be found under Item 8.1.

3.2.1.5 NATIONAL AND REGIONAL PLANS FOR PREVENTION AND RECOVERY (INCLUDING LEGISLATION AND OTHER INITIATIVES) – EFFICACY, GAPS AND LESSONS LEARNT

Wallace reported that the NOAA Marine Debris Program undertakes many activities in order to prevent the occurrence of marine debris. The US Congress has authorised and mandated the Program to identify, determine sources of, assess, prevent, reduce, and remove marine debris, with a focus on marine debris posing a threat to living marine resources and navigation safety; and to provide national and regional coordination to assist States, Indian tribes, and regional organisations in the identification, determination of sources, assessment, prevention, reduction, and removal of marine debris.

The focus of the US program is to work with local partners to conduct on-the-ground outreach to encourage behaviour changes. There have been regional action plans developed in Hawaii, the West Coast and the Great Lakes. Plans are currently being developed in Florida and the Southeast United States. All of these plans include prevention as a major component. Monitoring is an important part of determining baseline levels of marine debris and to determine if prevention efforts are working. NOAA has developed protocols that many partners are using to monitor levels of debris. NOAA also

has a curriculum that can be shared with educators and funds specific projects around the country. Examples of these projects include teacher workshops with the Monterey Bay Aquarium, the Gyre Exhibit at the Anchorage Museum, the Teen Marine Debris Summit with the Mystic Aquarium, and exhibits at the National Zoo. Wallace concluded that the key lessons learned included that prevention can be low cost, while some activities can be large scale, regional hands on approaches seem to have the biggest impact, and it can be difficult to measure success.

The Workshop noted that some of the well-developed initiatives now being deployed in the USA might help to inform initiatives elsewhere in the world.

3.2.2 Data needs and recommended research actions to inform longer term management strategies for addressing the impacts of marine litter on cetaceans

3.2.2.1 ASSESSING IMPACTS OF INGESTION (MACRO AND MICRO) AT THE INDIVIDUAL AND POPULATION LEVEL - REPORTING OF INCIDENTS TO IWC

Baulch presented results from a literature review of data on debris ingestion by cetaceans (Baulch and Perry, 2014a; 2014b). The review found that ingestion of debris has been documented in 48 (56% of) cetacean species, with rates of ingestion as high as 74% in strandings analysed from certain populations. Plastics were the dominant type of debris ingested, with parts of fishing gear also frequently ingested. Debris-induced mortality rates of 0–10% have been documented in stranded animals where a cause of death could be determined, suggesting that debris could be a significant threat to some populations; however data on ingestion and mortality rates is only available for a few species and regions and there is no information on rates of sub-lethal pathology in stranded animals examined. A significant problem is the lack of storage of information on debris interactions by strandings networks.

The Workshop noted that recommendations had been made by the first IWC Marine Debris Workshop (IWC, 2014a) and endorsed by the IWC Scientific Committee (IWC, 2014b, pp.18-19). These included necropsy protocols and the addition of specific data fields to the national progress reports made to the IWC, in order to collate data on rates of debris interactions and thereby improve understanding of the threat that marine debris poses to cetaceans and to inform prevention and mitigation actions.

Baulch also provided a brief review of current microplastics research. It was noted that oceanic sampling indicates that the abundance of microplastics has significantly increased in some areas (Goldstein *et al.*, 2012; Rochman and Browne, 2013), and that ingestion has now been demonstrated in many marine species, including plankton, fish, and (using phthalates as a tracer) also in Mediterranean fin whales (Fossi and Depledge, 2014; Frias *et al.*, 2014; Lusher *et al.*, 2013; Van Cauwenberghe and Janssen, 2014; Wright *et al.*, 2013). However, the physiological and toxicological effects of microplastic ingestion for cetaceans remain poorly understood. Specific recommendations regarding research priorities for microplastics were made by the first workshop on marine debris (IWC, 2014a).

In discussion, the Workshop **welcomed** the addition of microplastics research to the IWC Pollution 2020 workplan. It noted that it would be helpful to many initiatives to more widely disseminate the research recommendations made by the first IWC workshop on marine debris and this is the subject of a recommendation under Item 8.6.

3.2.3 Immediate opportunities and recommendations for policy/management action by the IWC on 'other' [non-fishing derived] debris

The Workshop took note of the research recommendations made by the previous IWC workshop on marine debris and its recommendations on policy and management can be found under Item 8.

4. THE ROLE OF THE IWC AND OTHER INTERNATIONAL BODIES IN ADDRESSING MARINE DEBRIS

The potential role of the IWC alone, and in concert with other IGOs, was considered first by a number of small break-out groups. These groups also discussed the major impediments to progress on marine debris. In introducing this topic, Simmonds suggested that the strengths of the IWC include its regular reviews of the status of cetaceans and the threats that they face as conducted primarily by its Scientific Committee (a body of some 200 scientists from across the world which meets on an annual basis). He noted that the Scientific Committee's cutting-edge work extended to all cetacean species, which between them occupy all the world's oceans from the tropics to the poles and some of the larger river systems. Information coming from the IWC Scientific Committee and the IWC's ongoing disentanglement initiatives could be of assistance to other IGOs in helping to inform their work, including outreach to policy makers and the public. In many parts of the world, cetaceans can be good educational and outreach tools that can help relate the problems of the oceans to wide audiences.

Simmonds added that whilst the IWC may not be the lead agency in tackling marine debris it had considerable potential to facilitate the work of other agencies. Collecting and sharing information between all concerned parties that leads to effective actions to address marine debris would seem to be a priority and so the challenge may be how best to achieve this.

The Workshop identified a range of impediments to progress in reducing sources of marine debris. In particular these included:

(a) the need for more innovative partnerships that can help to reach out to the public to shift market forces towards more sustainable practices;

(b) a general lack of engagement with the relevant industries, including fisheries and waste management on land;
(c) a general lack of funding and resources – all of which underpinned the need for productive partnerships;
(d) inadequate waste management standards on land and at sea;
(e) the lack of opportunity (including the lack of an appropriate platform) for sharing effective solutions to marine debris and prevention solutions; and
(f) problems related to high IUU and unsustainable fisheries (leading to discarding of gear and high-risk fishing practices); and that industry needs to give consideration to the full environmental costs of different types of debris.

Following the break-out group work and further discussion and prioritisation in plenary, the Workshop concluded a number of recommendations (see Item 8).

5. DISENTANGLEMENT

5.1 Review of disentanglement training programmes and key needs/opportunities for growth

5.1.1 The IWC programme

As noted earlier under Item 1.6.2, much of the 2011 IWC workshop on entanglement (IWC, 2013), was focused on developing a strategy, curricula and advisory group to carry out the capacity building recommended at the first workshop (IWC, 2012). The result was a three-pronged strategy of: (1) providing an overview of the issue to relevant Government decision-makers and provide a context for the IWC endorsed capacity building; (2) discussions with appropriate resource managers about feasible team and network structure; and (3) detailed entanglement response training by members of the IWC expert advisory group.

The two-day training consists of one day on land, largely in a classroom, where all participants are given an overview of the issue globally, with background information on how other countries are approaching this problem. In addition, the host Government is asked to provide a brief overview of what is known for the region, including: species and gear involved, examples of local events, and any local regulations. An overview of the science and methods used to understand the issue is also presented, and two overarching 'principles' are reiterated. Firstly, that human safety must come first, and secondly, that disentanglement is only the first step; prevention is the ultimate solution to this problem, and all responses to an entangled whale should include gathering information (safely) that will eventually lead to prevention.

The remainder of the first day is spent going over safe disentangling procedures using many images and video clips to illustrate the proper use of tools, techniques and safe decision-making procedures. The number of attendees for the first day in the class is only limited by the size of the room. However, not all of the attendees will be candidates for the hands-on training on the water, during the second day.

The second day takes place on the water. Two small boats (per trainer) are used; one acting as the 'whale' and the other as the 'rescue' boat. The 'whale' boat tows a long rope with a variety of objects on the end (e.g. buoy, tangle of net….etc.), as the 'rescue' boat makes multiple approaches using various tools. As only 2 trainees are in the 'rescue' boat at any time, and the process is time-consuming, only 10-12 trainees can be accommodated.

Since the 'hands on' work releasing a whale can be dangerous, and the second day can only accommodate 10-12 trainees, the following consensus criteria are provided in order to help identify key trainees for the second day:

(a) experience with whale behaviour and driving small boats around whales;
(b) experience with fishing gear and with handling lines under powerful 'load' or strain;
(c) experience with small boat safety;
(d) adequate physical fitness;
(e) availability to respond (there is no point training someone who will not be around or available to respond);
(f) level-headedness (is able to remain calm and think clearly in stressful situations); and
(g) authorisation of the relevant authority and, if applicable, has the requisite insurance.

At the conclusion, the trainees are evaluated and the trainer works with the relevant authority to identify key participants who may be able to undertake a three week apprenticeship with one of the existing networks. So far these apprenticeships have been conducted at the Center for Coastal Studies in the USA, as they have: rescue facilities, proximity to whales, ongoing entanglement related research and proximity to other valuable sources of related experience (e.g. necropsy and stranding, fishing gear research, etc.). This is effectively training future trainers for the country represented.

IWC training requires that the member state is aware of and approves that training takes place; in several instances a country will request and support the training. Requests that come through the IWC to the expert trainers are prioritised using the following criteria:

(a) Conservation: how endangered is the whale population and how significant is the entanglement impact?
(b) Human safety: are well-meaning but untrained people currently responding with dangerous techniques?
(c) Animal welfare: how many whales are likely to benefit from the range states developing a response network?
(d) Socio-economic impact: is the impacted fishery artisanal, or subsistence?
(e) National support: has the country requested or sanctioned the training?

(f) Added impact: does the training fit into and/or encourage other productive initiatives?
(g) Funding: is there logistical and financial support?

A productive approach has been to partner with regional IGOs in order to provide the training in fulfilment of regional action plans (e.g. the SPAW marine mammal action plan in the Wider Caribbean, and the SPREP whale and dolphin action plan in the South Pacific). The global entanglement response network now includes networks from 19 countries, and upcoming training is planned or in discussion for Mexico, Chile, and Russia.

In conclusion, training needs to better incorporate debris into its curriculum and needs political, logistical and financial support to continue. In particular, it was noted that the IWC had identified some regions and populations (e.g. Northern and Southeast Pacific right whales, Arabian Sea humpbacks and Western grey whales) as high priority for capacity building due to their conservation status and suggested that partnering with regional IGOs may be a way to accomplish that.

In discussion, the Workshop **recognised** that the IWC has long-standing engagement, both formal and informal, with many of the IGOs working on this issue. In addition, it **highly commended** the recent collaborative work accomplished on the large whale entanglement issue, which for whales is a major component of this important topic, with some of these IGOs, as well as NGOs and countries. In particular, it highlighted the recent partnerships with UNEP-CEP-SPAW, which co-sponsored human impact and entanglement training in the English, French and Spanish speaking Wider Caribbean, the cooperative work with the Permanent Commission of the South Pacific for training in Ecuador, including participants from Chile, Peru, Colombia and Panama, and the recent training in Tonga, which included support by the USA (NOAA), SPREP and WAP.

Kwann expressed the view that the regional UNEP programmes and their NGO partners in the Middle East would probably be interested in partnering in that region. It was also noted that, prior to the development of the 'official' IWC training, that NOAA and NGO partners had conducted training for subsistence fishers in Zanzibar.

In response to questions about tool costs and longevity, Mattila noted that an important consensus principle of the expert group was that, given the inherent danger in rescue efforts, the tools should always be accompanied by the expert training in how to use them safely and effectively. So far the trainers have been able to leave tools after the training with the appropriate authority in each country or region with the agreement that they may be copied for replacement, and expansion of their network, hopefully through trainings conducted by their successful apprentices. Some participants also noted that some of the same tools, and similar ones, have been provided, with proper instruction, to fishers so that they can help release turtles and other large animals from their gear (e.g. Hawaiian longlines).

In discussion of the data collected during and after entanglement events it was noted that, because gear can vary widely from region to region, specific training on gear (or debris) identification could not be provided, but that many established networks work with fishers and fishery engineers, in order to make determinations about origin. The value of understanding both the gear and debris (e.g. on the nearby beaches) in the area that the entanglement may have occurred, as well as the gear on the animal itself was noted.

The Workshop was pleased to hear that the IWC expert group is planning to meet within the year, and that assisting the IWC in developing the fields and guidance for a global cetacean entanglement database will be a major agenda item for that meeting. Incorporating the most current information on differentiating between actively used and ALD fishing gear, would be very useful (see Item 3.1.4.1).

Finally, while the generous support of the USA (NOAA) and WAP has accomplished a reasonable amount and was graciously noted, increased and sustained funding for continuing and expanding the programme is needed. It was noted that the IWC has a dedicated 'entanglement fund' into which countries, IGOs and NGOs can make voluntary contributions for this and related work.

5.1.2 NOAA

Saez reported on some of NOAA's recent work along the West Coast of the USA. NOAA's NMFS West Coast Regional Office (WCR) has been compiling data on entanglements and large whale migratory movements to identify areas of overlap and increased risk of entanglement[23]. The results of that effort are presented in a NOAA Technical Memorandum (Saez *et al.*, 2013). NMFS WCR hosted a two-day workshop to review, share, and analyse the information from Saez (2013) (along with results from similar analyses from other fisheries in the Pacific and Atlantic Oceans and other current research with interested stakeholders), to promote feedback, and consider next steps in achieving the long-term goal of reducing large whale interactions with fixed gear fisheries.

NMFS WCR workshop participants included scientists, managers, and experts with knowledge of large whales, large whale entanglement and fisheries. Presentations spanned several topics including: risk assessment models; large whale abundance, distribution and behaviour; fishery characterisations and management regimes; and, gear reduction/recovery efforts. The NMFS WCR workshop concluded that although the models presented provide direction on where whales are more likely to encounter commercial fishing gear, more research is needed to understand the conservation concerns

[23] *http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/fisheries_interactions.html*

and the mechanisms of large whale entanglement to help better inform future management actions aimed at reducing whale entanglement risks. In the interim, NMFS WCR workshop participants identified action items that may be pursued such as gear marking and engagement with the commercial fishing industry through port-based meetings.

Participants at the NMFS WCR workshop had identified the four following recommendations concerning reducing large whale entanglements off the US west coast:

(1) Engage with commercial fishermen and commercial fishery managers to better understand the fisheries and what measures may be taken to fill existing data gaps.
(2) Address the unknowns surrounding large whale entanglements:
    (a) conduct research which may be needed to encourage or support some fishery management actions or legislation changes;
    (b) identify and clarify the level of conservation concern surrounding population-level impacts from entanglement for different whales species;
    (c) conduct fine scale research on areas identified as having high co-occurrence of fishing gear and large whales; and
    (d) research mechanisms by which whales become entangled in gear.
(3) Evaluate the feasibility of gear modifications; e.g. research could be conducted to increase the number of traps per line, which could lead to a reduction in entanglement risk by reducing the number of vertical lines in the ocean with which whales could interact.
(4) Support lost gear and marine debris removal efforts to reduce the risk of whale entanglements.

NMFS WCR staff are planning the first set of port-based fishermen engagement meetings for the end of September 2014, modelling these on successful meetings with fishermen in Alaska. The goals of the meetings include: sharing NMFS research, discussing possibilities of researching alternative gear configurations, inquiring about the concern of the fishermen regarding entanglements of whales/other marine animals as well as gear loss, as well as gauging interest in joining the disentanglement network.

In addition NMFS WCR staff are planning a workshop for September 2014 to discuss recent efforts to quantify large whale occurrence and movements along the US west coast. The intent is to provide a forum for rich discussion on the latest work on large whale distribution and occurrence, including how results of work directly relate to management, conservation and protection of large whales and other marine resources.

It was noted that, while the IWC has been interested in whale welfare as well as the conservation aspects of entanglement, NOAA primarily concentrates on its regulatory mandates which are focused on conservation and species recovery. In discussion many participants mentioned that focusing on the welfare issue too heavily may alienate fishermen, who are essential to developing solutions. In virtually all aspects of the ALDFG issue, engagement with the fishing sector has been recognised as a key component. The Workshop recognised that the approach taken and words used were very important to success. Many noted that one to one discussions outside of formal meetings was often the most successful approach, especially at the beginning of attempts to establish co-operation.

In discussion, it was suggested that fishing gear sellers may be able to indicate how much new gear is purchased annually and may therefore help give some indication of the level of loss of various gear types.

As with understanding and preventing ALDFG, the Workshop **strongly encouraged** including the fishing sector in the growth of the entanglement response network, especially in high priority areas, and also during the follow up examinations of the gear removed from whales. Smith noted that on the Atlantic Coast of the USA, former fishers examined the gear removed from whales, and they were also the best liaisons to the fishing community.

5.2 Opportunities for marine debris entanglement reporting outreach (e.g. fishermen, shipping)

Mattila presented briefly on behalf of Lyman (who was called away due to the expected hurricanes and relayed his apologies). Lyman has participated in a number of workshops with the fishing communities in Alaska which while conducting outreach on the entanglement issue, have also provided the opportunity to listen to and gather ideas on prevention through modified gear and practices. One result was a laminated fact sheet with information on what to do if a fisher encounters an entangled whale, also contained practical tips from fishers on how to prevent entanglement in their gear (if they are tending it). Lyman noted that it was extremely valuable for managers to 'immerse' themselves in the fishers' world, including going to sea with them on occasion.

He also highlighted an outreach video produced by NOAA, which is targeted at all mariners and which has information about what they can do upon encountering an entangled whale. The video is available from NOAA and it was noted that an abbreviated version is available at *http://iwc.int/entanglement.*

In discussion, as noted elsewhere in this report, it was suggested that the issue of ALDFG be integrated into both entanglement response capacity building, and similar themed workshops with the fishing sector.

6. INFORMATION AND OUTREACH ISSUES

The Workshop noted that a number of the presentations and programmes already discussed in its report had referred to the importance of public outreach and the involvement of the local community. In this section, two example programmes were considered more specifically: the Northwest Straits Foundation and the work being undertaken by UNEP.

6.1 Public outreach, including a communications strategy for IWC

6.1.1 Northwest Straits Foundation

Drinkwin reported on the work of the Northwest Straits Foundation from Puget Sound in Washington State, USA, in particular its communications and public outreach related to its ALDFG Fishing Gear Program. Puget Sound has a unique and severe problem with ALDFG because of its high relief rocky habitat and long history of salmon gillnet fishery. Since 2002, the Northwest Straits Foundation, working as part of the Northwest Straits Initiative, has removed 4,925 ALDFG nets, weighing 365 tonnes, and spanning 708 acres. Found entangled in these nets were over 300,000 animals, representing more than 240 unique marine species, including harbour porpoise and other mammals, marine birds, protected fish and commercially valuable invertebrates. Projected annual impacts based on a published catch rate model exceed 3 million animals annually entangled by the nets removed.

The Northwest Straits Foundation has engaged in program outreach since the program inception. As in any communications strategy, there are some basic steps to make sure your efforts are focused and effective (see Fig. 2). Steps include: identify your goals (what do you want to happen?); identify your target audience (who do you want to take action?); how do you reach them (what are you going to do?); how do you know you've succeeded (what are you going to measure?). The Foundation's communications approach has been taken in stages. Initially, the goal was to increase awareness of the problem of ALDFG gear by resource managers. Next, the goal was to build support for the removal programme from funders. Currently, the goal is to increase timely and accurate reporting of newly lost fishing nets by active fishermen. Future activities may focus on preventing crab pot loss by recreational crab fishermen.

Activities	Project Outputs	Short-term Outcomes	Measure	Long-term Outcomes
Develop information material explaining impacts of derelict gear and the reporting system	Rack card and letter to fishermen	Improved reporting of lost nets	Ratio of newly lost nets reported by fishermen to those reported by others	Reduced impacts of derelict fishing nets on marine species and habitats
Mail reporting information annually to non-tribal commercial fishermen	800 letters mailed to licensed gillnetters	Improved ability to locate and retrieve lost nets	% of reports made within 24 hours	Newly lost nets are removed before they become derelict
Communicate annually with Tribes previously contacted	15 phone conversations with tribes	Database populated with accurate lost net locations	% of reports with accurate location information	
Meet annually with Tribes not previously contacted	9 meetings with tribes	Increased awareness of impacts of derelict gear among fishermen		
Develop advertisement explaining derelict gear impacts and reporting system	Print ready advertisement			
Advertise in commercial fishing publications	4 advertisements in fishing publications			
Outreach at marine/fishermen events	4 presentations/ outreach activities at marine/ fishermen events			

Fig .2. A good example of how activities can be evaluated by identifying measurable outcomes (see text).

One of the focuses of the Foundation's current work is to increase reporting from fishermen. For tribal fishermen, the Northwest Straits Foundation employs a consultant to meet annually or communicate by telephone annually with tribal fisheries managers. Also, support materials are provided when requested. For non-tribal fishermen: annual mailings are sent to all licensed fishermen; advertisements have been placed in Pacific Fisherman magazine; and information is provided through the Washington Department of Fish and Wildlife regulatory information to fishermen. The Northwest Straits Foundation has measured success by documenting how many reports of newly lost nets were received and what per cent of those reports came from fisherman and how adequate were the reports to find and retrieve the nets. Over an eighteen month period, 23 lost net reports were received, with three coming from fishermen. Reports resulted in 10 nets retrieved.

The Workshop **commended** this work as an example of excellent uses of various outreach tools, whilst **recognising** that different strategies may be needed in different parts of the world with regard to the best approach to different target

audiences. In that context, it was noted that the IWC needs to identify who its 'target audience' is for any outreach that it considers.

6.1.2 UNEP
Savelli summarised some of UNEP's education and outreach projects on the topic of marine debris that are either planned or currently underway. These vary considerable, depending on their target audience, region or intended messages. Some of the projects that she highlighted included: sponsoring competitions for students and faculty at Universities, with challenges to develop better ways to locate, recover, communicate and prevent marine debris; online courses and sources of information on the topic; photographic competitions; professional documentaries; development of 'edutainment'; traveling exhibitions for museums and public spaces (e.g. subways and airports); interactive kiosks (e.g. at aquariums); involvement of celebrities (e.g. actors, sports and other well-known individuals); working with professional public relations and marketing companies; and the use of new communication technologies (especially Apps) for communicating to and engaging with the public.

In particular a key principle, especially when working with the general public, is to give them 'actions that they can do'. Apps in particular might represent good opportunities to both educate and engage. In addition, IGO, NGO and Government personnel who are attempting to advance a message on this (or any) topic, should strongly consider media training.

The Workshop **commended** UNEP on the variety, scope and creativity of their many projects. In particular, it **recognised** the importance of getting good, accurate information to all target audiences. It also noted, especially in the case of some of the more emotional aspects of debris' impact on animals, that it can be very helpful to responders if the public, industry and government, have solid information in advance. During any high profile events (e.g. an entangled whale), it is a good time for all stakeholders to use the opportunity as a 'teachable moment' with shared common talking points, where possible.

6.1.3 General outreach matters
The Workshop reiterated a common theme that it takes all stakeholders working together to find a viable long-term solution to the problems posed by debris. Keeping all stakeholders onboard can be difficult at times but the results are longer lasting. In this regard it was noted that an incident where a fishermen was penalised for helping release a whale, in the Northeast USA, disrupted an ongoing working relationship and that this has the potential to make fishermen reluctant to help.

With respect to the public (or most audiences) it is important to explain what they can and should do to help. There was some discussion about which audience is the highest priority to affect change. This will depend on the particular type of change desired - in some instances the best target may be managers and politicians but in others it may be the broader public; politicians often respond when many people demonstrate their desire for change.

Several participants noted the use of new technology and social media as a powerful tool for communication and engagement, and much of this engagement is measurable. In particular, UNEP and others are interested in Apps[24] as a way to educate and engage. However, when considering some of these tools as a way to collect data, developers and proponents need to be sure that they understand and communicate clearly what is required, otherwise there is the risk of collecting unreliable data and disappointing users who may have high expectations.

Some suggested that when using mass media for communication or 'edutainment', celebrities can be very helpful in getting attention; the value of undertaking media training when dealing with the mass media was stressed. The value of images, video and art was also highlighted. This is especially true for any 'captured' audience, whether the public in an airport, cruise ship or commissioners in a conference hall. 'Calendar events' can also help to draw attention to issues as witnessed by events like 'whale day' and SPREP's upcoming 'year of the whale'.

With regard to how the IWC and other IGOs can best communicate with the relevant target audiences, the Workshop **agreed** that the report of this workshop should be distilled and highlighted into an executive summary for the IWC's member countries and those of other IGOs. This could be placed on the IWC's new and expanding web site. In addition, it was suggested that the IWC, member countries or NGOs might hold side events where feasible at meetings of the parties. One potential opportunity might be to participate in COFI 2016 side events addressing bycatch and incidental capture of non target species.

The Workshop also discussed how outreach may lead to better data. This would most likely focus on the fishing sector, but could include all mariners and beach users. It was noted that gear marking can and should more often be portrayed in a more positive light to the fishing industry as a tool to reduce gear loss, unintended biodiversity impacts and to distinguish bona fide gear from IUU gear. Finally, the Workshop noted that there is a tremendous amount of good information on this topic available from a variety of sources, in fact so much that it can be overwhelming, and thus it needs to be 'distilled' to the needs of the target audience.

[24] For example, NOAA has a marine debris tracker: *http://www.marinedebris.engr.uga.edu/*

7. IDENTIFYING PRIORITY RESEARCH AREAS (FROM THOSE IDENTIFIED ABOVE) AND POTENTIAL SOURCES OF FUNDING

The Workshop recognised the funding implications of many of its recommendations and **acknowledged** that these were beyond the funding ability of the IWC alone and in many cases related to work beyond simply cetacean issues. It also noted ongoing work within the IWC to consider alternative sources of funding to the present model. A recommendation on this issue is given under Item 8.5.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1 Collaboration

The Workshop **emphasises** that the issue of marine debris, while important for cetaceans, was a major environmental issue in its own right that was already the subject of a number of important international and national initiatives. There is a need to identify a coordinating body to review all of the international efforts related to marine debris and compare the resolutions and recommendations, identify those that overlap and facilitate prioritisation and implementation (e.g. the UNEP Global Partnership on Marine Litter[25]).

It further **emphasises** that any lack of strong evidence of quantified impacts for some cetacean species and some debris types at present should not preclude efforts to remove existing debris and prevent future accumulation in the marine environment. It also **agrees** that, from an animal welfare perspective, the absolute number of cetacean entanglements and the associated suffering and times to death are unacceptable, irrespective of population level effects.

The Workshop **agrees** that the IWC's primary contribution should be to ensure that cetacean-related issues and specific impacts on cetaceans are adequately represented within existing marine debris initiatives and that its strong scientific and other expertise is made available in collaborative efforts.

It **strongly recommends as the highest priority** that the IWC and its Secretariat work together with the Secretariats of the other major IGOS and RMFOs relevant to this issue to ensure consistency of approach, synergy of effort and collection and exchange of information to develop appropriate mitigation strategies that recognise that: (a) prevention is the ultimate solution; but that (b) removal is important until that ideal is realised.

It also **recommends** that individual IWC member countries collaborate with such initiatives and that the IWC continues to highlight issues surrounding marine debris and cetaceans.

The Workshop also **recommends** that every effort is made to work with fisheries, terrestrial waste management industries and other relevant industries and NGOs as appropriate. Understanding both the extent of the actual and potential threats to cetaceans as well as the development of mitigation measures cannot be achieved without industry involvement. The present workshop has begun that process but increased industry participation at relevant future workshops and other IWC initiatives (see below) is strongly encouraged. In addition, the IWC Secretariat and Member Governments should explore opportunities to build awareness and collaboration with the commercial sector, for example at industry events.

Finally, the Workshop **recommends** that the IWC (and other IGOs) encourage their members to review national level implementation of MARPOL Annex V and other conventions relevant to marine debris reduction. The IWC should **encourage** its members to prioritise the strategic use of a range of measures to improve marine and terrestrial waste management, including national legislation and policy, stakeholder partnerships, industry training schemes and economic tools aimed at reducing public consumption of key types of debris such as packaging waste.

8.1.1 IMO

The Workshop noted that the IMO, within the context of MARPOL Annex V, is the relevant UN agency with which to collaborate on the plastics (including fishing gear) that are disposed of at sea as well as to gather information on Member States enforcement and industry compliance with the MARPOL Annex V prohibition on discarding of other vessel-generated garbage. GISIS (Global Integrated Shipping Information System) provides a searchable database of port waste reception facilities and this is a potentially valuable tool to help decrease ALDFG and other marine debris. It **recommends** that the IWC and IMO Secretariats consider the most effective way (e.g. via IMO's Marine Environment Protection Committee) to request that the GISIS port reception facility database is updated to specify which ports accept end of life fishing gear, including any restrictions on the gear they accept and additional useful information (such as recycling potential) and to encourage an expansion of the provision of no-special-fee port reception facilities.

8.1.2 SPREP

The Workshop **welcomes** information that SPREP will report annually to the IWC on progress with initiatives on the issue of marine debris. It **encourages** SPREP to work with regional and international agencies on existing and new initiatives to address the problem of marine debris including its impact on cetaceans.

[25] *http://www/marinelitternetwork.org/page/global-partnership-marine-litter.*

8.2 Data needs and research recommendations

The Workshop **endorses** the research recommendations from the previous workshop (IWC, 2013) and the recent Scientific Committee meeting (IWC, In press) including incorporation of data on marine debris into IWC national progress reports in a standard format and development of a global IWC entanglement database. The items below are expansions or additions to those recommendations.

8.2.1 Improved information on fishing gear including gear marking

There is sufficient evidence to show that entanglement in fishing gear can be a significant mortality factor affecting the conservation status of several endangered large whale populations (e.g. North Atlantic right whales, gray whales in the western North Pacific, humpback whales in the Arabian Sea) and is perhaps the major human activity affecting small cetacean populations worldwide (e.g. Read *et al.*, 2006) including one critically endangered species, the vaquita. However, the Workshop **agrees** that while at present COAFG was the major factor, there was insufficient evidence to reliably assign a precise proportion of entanglements to either COAFG or ALDFG (or both). It therefore **recommends** that a concerted effort be made to collect data using a standard approach that will allow a better assignation of entanglements (see Item 3.1.4.1); this matter will be discussed further at the 2015 workshop of the Global Entanglement Response team where consideration could be given to the development of working guidelines on differentiation methods which could be regularly reviewed as knowledge improves.

The Workshop also **agrees** that the development of priorities for mitigation strategies for cetacean entanglements (both commercial and other active fishing gears and ALDFG) was hampered by a lack of reliable information on a number of factors related to gear including: gear types, loss rates of the various gear types, the persistence of ghost gear by type as a threat in the water column, and the 'fishery of origin' of ghost gear. Recognising past and existing efforts, especially within FAO, with respect to the marking of gear, it **recommends** that the IWC **encourages** COFI to conclude its work on gear marking and that the IWC participates in technical work associated with its finalisation, this process, drawing attention to the value that gear marking can contribute to mitigation approaches. In particular, it noted that a 'low-tech' gear marking scheme in combination with examinations of gear removed from whales would be particularly important to resolve three key questions: (1) the region in which gear is set; (2) the fisheries from which gear came (e.g. traps vs gillnets); and (3) the part of fishing gear from which it came (e.g. buoy lines vs. groundlines between traps).

The Workshop also **recommends** that the IWC **encourages** disentanglement and stranding teams to collect detailed information on entangling gear/material that is removed from whales, and on marine debris present in the immediate environment of the entangled or stranded whale (although this must be interpreted carefully given the great distances whales can travel with gear), in order to improve collective knowledge of the scope and source of entangling debris (including COAFG vs. ALDFG gear). This should include improving instructions for how to discern COAFG vs. ALDFG gear (see Item 3.1.4.1), and aiming to move from subjective to more objective assessments of gear, ideally with the knowledge and expertise of local fishermen.

8.2.2 Specialist workshop

The Workshop **endorses** the forthcoming IWC workshop (anticipated March-April 2016) on prevention of the incidental capture of cetaceans. It **agrees** that this should incorporate discussion of entangling ALDFG as well as in-use gear. It **reiterates** the importance of ensuring participation of experts from industry and relevant IGOs especially FAO. The Workshop noted that there is emerging evidence that individual human behaviour plays a significant role in the introduction of anthropogenic materials into the marine environment in the context of fishing equipment (and indeed marine debris more generally). The importance of individual behaviour and operator proficiency (e.g. some individuals using the same gear as others may have higher bycatch rates and gear loss rates) should be considered as part of mitigation strategies and addressing this may in some cases prove more effective than general, industry or sector-wide measures.

8.2.3 Modelling

The Workshop **requests** that the IWC Scientific Committee explores ways of combining estimates of oceanic debris and information on cetaceans to identify priorities for mitigating and managing the impacts of marine debris on cetaceans as discussed under Item 2.5.

8.3 Consideration of the use of the IWC Conservation Management Plan approach

The IWC has developed a Conservation Management Plan approach that has thus far been used for southeast Pacific right whales, South Atlantic right whales and gray whales in the western North Pacific and other populations are being considered for candidate CMPs (e.g. Arabian Sea humpback whales). The potential for threat-based CMPs was also anticipated and the Workshop was asked to consider whether the issue of marine debris should be considered directly in that context or indirectly through individual population CMPs (entanglement is an important component of existing CMPs). Guidelines for the development of CMPs can be found on the IWC website[26].

As highlighted in this report, prevention and mitigation related to cetaceans and marine debris is a broader issue that cannot be addressed by the IWC alone; thus should the IWC agree that a CMP be developed it is essential that a broad range of stakeholders including IGOs are involved. The Workshop **agrees** that before going ahead with the development

[26] *http://iwc.int/conservation-management-plans*

of an IWC CMP focussed on marine debris, the IWC's Standing Working Group on CMPs should initially consult with the relevant IGOs to consider how this concept fits best within existing initiatives. In doing so the CMP Steering Group should consider establishing a Marine Debris sub-group to work on this issue.

Components of a CMP or other approach should include: consideration of the development of best management practices for preventing cetacean entanglement in marine debris (this will be part of the agenda for the 2016 IWC incidental catch Prevention Workshop); and the possibility of working with relevant stakeholders on one or more pilot projects to address ghost gear in specific areas.

8.4 Global Cetacean Disentanglement Network

The Workshop **commends** the present IWC Global Cetacean Entanglement Response Network, recognising its value both from an individual animal welfare perspective as well as at the population level, especially for threatened and endangered populations. The network is extremely valuable and effective in building capacity and raising awareness. The Workshop therefore **recommends** that the IWC continues to support and develop this network, and carefully considers incorporating the issue of all marine debris into the training programme. This could include the dissemination of information on gear identification, data collection and necropsy protocols which were developed during the first workshop on marine debris (IWC, 2014a). The Workshop **stresses** the importance of involving the local fishing communities in the training.

The Workshop **encourages** all members and non-members of the IWC to take advantage of this network especially in those regions where entanglement represents a threat at the population level (e.g. Western Pacific, Eastern South Atlantic, and Gulf of Oman).

8.4.1 Broader implications of this approach

The Workshop **recommends** that the IWC promotes and shares lessons from its successful model of expert training/capacity building for disentangling whales (see Item 5.1). This approach could be incorporated into existing marine debris initiatives including the Global Partnership on Marine Litter as well as at the national level. Such an approach could assist in developing technical expertise and activities related to: (1) removal of ALDFG from marine areas where it accumulates (perhaps as a pilot study in an area where whales are most likely to encounter and become entangled such material); (2) collection and proper disposal of old, damaged, or dysfunctional fishing gear so that it does not become ALDFG; and (3) marine debris outreach and awareness campaigns that target fisheries and other sectors from which debris originates to explain their impacts, the importance of reducing the amount of such debris, and actions that can be taken to prevent its impacts.

8.5 Funding streams

The Workshop recognises the funding implications of many of its recommendations. It **recommends** that the IWC, in concert with other IGOs, approach a range of organisations for financial and other support including financial institutions, public and private foundations, industry, businesses and NGOs.

8.6 Outreach

As noted under Item 8.1, an important component of the IWC contribution to existing marine debris initiatives relates to the provision of expert and technical advice with respect to cetacean-related issues. As part of this contribution, the Workshop noted the need to more widely disseminate the recommendations from the first IWC workshop on marine debris and those from the present workshop. The Workshop **recommends** that the IWC Secretariat examine ways in which it and its member nations can most effectively communicate these recommendations to the relevant target audience(s) including IGOs, appropriate government agencies and NGOs. In addition, the IWC should develop a dedicated section of its website to the issue of marine debris with the assistance of a small expert group. The IWC Secretariat should also consider highlighting the IWC's work on the impacts of marine debris on cetaceans at meetings of other IGOs, e.g. the forthcoming COFI in 2016.

The Workshop also **recommends** that the IWC develops improved methods to **encourage** its member nations and others to provide the marine debris and entanglement related data discussed in this report) and to provide progress reports on their general work on reducing marine debris as part of their national conservation reports.

In general, the Workshop noted that outreach materials on this topic should: (1) be developed in cooperation with all key stakeholders, including industry; (2) be tailored to specific target audiences; and (3) recognise the powerful impact of images and video of iconic species such as cetaceans, provided that they are used carefully and in the appropriate context.

9. ADOPTION OF REPORT

Mark Simmonds thanked all participants for their hard work over the preceding three days despite some significant distractions. He noted that this was probably the first IWC workshop to be run in part in a nightclub and certainly the first to have coincided with the trajectories of two hurricanes. He thanked the workshop steering committee for its advice and similarly his co-convener David Mattila. He also expressed his gratitude to the rapporteur team (whose work was far from over), to Julie Creek of the IWC Secretariat (for her efficient administrative support to the meeting and its participants), and to Naomi MacIntosh (for effectively acting as the 'local anchor' and hotel liaison).

He noted that all the workshop's recommendations had been agreed and approved during the course of the meeting and that the full report of the meeting would be drafted, circulated and approved by email in the days following. Finally, he wished everyone a safe journey home and closed the meeting at 18.32 on 7 August 2014.

Annex A

List of Participants

Claire Bass
World Animal Protection, UK
ClaireBass@worldanimalprotection.org

Sarah Baulch
Environmental Investigation Agency (EIA), UK
SarahBaulch@eia-international.org

Francis Chopin
Food and Agriculture Organization of the United Nations (FAO), Italy
Francis.chopin@fao.org

Keith Christman
American Chemistry Council, USA
keith_christman@americanchemistry.com

Andrea Cooke
IWC Secretariat
Andrea.cooke@iwc.int

Michael Donoghue
Secretariat of the Pacific Regional Environment Programme (SPREP), Samoa
Michaeld@sprep.org

Greg Donovan
IWC Secretariat
Greg.donovan@iwc.int

Joan Drinkwin
Northwest Straits Foundation, USA
drinkwin@nwstraits.org

Michelle Evans
Department of the Environment, Australia
michelle.evans@environment.gov.au

Kirsten Gilardi
UC Davis Wildlife Health Center, USA
kvgilardi@ucdavis.edu

Eric Gilman
FAO Consultant,
Hawaii, USA*EGilman@fisheriesresearchgroup.org*

Bill Gilmartin
Hawaii Wildlife Fund, USA
bill.hwf@gmail.com

Gail Godenzi
Covanta Honolulu R.R.V.
ggodenzi@covantaenergy.com

Riki Gunn
GhostNets Australia, Australia
riki.ghostnets@northerngulf.com.au

Britta Denise Hardesty
CSIRO Oceans and Atmosphere Flagship, Australia
Denise.Hardesty@CSIRO.au

David Haynes
Secretariat of the Pacific Regional Environment Programme (SPREP), Samoa
DavidH@sprep.org

Elizabeth Hogan
World Animal Protection, USA
ElizabethHogan@worldanimalprotection.us.org

John Kieser
Plastics/SA, South Africa
John.Kieser@plasticssa.co.za

Kyle Koyanagi
NOAA, PIFSC, Hawaii, USA
Kyle.koyanagi@noaa.gov

Donna Kwan
UNEP/CMS Office, Abu Dhabi, UAE
dKwan@CMS.int

David Laist
Marine Mammal Commission, USA
dlaist@mmc.gov

Megan Lamson
Hawaii Wildlife Fund, USA
meg.HWF@gmail.com

Ed Lyman
Hawaiian Islands Humpback Whale National Marine Sanctuary, USA
ed.lyman@noaa.gov

David Mattila
IWC Secretariat
David.Mattila@iwc.int

Naomi McIntosh
NOAA, PIFSC, Hawaii, USA
naomi.mcintosh@noaa.gov

Heidi Ruud
Norsk Fiskeriretur, Norway
Heidi@nofir.no

Lauren Saez
Ocean Associates, Inc. with NOAA Protected Resources Division, NOAA, USA
Lauren.Saez@noaa.gov

Heidi Savelli
United Nations Environment Programme (UNEP), Kenya
Heidi.savelli@unep.org

Mark Simmonds
School of Veterinary Sciences, University of Bristol and Humane Society International.
UK
Mark.Simmonds@sciencegyre.co.uk

Jamison Smith
NOAA, USA
Jamison.Smith@noaa.gov

Monika Thiele
United Nations Environment Programme (UNEP), USA
Monika.thiele@unep.org

Nancy Wallace
NOAA Office of Response and Restoration, USA
Nancy.Wallace@NOAA.gov

Chris Wilcox
CSIRO Marine and Atmospheric Sciences, Australia
Chris.wilcox@csiro.au

Annex B

Agenda

1. Introductory items
   - 1.1 Welcoming comments
   - 1.2 Appointment of Chairs and rapporteurs
   - 1.3 Objectives of the Workshop
   - 1.4 Adoption of Agenda
   - 1.5 Available documents and list of acronyms
   - 1.6 Review of previous IWC work
     - 1.6.1 Overview of the first IWC Workshop on marine debris and review of progress of recommendations
     - 1.6.2 Overview of previous IWC whale disentanglement workshops (Maui 2010; Provincetown 2011)
   - 1.7 Overview of relevant recent non-IWC meetings
     - 1.7.1 Overview of the 2012 'Untangled' global symposium hosted by WSPA (now WAP) in Miami
     - 1.7.2 Overview of UNEP, CMS, and CBD activities on marine debris
   - 1.8 Conclusions and recommendations
2. Overarching issues
   - 2.1 Clarifying marine debris terminology
   - 2.2 Improved data collection (including retention/identification of gear from cetaceans)
   - 2.3 Identifying hotspots of debris (geographically, temporally and within the water column)
     - 2.3.1 Technological data collection e.g. use of Synthetic Aperture Radar, deep sea surveys)
     - 2.3.3 Modelling approaches (e.g. cetacean and debris (lost gear/other debris) co-occurrence; fishing effort modelling)
   - 2.4 What can be learnt from other species (e.g. risk analyses for seabirds and turtles by CSIRO)
   - 2.5 Future work on high risk areas and populations
3. Developing mitigation approaches
   - 3.1 Abandoned, lost and discarded fishing gear (ALDFG)
     - 3.1.1 Overview of existing legislation, agreements and strategies to tackle ALDFG by UN agencies
       - 3.1.1.1 Minimising the incidental capture of whales in commercial fisheries – an FAO perspective
       - 3.1.1.2 Monitoring and management of ALDFG by regional fisheries management organisations and other intergovernmental organisations
       - 3.1.1.3 IMO – MARPOL Annex V
       - 3.1.1.4 UNEP (Honolulu Strategy and GPML)
     - 3.1.2 National and regional plans for prevention and recovery of ALDFG
       - 3.1.2.1 Norway
       - 3.1.2.2 USA
       - 3.1.2.3 Hawaii Marine Debris Action Plan
       - 3.1.2.4 South Korea
       - 3.1.2.5 Western Europe (Healthy Seas)
       - 3.1.2.6 Philippines (Net-Works)
       - 3.1.2.7 Australia
       - 3.1.2.8 WAP Sea Change
     - 3.1.3 Facilitated panel discussion – strengths, weaknesses, opportunities and threats
     - 3.1.4 Data needs and recommended research actions to inform longer term management strategies for impacts of ALDFG on cetaceans
       - 3.1.4.1 Diagnosing active versus ALDFG fishing gear entanglement
       - 3.1.4.2 Identifying 'problem' fisheries with high rates of gear loss
       - 3.1.4.3 Assessing impacts of ALDFG at the individual and population level
       - 3.1.4.4 Identifying ALDFG cetacean entanglement hotspots
       - 3.1.4.5 Gear modifications (e.g. rope tensioning or weak-links) and new gear development
   - 3.2 Other marine litter: macrodebris and microdebris
     - 3.2.1 Overview of existing legislation and strategies to tackle marine litter (non-ALDFG)
       - 3.2.1.1 International laws and agreements (Basel Convention, UNGA regulations A/RES/60/30 and A/RES/63/111 on Oceans and the Law of the Sea – introduction to existing international instruments
       - 3.2.1.2 UNEP Regional Seas programmes and GPA
       - 3.2.1.3 UNEP Convention on Migratory Species (CMS) activities
       - 3.2.1.4 SPREP regional activities

- 3.2.1.5 National and regional plans for prevention and recovery (including legislation and other initiatives) – efficacy, gaps and lessons learned
- 3.2.2 Data needs and recommended research actions to inform longer term management strategies for addressing the impacts of marine litter on cetaceans
  - 3.2.2.1 Assessing impacts of ingestion (macro and micro) at the individual and population level – reporting of incidents to the IWC
- 3.2.3 Immediate opportunities and recommendations for policy/management action by the IWC on 'other' [non-fishing derived] debris

4. The role of the IWC and other international bodies in addressing marine debris
5. Disentanglement
   - 5.1 Review of disentanglement training programmes and key needs/opportunities for growth
     - 5.1.1 The IWC programme
     - 5.1.2 NOAA
   - 5.2 Opportunities for marine debris entanglement reporting outreach (e.g. fishermen, shipping)
6. Information and outreach issues
   - 6.1 Public outreach, including a communications strategy for IWC
     - 6.1.1 Northwest Straits Foundation
     - 6.1.2 UNEP
     - 6.1.3 General outreach matters
7. Identifying priority research areas (from those identified above) and potential sources of funding
8. Conclusions and recommendations
   - 8.1 Collaboration
     - 8.1.1 IMO
     - 8.1.2 SPREP
   - 8.2 Data needs and research recommendations
     - 8.2.1 Improved information on fishing gear including gear marking
     - 8.2.2 Specialist workshop
     - 8.2.3 Modelling
   - 8.3 Consideration of the use of the IWC Conservation Management Plan approach
   - 8.4 Global Cetacean Disentanglement Network
     - 8.4.1 Broader implications of this approach
   - 8.5 Funding streams
   - 8.6 Outreach
9. Adoption of Report

Annex C

List of Acronyms

5IMDC	5th International Marine Debris Conference, Honolulu, 2011
ACAP	Agreement on the Conservation of Albatrosses and Petrels
ALDFG	Abandoned, Lost, or otherwise Discarded Fishing Gear
AMSA	Australian Maritime Safety Authority
ATSEA	Arafura Timor Seas Ecosystem Action programme
CAR-SPAW-RAC	Caribbean Specially Protected Areas and Wildlife Regional Activity Center
CBD	Convention on Biological Diversity
CMMs	Conservation and Management Measures
CMP	Conservation Management Plans
CMS	Convention on Migratory Species
COAFG	Commercial and other active fishing gears
COFI	Committee on Fisheries (FAO)
CPPS	Permanent Commission for the South Pacific
CSIRO	Commonwealth Science and Industrial Research Organisation
DFG	Discarded Fishing Gear
ECNC	European Centre for Nature Conservation
EEZ	Exclusive Economic Zone
EIA	Environmental Investigation Agency
FADs	Fish Aggregating Devices
FAO	Food and Agriculture Organization of the United Nations
FFA	Forum Fisheries Agency
FMP	[Indonesian] Fisheries Management Plan
GEF	Global Environment Facility
GGGI	Global Ghost Gear Initiative
GISIS	Global Integrated Shipping Information System
GNA	Ghost Nets Australia
GOM	Gulf of Maine
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
GPML	Global Programme on Marine Litter
GPWM	Global Partnership on Waste management
H-POWER	Honolulu Project Of Waste and Energy Recovery
IMO	International Maritime Organization
IUU	Illegal, Unreported and Unregulated fishing
IWC	International Whaling Commission
MARPOL	International Convention for the Prevention of Pollution from Ships
NOAA	National Oceanographic and Atmospheric
POV	?
PRF	Port waste Reception Facilities
RMFO	Regional Marine Fisheries Organisations
SAR	Synthetic Aperture Radar
SPREP	Secretariat of the Pacific Regional Environment Programme
UNEP	United Nations Environment Programme
UNEP-CEP-SPAW	United Nations Environment Programme Caribbean Environment Programme Specially Protected Areas and Wildlife
UNGA	United Nations General Assembly
WAP	World Animal Protection
WCGA	West Coast Governors' Alliance of Ocean Health
WCR	West Coast Regional Office
WGW	Western gray whales
WSPA	World Society for the Protection of Animals (now WAP)
WWF	World Wide Fund for Nature
ZSL	Zoological Society of London

Annex D

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