Annex J

Working Group on Non-deliberate Human-Induced Mortality of Large Whales

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1. CONVENOR'S OPENING REMARKS AND TERMS OF REFERENCE

Leaper welcomed the participants and noted that this Working Group would continue to work on non-deliberate, human induced mortality with an emphasis on both bycatch and ship strikes. In addition, the Committee's agenda identifies close links with the Commission's Working Groups including collaboration with Commission initiatives on entanglement and the Commission's Ship Strikes Working Group.

2. ELECTION OF CHAIR

Leaper was elected as Chair.

3. ADOPTION OF AGENDA

The agenda was adopted unchanged.

4. APPOINTMENT OF RAPPORTEURS

Mattila offered to serve as rapporteur.

5. AVAILABLE DOCUMENTS

SC/66a/HIM01-15, SC/66a/BRG15, Fais *et al.* (2015), Ritter *et al.* (2015), Bezamat *et al.* (2014), Ijsseldijk *et al.* (2014), Reseau d'observation de mammiferes marins (ROMM) (2014), Zitterbart *et al.* (2013), NOAA (2014), Ports of Auckland (2014), Monnahan *et al.* (2015), Irvine *et al.* (2014), Constantine *et al.* (2015), McKenna *et al.* (2015), Van der Hoop *et al.* (2015) and Pace *et al.* (2014).

6. ENTANGLEMENT

6.1 Progress on including information in National Progress Reports

The Secretariat produced a summary of large whale bycatch reported to SC/66a through the National Progress Reports (Table 1 and 2). It was noted that only seven countries were represented as reporting to this year's meeting which is the fewest in recent years. It was also noted that only 14 countries have filled out their National Progress Reports online since the system went live. The system does not assume and report 'zeros' if a country fills out other parts of the online progress report but does not select the large whale bycatch section. They have to enter the 'zeros' manually. Some members also wondered how the proposed entanglement database would impact National Progress Reporting, and whether the bycatch section would become obsolete or result in duplication of effort. This is discussed more fully under Item 6.2.

6.2 Collaboration with Commission initiatives on entanglement, including consideration of mitigation measures

6.2.1 Report of the Provincetown Workshop

In 2007 at IWC/59, Norway, soon joined by Australia and the USA, initiated a series of Workshops and actions focused on addressing the welfare aspects of large whale entanglement. This included two Workshops (2010 and 2011), and a subsequent capacity building initiative. A third Workshop to review progress on the capacity building and provide advice on entanglement data and databases, was held 21-23 April 2015 (Provincetown, MA, USA). This was also the first official meeting of the IWC entanglement expert advisory group, since endorsed by the Commission in 2012, and the first meeting of the Global Whale Entanglement Response Network, as currently convened by the IWC. Mattila presented the aspects of the Report of the Third Workshop (IWC/66/WK-WI-Rep01) that were relevant to the Scientific Committee.

The Workshop reviewed new information on entangling gear, including the previously undocumented risk of pelagic FADs (Fish Aggregating Devices) and aquaculture, which trends suggest is increasing and moving further offshore. It also discussed new tools and techniques including some new uses of POV (Point of View) cameras and UAVs (Unmanned Aerial Vehicles) that will help to improve assessment and documentation of these events. An update on the drag and energetic cost incurred by entangled whales suggested that on average they expend 1.35 to 1.98 times the energy of non-entangled whales. In addition, new information from a study that tested the breaking strength of rope removed from entangled whales and compared it with the wounds and outcomes, suggest that this may provide insight into mitigation. Finally, the Workshop received a new analysis of the survival of entangled right whales, which indicated that entangled whales showed approximately 20% lower survival than non-entangled, but that intervention to remove the entangling gear improves their chances of survival.

Since 2012 the capacity building initiative has provided training to 336 individuals from 19 countries. All training is conducted with the endorsement, and frequently the direct support of the Government, and many were conducted in partnership with other regional inter-governmental organisations (IGOs) such as the Permanent Commission of the South Pacific (CPPS), United Nations Environment Programme's (UNEP), Caribbean Environment Programme

Table 1

Total reported bycatch incidents – outcome may be death, serious injury or unknown.

	Bowhead whale	Common minke whale	Fin whale	Gray whale	Humpback whale	North Atlantic right whale	Southern right whale	Sperm whale	Unknown large whale
Australia	-	1	2	-	10	-	-	-	-
Denmark	-	-	-	-	1	-	-	-	-
Japan	-	140	1	-	7	-	-	-	1
Korea, Rep. of	-	54	1	-	-	-	-	-	-
Peru	-	-	-	-	4	-	-	-	-
UK	-	-	-	-	1	-	-	-	-
USA*	-	12	1	17	8	4	-	-	1

*Incidents from 2012-13.

Table 2

Total reported bycatch incidents resulting in death.

	Bowhead whale	Common minke whale	Fin whale	Gray whale	Humpback whale	North Atlantic right whale	Southern right whale	Sperm whale	Unknown large whale
Australia	-	1	-	-	-	-	-	-	-
Denmark	-	-	-	-	1	-	-	-	-
Japan	-	140	1	-	7	-	-	-	1
Korea, Rep. of	-	54	1	-	-	-	-	-	-
Peru	-	-	-	-	4	-	-	-	-
UK	-	-	-	-	1	-	-	-	-
USA*	-	6	-	4	-	2	-	-	-

*Incidents from 2012-13.

(CEP) and Secretariat of the Pacific Regional Environment Programme (SPREP). This training has produced formal networks in some of the countries who now report large whale entanglements and related science more regularly to the IWC, thus assisting this Working Group. Examples highlighted at the workshop included new entanglements from Argentina and Mexico, and fishermen questionnaires from Brazil which showed an interaction rate that was high enough for fishermen to voluntarily change to lower risk gear during the season when whales were present.

Finally the Workshop reviewed existing national and regional entanglement databases. Most were organised by the case (i.e. individual whale) and some had over 150 data fields. The Workshop produced guidance to the Scientific Committee as it considers establishing a global entanglement database, and suggested that a small meeting of entanglement data experts and Scientific Committee members with this expertise was likely the best way forward.

The Working Group thanked Mattila and commended the Secretariat and the IWC entanglement expert group on the results of this Workshop and the positive overall work that it summarised. It was noted that support for the work originally came from the USA, but has subsequently been supported by numerous countries, IGOs and NGOs, who were acknowledged in the Workshop report.

The Working Group reviewed the Workshop's recommendations for the possible establishment of a global entanglement database, housed and maintained by the IWC. Members noted that requirements for such a database: (i) would need to take into consideration all potential sources of entanglement information, beyond that collected by response networks (e.g. stranding data, subsistence hunt, fisheries observers, etc.); (ii) would need to work with member countries to ensure consistency and appropriate reporting, locally, regionally, nationally and internationally; and (iii) would need to interface smoothly with the National Progress Reports. With those caveats, the Working Group endorsed the goal, objectives and considerations outlined in the Provincetown Workshop report, and **recommended** that the proposal for a small group meeting to advance this initiative go forward.

6.2.2 Evaluation of mitigation measures

Given the cryptic nature of large whale entanglement, and the subsequent paucity of events to monitor and analyse for trends, Pace *et al.* (2014) described an approach to discern if management initiatives intended to reduce entanglements in the New England region of the USA, are having the desired effect. Both the number of annual events reported and the time between events were used. The annual number of mortality events (including serious injuries) related to fishing gear entanglements averaged 2.5 for right whales, 6.5 for humpbacks, 0.6 for fin whales, and 2.4 for minke whales. Annual entanglement rates increased during the study period, but evidence for increased rates of entanglement-related mortality was equivocal. No significant changes occurred in waiting time (the number of days between entanglement events) in response to any management measures implemented to reduce large whale mortalities between 1998 and 2009, implying that these measures were generally ineffective in abating whale deaths from entanglements in fishing gear.

In discussion it was noted that simulations showed that rates of detected entanglement-related mortality would have to be reduced substantially (of the order of 50% or more) to allow a change over a ten year time frame to be detected. It was also noted that the management initiatives were incremental, but they were not listed, and there is no information if rates of compliance have been identified. As some of the management initiatives had differing goals; some were implemented to prevent entanglements altogether, and some were to lessen the likelihood of mortality, this may have further reduced the ability to detect changes. However, the Working Group welcomed the approach and hoped that with new, broader management initiatives, it may be possible to find a measurable effect with future monitoring and analyses.

6.3 Estimation of rates of entanglement, risks of entanglement and mortality

An entangled Eastern South Pacific right whale was reported off Pichilemu, central Chile, in October 2014 (SC/66a/BRG15). As there was no trained response team in the area, a full intervention was not possible. However positive steps were taken: (1) those involved in responding contacted the IWC entanglement expert group which provided consultation and advice that encouraged and produced good documentation of the event, for assessment and future possible mitigation; (2) the Chilean Navy provided significant support to the effort to find and assess the whale; and (3) the Government of Chile has formally requested entanglement response training from the IWC.

The Working Group noted that the fact that there was a Conservation Management Plan in place may have helped to facilitate the support of the Chilean Navy in this effort. It also noted the synergy between the CMP and the IWC entanglement expert advisory group, as they assisted the effort with advice in real time. The Working Group was pleased to hear of the proposed entanglement response training in Chile in November 2015, and **recommended** that it take place.

The North Slope Borough bowhead science programme started in 1981, focused on estimating population abundance, and as part of post-mortem examinations on anatomy, pathology, reproductive biology, and studies related to possible effects of oil contact. Subsequent examinations broadened to include health related questions including categorising scar types. The study described in SC/66a/HIM15 aimed to quantify the frequency of line entanglement, ship strike, and killer whale injuries on bowhead whales harvested by Alaska Natives. After data quality screening of 904 records (1990-2012), scarring was observed on 521 harvested bowhead whales. This period was chosen because the authors had more sophisticated methods to recognise these scar types by that time. Logistic regression was used to evaluate different combinations of explanatory variables (body length, year, sex) to develop a predictive model for each scar type. There is also a list of bowhead whales entangled in commercial fishing gear that were harvested, found dead, or observed alive by hunters and during aerial surveys. Note that six animals found dead had stranded with gear. Of 515 whales examined for entanglement injuries, 59 had scars consistent with line entanglement. Around 12% of the population show entanglement scars. Scars associated with ship strikes are quite infrequent and occur on ~2% of all harvested whales; neither sex nor body length was a significant factor. The frequency of entanglement scars is highly correlated with body length; about 50% of large bowheads (>17m) exhibit gear scars while whales <9m rarely show such scars. The entanglement rate is higher on males than females at a given body length which is attributed to exposure time as males tend to live much longer, but it may also be related to habitat difference in winter areas. For both sexes, results suggest that accumulation of entanglement scars is related to exposure time. Spatial temporal analysis by Citta *et al.* (2014) of telemetry data suggests bowheads hitting 'ghost gear' but these data could be biased towards animals which did not venture into the southern fringes of the pack ice. The authors did not believe that the observed scars were from harpoon lines. The North Slope Borough now has good baseline data on entanglement rates and should have the power to a detect change in entanglement rates in the future. Based on the current rate of increase in the population, it appears that population level effects are low but there are clearly some animal welfare issues.

The Working Group noted that some results appeared contradictory to findings in other areas with other species. Of particular interest to the Working Group is the suggestion that most of the entanglements may be in ghost gear (still fishing) or Abandoned, Lost, or Discarded Fishing Gear (ALDFG), as most entanglements in other areas are believed to be in actively fished gear. However, George noted that the bowhead habitat overlaps an area with high gear loss due to sea ice. Also 'wet storage' of gear, that is leaving it in the water while not in use, was also suggested as a possible source of entanglement. As juveniles of other species have been documented to have some of the higher entanglement rates, some asked if there was evidence that juvenile bowhead whales may not roam as widely as adults, and therefore be less exposed to gear. George responded that this could be possible. In further discussion of what is known of this population's use of the habitat it was also noted that proposed shipping traffic lanes currently transect several hot spots for this population, identified by Citta *et al.* (2014), and that this development is of concern and should be monitored.

SC/66a/HIM15 describes the entanglement of a North Pacific right whale in aquaculture gear off Korea in 2015. This was the first sighting of this species in Korean waters since the last one had been landed in the East Sea in 1974. This was also the first disentanglement performed in aquaculture gear in Korea, as previous entanglements have all involved non-protected species. The young male right whale was entangled in hanging aquaculture for mussels off the island of Namhae, in the Korea Strait, on 11 February 2015. The whale was entangled by the main rope (3cm in diameter) at the caudal peduncle. Untrained responders, including fishermen, first tried unsuccessfully to cut the ropes using poles with hooked knives. Two scuba divers then entered the water and cut two wraps with diver's knives, but they had to cease the operation due to dangerous behaviour of the whale and limited visibility in the late evening. The responders returned the next morning, but the whale was gone. As divers found no trace of the whale on site, an aerial survey was conducted with no sighting. The whale was assumed to have escaped the remaining entanglement. Photos, video clips and biopsy sample of the right whale were taken during the attempted rescue in order to identify and register the animal.

The Working Group thanked the authors for this information. The event was discussed in detail at the Provincetown Workshop, but members also noted the growing potential risk posed by the expansion of this type of aquaculture in this region and globally.

6.4 Proposal for entanglement prevention workshop

At SC/65b the Scientific Committee endorsed a proposal for the IWC to convene a large whale entanglement prevention Workshop (IWC, 2015), and provided seed funds of £10,000. The Working Group **agreed** that this was a very important and timely Workshop, and endorsed the terms of reference given in Appendix 2. The Secretariat will seek partners and supplemental funds in order to carry out the Workshop in time to report back at SC/66b. Double indicated that Australia has ongoing mitigation efforts that could be valuable to this effort, and DeMaster indicated that, given the new information on entanglement in bowheads, and concern over expansion of fisheries as the polar ice retreats, that the Bering Sea Fisheries Research Foundation might provide valuable input. Mattila noted that the Permanent Commission of the South Pacific (CPPS) which is a fisheries

treaty between Chile, Peru, Ecuador, Columbia and Panama, has also expressed interest. The Secretariat will convene a steering committee in order to develop an agenda and participants list.

7. SHIP STRIKES

7.1 Progress on the global database

Panigada described the third year of work carried out by the IWC ship strike data coordinators up until May 2015 (SC/66a/HIM08). The coordinator's contract was renewed at the end of 2014 and now covers a two year term to follow the biennial Commission meeting schedule. The activities carried out in the past 12 months resulted in a variety of outreach actions, with a large number of further contacts being established, including follow-up on the guidance documents for sailing and cruise ships drafted previously. Significant effort has also been dedicated to increasing user friendliness, as well as the technical functioning of the IWC ship strike database, which is currently being overhauled. As of May 2015, the database held a total of 1,156 reports, both historical and recent; 559 of these were previously classified as being 'definite strikes'. All new entries are still to be verified by the IWC Ship Strike Data Review Group. There are around 250 reported incidents that will be entered in the coming year. Contacts with the ACCOBAMS and the Pelagos Sanctuary have been regularly maintained to discuss possible synergies in assessing and mitigating ship strikes. Outreach efforts have included contacts with national and international maritime organisations and companies. Media work included radio interviews and a press release for *Sustainableshipping.com*. An information brochure for the Volvo Ocean Race (a global sailing regatta) was developed as part of the Global Oceans campaign in collaboration with the World Wildlife Fund (WWF) International. A presentation on ship strikes and the role of the IWC (SC/66a/HIM01) was developed with a view to distribution to a range of stakeholders including a presentation made at *WhaleFest* in Brighton, UK in 2014.

The Working Group welcomed this report of the activities of the ship strike data coordinators and commended them on the amount of outreach work that had been achieved. The technical issues with the database and the development of a new data entry system had resulted in a backlog of incidents that need to be entered and reviewed. The Working Group **recommended** that the work of the data coordinates should be continued with the same work plan but that the priority for the work over the coming year should be on data entry and validation.

7.2 Estimating rates of ship strikes, risk of ship strikes and mortality

7.2.1 Eastern North Pacific blue whales

A workshop on large whale distribution and occurrence was held by NOAA Fisheries in September 2014 (NOAA, 2014) reviewed several different tools that have been developed to predict species distribution at various spatial and temporal scales. The aim was to improve understanding of the risk of vessel collisions with whales along the California coast to create a foundation for future research and management actions to minimise human-induced mortality or injury. The workshop reviewed the latest work on distribution and occurrence, including new methods, data limitations and next steps. These general issues were not just limited to the US west coast but blue whales off the California Coast were a major focus. Presentations included large whale stranding information and the caveats associated with these data, large whale abundance, distribution and behaviour; predictive modelling; risk assessment (relative to human impacts such as fishing and vessel collisions); and, new technology for the collection and dissemination of sightings (smartphone apps), and specific ship-based information (including AIS). The workshop concluded no one model, or survey technique captured the full picture especially relative to risk from a threat such a vessel collision. Key recommendations from the workshop included: (i) support for collaboration between scientists and managers; (ii) a workshop on 'consensus' or 'ensemble averaging' of cetacean distribution models held immediately prior to SC/66a; (iii) support for a citizen science program with joint effort between NMFS, Academic Institutions, and others; (iv) explore the development of carcass detection models; and (iv) explore platforms of opportunity for providing near real-time detection of large whales. This would also continue to foster relationships with interested stakeholders.

DeAngelis reported that NOAA Fisheries Southwest Fisheries Science Center has been attempting to model carcass drift in order to be able to make better use of the stranded carcass data, by working backwards to possibly identify the location of the strike, but that this has proven very difficult. The Working Group noted that this work could also assist understanding of this issue in other areas and encouraged a paper to a future meeting.

An approach to determine possible total ship strikes for eastern North Pacific blue whales based on scaling up observed ship strikes using an estimate of the reporting rate was described in Monnahan *et al.* (2015). Previously, Redfern *et al.* (2013) had estimated a rate of 10.6 per year based on 1.8 observed ship strikes per year over the six year period 2005-10, combined with an assumed reporting rate of 17% which had been estimated for North Atlantic right whales. Monnahan *et al.* (2015) used the approach of Williams *et al.* (2011) to estimate a plausible range of ship strikes. A combination of survival rates (0.907 to 0.975), and encountered deaths (1.05 a year from 1988-2007, of which 38% were from ship strikes), suggested reporting rates of 0.4-4.2%, leading to a plausible annual rate of ship strikes of between 10 and 35 in 2013. The estimated upper bound on this ship strike rate was 93 assuming an annual survival of 0.907 and that all deaths are from ship strikes. This is incompatible with observed trends in population abundance estimates and other biological parameters. A range of 10 to 100 ship strikes per year was used as input into an assessment of population status of North Pacific blue whales.

The Working Group noted the difficulties of estimating mortality rates for ship strikes given the cryptic nature of events and small data sets. Some members thought that the annual survival of 0.907 was low and therefore the upper bound of 93 ship strikes in 2013 was likely positively biased. Nevertheless, the Working Group expressed concern over the estimated mortality rates, even though the population appeared to have recovered. It was also noted that the long-term data collected in this region on whale abundance, distribution and ship strike mortalities could help to determine ship strike rates for blue whales in other less well-studied areas. The Working Group **recommended** that collection of relevant data on blue whales in this region continue.

Mate and Palacios reviewed the satellite-monitored radio tracking of 171 blue whales in the eastern North Pacific between 1993 and 2008 (Irvine *et al.*, 2014). Tags were deployed along the California coast, mainly at the

western part of the Santa Barbara Channel or in the Gulf of the Farallones. A full description of this tracking data set and the state-space model applied to them are presented in Bailey *et al.* (2009). Fifty-three of these tracks from eight years within the period 1998-2008 had 30 or more locations after applying the state-space model and extracting locations inside the Exclusive Economic Zone of the USA. Kernel-derived home ranges were computed for these tracks and the number of overlapping areas (for both the 90% home range and 50% core area contours) was used as a metric to characterise how much an area was used by the tagged whales. While the whales in this study generally occupied a wide region, most of the areas of highest concentration were close to large human population centers and busy ports. International shipping lanes transit through the two areas that were most heavily used from July to October, the Channel Islands in Southern California and the Gulf of the Farallones off Central California. A recent assessment of ship strike risk for whale species within Southern California concluded that risk could not be reduced substantially for blue whales in the area because population densities were similar throughout the area, and all shipping lane alternatives would cross moderate-to-high density areas (Redfern *et al.*, 2013). That conclusion contrasts with the localised core areas identified from the telemetry data in this study (Irvine *et al.*, 2014), from which the authors suggest that risk for blue whales could be reduced by: (a) moving the shipping route to/from Los Angeles south of the northern Channel Islands, particularly during July to October; and (b) closing the northern route of three shipping lanes heading to/from San Francisco during August to November.

This data set had a very high number of tag deployments. It was suggested that the data could be used to assess studies in other areas with fewer deployments to estimate the sample sizes required to address issues such as ship strike risk. The authors are working on this indirectly, as they are using the tag data, along with oceanographic data, to identify hot spots and their predictability through seasons, years and decades. As a result of these analyses it should eventually be possible to determine a minimum numbers of satellite tracks, and therefore tags that would be needed. Palacios noted that the next set of tag deployments will commence shortly.

The value of overlaying ship traffic with telemetry results or other data was noted. Palka described a State and Federal partnership on the northeast Atlantic coast of the USA called NROC (Northeast Regional Ocean Council), which has supplied the funds for several layers of marine data, including the AIS data used by marine managers there. The Working Group **agreed** that in addition to co-occurrence, ship strike risk assessments needed to explicitly include the seasonality and annual variability in whale and shipping distribution. Integration of co-occurrence models over time and space can provide estimates of the overall risk to a population.

7.2.2 Great Barrier Reef (Australia) and Abrolhos Bank (Brazil) humpback whales

An increase in activity within the shipping lanes of the Great Barrier Reef (GBR) together with the approximately 10.9% annual rate of increase of the humpback whale population that uses the region seasonally suggests an increasing risk of ship strikes. SC/66a/HIM16 attempted to identify relative risk by examining the co-occurrence of whale distribution, as determined by aerial surveys, and ship traffic, using AIS tracking data from 2012 onwards. Surface models of humpback whale densities were produced from two years of aerial survey data (August 2012 and September 2014). In addition, mother calf group distribution, a potentially higher risk category, were compared to mating group distribution. Generally humpback whale densities were found to be higher in the south of the GBR region, and mothers and calves tended to be more coastal, although not significantly so. Collision risk was calculated in two steps. Firstly, co-occurrence was examined for areas where both whales and ships showed high densities. Secondly, a probabilistic framework of relative risk was developed which incorporated the co-occurrence, along with considerations of vessel speed and type. The results showed high density traffic along the entire GBR, with more dispersed traffic in the south of the region. Unfortunately, this southern area corresponded both to an area of high whale density, and an adjacent area where whale densities were not able to be estimated, therefore not allowing for clear recommendations to manage potential risk. The authors indicated the need for more aerial surveys to understand process error and consideration to extending coverage to the south.

It was noted that this approach, and other studies of co-occurrence, could only produce a measure of relative risk, and that without a known rate of collisions, the actual risk could not be estimated. This makes initiating management actions problematic. It was suggested that the relative risk from the model could be compared to other regions where collisions have been reported. The authors had not attempted to do this and commented that it could be difficult to estimate all the appropriate parameters to make useful comparisons. Although the probabilistic framework did indicate a small level of bias when using co-occurrence models (due to the 'removal' of individuals in the models) the authors responded that they considered that this was negligible.

The Abrolhos Bank is the main breeding area of humpback whales in Brazil (BSA). In 2003, two shipping routes were established in the area for transporting eucalyptus logs. Bezamat *et al.* (2014) describes a study to evaluate the risk of collision between large vessels and humpback whales along coastal shipping routes. Surveys were conducted aboard these vessels, used as platforms of opportunity, for humpback whale observation, during the 2003, 2004, 2005 and 2011 breeding seasons. The number of potential interactions between ships and whales was estimated from a simple collision risk model. In this model the number of potential interactions are estimated using a model based on vessel size and speed, track lengths, population density and the surfacing behaviour of whales. The results suggested that the three commercial vessels operating in coastal waters had the potential to collide with 25 humpback whales during the 2011 breeding season. This was the first risk assessment for ship strike made in Abrolhos Bank. A three year study initiated in 2014 will include ship based observers, an aerial survey in 2015 and necropsy of any whales stranded in the area.

It was noted that the model did not take into consideration the possibility of avoidance behaviour on the part of either the whale or vessel. Similar calculations from other areas suggest that assuming no avoidance response by whales would substantially over estimate ship strikes. However, data on avoidance behaviour that could be used in such models are currently lacking.

7.2.3 Northern Indian Ocean blue whales

Measures to reduce ship strike risks often require data on the relative density of whales in localised high risk areas, but these may be remote or logistically difficult to survey. Satellites can now be sent on request to view small areas of sea with sufficient resolution to detect whales. The

WorldView2 satellites have a field of view for each pass of 17km. The images consist of eight colour bands with an on the ground resolution of 2m per pixel and a panchromatic (all frequencies) band with a pixel resolution of 0.5m.

SC/66a/HIM02 evaluated the potential for detecting blue whales in areas of dense shipping and blue whales off southern Sri Lanka using such satellite images. Satellite images were acquired during a period when there was concurrent boat survey effort. The boat survey data suggested an expected 50 blue whales within the 570km^{-2} area of satellite images acquired. Dive data suggested an expected five whales to be visible at the surface on these images. Observations at sea indicated that the sea state was Beaufort 2-3 at the time of acquisition with few white caps. Small vessels of similar size to blue whales were clearly identifiable in the images and a total of nine targets were classified as possible blue whales. However, it was not possible to attribute possible to targets to blue whales with any degree of confidence. This was mainly due to confusion with waves. Hence the success of the use of satellite imagery to estimate relative whale density appears to critically depend on sea state. It seems likely that there is quite a sharp cut off as sea state increases between being able to reliably classify whale targets or not.

In discussion it was noted that this technology currently might be useful for determining whale densities under very specific conditions of very calm waters, such as breeding lagoons (as has been shown by Fretwell *et al.*, 2014 for southern right whales) or for minke whales in the ice. Although detecting whales had proven difficult, the images did provide good information to examine all types of vessel distribution.

The southern coast of Sri Lanka has been identified as an area with a high risk of ship strikes due to the overlap of high densities of blue whales and one of the world's busiest shipping routes. The apparently high level of risk is confirmed by a large number of reported ship strikes. An analysis of 15 whale mortalities attributed to ship strikes around Sri Lanka between 2010 and 2012 found that 11 of these were blue whales. Visual transects perpendicular to the shipping routes and extending further offshore than the current shipping lanes were initiated in 2014 (Priyadarshana *et al.*, 2014). Results from these surveys coupled with observations from whale watch boats over a number of years suggested that moving the current Traffic Separation Scheme slightly further offshore would substantially reduce risk of collisions with blue whales.

SC/66a/HIM09 reports on progress on recommendations from the Scientific Committee including further surveys of blue whale distribution and analysis of a year's AIS data to investigate shipping density. A total effort of 2,616km from 2014 and 2015 combined resulted in an estimate of mean density of 0.036 individuals km^{-1}. For the survey area of 50km by 150km, this gives an approximate abundance estimate of 270 blue whales (CV=0.09, 95% CI 226-322) assuming $g(0)$=1. A spatial model of blue whale distribution showed a peak in density along the 800m contour with densities also increasing with steeper gradients in depth. Shipping density between 80.5°E and 81°E (measured in distance travelled per unit area, km^{-1}) averaged 1,090km^{-1}year^{-1} in the westbound lane and 810km^{-1}year^{-1} in the eastbound lane. These are some of the highest open ocean densities reported, and a collision risk analysis based on co-occurrence indicated a potential for over 1,000 interactions annually between blue whales and vessels within the study area, assuming no evasive response by whales or vessels. Based on survey data up until April 2015, a 15n.mile southward shift in shipping would reduce this collision risk by 95%. For shipping in transit to or from the Red Sea this would add around 5 n.miles to the total transit distance.

The Working Group welcomed that the study had followed the Committee's recommendations from SC/65b to conduct further surveys including trying to expand the seasonal coverage to the SW monsoon period.

De Vos recalled that an earlier paper (De Vos *et al.*, 2013) had described two incidents of ship strike in Sri Lankan waters and identified ship strikes as a possible problem for this population. SC/66a/HIM13 reports that the high levels of shipping activity off the south coast of Sri Lanka and the small population size and non-migratory nature of pygmy blue whales in these waters, all pointed to the need to reduce ship strike mortality. It was highlighted that all surveys conducted in this region to date have occurred near-shore (within 50km of the coast). However, Soviet whaling records indicated the presence of blue whales in broader regions. AIS data shows that shipping traffic wraps around the coast of Sri Lanka on a high traffic route between Sri Lanka and India. Consequently, de Vos emphasised the need to explore ship strike risk in as large an area as possible and identified a multi-part approach that enables the assessment of risk in a broader area and the estimation of potential costs of management actions to the shipping industry through the following steps: (i) explore the transferability of habitat models built in data-rich regions to the northern Indian Ocean to identify areas of highest whale density; (ii) use predictions from multiple models to conduct the ship strike risk assessment. For this assessment, areas of highest shipping traffic will be identified using global satellite data and consequences of changing shipping patterns will be explored. Results of these analyses will be used to suggest approaches for minimising risk; and (iii) estimate economic effects of implementing the modeled ship traffic management measures. These analyses were identified as a powerful means by which to assess and minimise ship strike risk to blue whales off Sri Lanka and could help ensure that management recommendations consider ship strike risk throughout as broad a region as possible. The resulting predictions will help identify and prioritise future studies within this region and it is anticipated that all predictions can be updated and improved by the addition of data collected through future surveys. Further, the risk assessment methodology can be updated and expanded as necessary.

The Working Group thanked de Vos for this information about the approach and planned work. Given that SC/66a/HIM09 estimated a 95% reduction in risk of ship strike to blue whales if the current TSS were moved further offshore there was some discussion about whether it was time to approach the appropriate authorities in Sri Lankan Government in order to suggest a proposal to the IMO. However, it was **agreed** that the most effective advice on routing options and estimates of the associated risk reduction could be achieved by combining the results described in SC/66a/HIM09 with the results of the ongoing work described in SC/66a/HIM13. The surveys and analysis in SC/66a/HIM09 cover a relatively small (150x50km) area to the south of Sri Lanka, whereas the habitat modelling in SC/66a/HIM13 covers a much wider region. Thus the two approaches should provide complementary information that can be used to evaluate the implications of different potential routing schemes over a wide region, well beyond any specific Traffic Separation Schemes that might be established off the south coast. De Vos and Redfern indicated that they expected to have results from their analyses in October. They will then work

with the authors of SC/66a/HIM09 to integrate the two approaches. The integrated results could then be provided to the Sri Lankan authorities, possibly through a workshop in early 2016. Brownell, de Vos and Leaper will work with the Secretariat to maintain the dialogue with the relevant Sri Lankan authorities including those involved with IMO. Some members also suggested other possible technologies such as telemetry or UAVs for filling data gaps in the region, both offshore and during the SW monsoon season. But these would require a very large investment in time and resources.

7.2.4 Hellenic Trench, Greece, sperm whales

Ship strikes are recognised as a significant threat to the eastern sub-population of sperm whales in the Mediterranean which is considered as Endangered by IUCN. In 2014 the Committee considered an analysis of sperm whale and shipping distribution patterns in the Hellenic Trench, Greece (Frantzis *et al.*, 2014), which noted that the potential for small changes in shipping routes to dramatically reduce risk in these high risk areas suggested considerable scope for effective mitigation. Following this risk analysis and also considering the number of reported ship strike incidents, the Committee recommended that a dialogue should be initiated with shipping regulators and interests in the area.

However, the possibility that fin whales may occur further offshore than the current shipping routes was raised and it was suggested that there should be further study of those deeper waters prior to recommending that shipping move offshore. SC/66a/HIM06 reviewed available data on fin whale distribution around the Hellenic Trench and reported details of a number of sperm whale strandings showing evidence of ship strikes including a new case from 2014. Examination of available data on fin whale distribution in the area provided no evidence that routing measures to take shipping offshore of areas of high sperm whale density would increase the risk of collisions to fin whales. A total of 28 sperm whale strandings have been reported between 1992 and 2014 along the coast of Greece. Twenty-three of these were examined and of those, 12 showed clear evidence of ship strikes with another three that could possibly be due to ship strike. Eight of these strandings occurred along the coasts of the Hellenic Trench. Following meetings with the Greek authorities there is an interest to address the risks to sperm whales through routing measures. This would require a proposal to IMO based on a risk analysis to whales of potential routing options and an evaluation of the impacts of these options on shipping.

The Working Group welcomed the additional information which followed up on previous recommendations of the Committee. Based on this new information the Working Group **agreed** that there was no reason to expect that routing measures designed to reduce risk to sperm whales would increase risk to fin whales. The Working Group **recommended** that the Secretariat continue to work with interested parties and now move forward with Greece in order to develop a proposal for routing measures in accordance with IMO guidelines. The Working Group also recommended liaison with ACCOBAMS in this process. In addition the need to consult with stakeholders in the shipping industry was emphasised.

7.2.5 Bryde's whales in Hauraki Gulf, New Zealand

The entrance through the Hauraki Gulf to the Ports of Auckland, New Zealand holds a year-round population of endangered Bryde's whales and out of 44 Bryde's whale-deaths, 17 of 20 (85%), with known cause of mortality, sustained injuries consistent with vessel-strike; a mortality rate that is likely to be unsustainable (Constantine *et al.*, 2015). This information started a social forum with stakeholders engaged in science-based discussion of mitigation measures to reduce lethal vessel-strikes in the region. Whales are broadly distributed throughout the Gulf so re-routing traffic would not lessen the threat of vessel-strike. Monitoring whales visually is difficult and not applicable at night, when whales rested closer to the surface than during the day. Passive acoustic monitoring is unreliable due to the whales' low vocal activity and because low frequency calls are susceptible to masking from vessel noise. These findings resulted in a Transit Protocol for Shipping including voluntary speed restrictions and a monitoring plan, highlighting the value of scientific and social stakeholders working together for conservation.

Ports of Auckland, the shipping industry, New Zealand's Department of Conservation (DOC), and Auckland University, are collaborating on ways to reduce the risk of collisions. The protocol described in Ports of Auckland (2014) is part of that effort. It outlines steps masters should take when planning their passage to and from Auckland, and what to do while transiting the Hauraki Gulf. This includes recommendations such as to allow for reduced speed when transiting the Hauraki Gulf.

The Working Group commended those involved with this effort. In discussion it was noted that the voluntary speed recommendations had not produced immediate results in reducing ship speeds, but that over time vessel speeds had been decreasing towards the suggested 10 knots. Willson noted that similar engagement with the Port Authorities of Duqum, Oman had produced similar results, which underscores the value of working with all stakeholders.

7.2.6 Sperm whales in the Canary Islands

Fais *et al.* (2015) describes a study to examine the impact of ship strikes on sperm whales around the Canary Islands. A passive acoustic survey was conducted to estimate the absolute abundance of sperm whales in the waters of the Canary Islands. The survey resulted in 225 hours of acoustic effort covering 2,668km. Many of the areas with higher whale density within the archipelago are consistent with those previously described, suggesting that these are important habitats for females and immature components of the population. Some of these areas overlap with high shipping activity. Data on sperm whale diving behaviour, obtained from biologging, were used to estimate $g(0)$=0.92, improving the accuracy of the absolute abundance estimate, resulting in an estimate of 220 sperm whales (95% log-normal CI 117-413) in the survey area. Comparison of the minimum mortality rate based on known strandings of animals showing signs of ship collisions (two sperm whales per year) suggested that mortalities due to ship strikes probably exceed the reproduction rate. These results suggest that the archipelago might be acting as an attractive sink habitat, where the area is considered a high quality or even critical habitat from an occupancy standpoint, but where the mortality rate may be higher than the recruitment rate. When such attractive sink habitats are preferred the whole population may decline rapidly or go locally extinct. In order to unravel the effects of this potential attractive sink habitat on sperm whales around the Canary Islands, long-term studies are required. Furthermore, given the philopatry in female sperm whales, precautionary mitigation measures should be applied to reduce ship strikes in the archipelago. The author makes a number of recommendations, outlining practical steps in order to reduce the impact of ship strikes on sperm whales in the Canary Islands.

The Working Group welcomed this new abundance estimate for sperm whales around the Canary Islands, as in the past the Scientific Committee has expressed concern about the ship strike rate in this region. For the first time an abundance estimate for sperm whales in the archipelago is available which can be related to the number of stranded animals showing signs of collisions, indicating that the human-induced mortality rate may not be sustainable in the area. SC/66a/HIM11 describes the work and the main outcomes of the Working Group for the Prevention of Ship Strikes (WGPSS), established in 2014, comprising the three main inter-island ferry companies of the Archipelago, the Spanish national and the Canary Islands regional governments, as well as cetacean scientists. Based on the best available scientific information, the WGPSS concluded that mitigation measures should address risk from both international shipping passing the waters of the archipelago, and local ship traffic. Mitigation measures already agreed by the WGPSS include providing education to mariners and information to the public, as well as testing of the potential effectiveness of thermal detection of whales to allow avoidance manoeuvres by ships. The Working Group **endorsed** these suggested mitigation measures. It also noted that the Particularly Sensitive Sea Area (PSSA) designated by IMO in the Canary Islands may facilitate implementation of ship strike mitigation measures. For example, CANREP, the mandatory reporting system for ships entering the PSSA, could be a mechanism for relaying relevant information and guidelines to ships. Such measures might be co-ordinated through the development of a dedicated regional conservation management plan for sperm whales in the Canary Islands.

Ritter described analysis of photographs taken from platforms of opportunity during regular whale watch trips off La Gomera between 1995 and 2014. These showed a number of injuries that were likely attributable to ship strikes. Severe injuries were seen on 11 individuals of four different species, all small cetaceans. Pilot whales were the most affected species with 37 individuals showing injuries. He noted that documenting anomalies, even if conducted in a non-systematic way from platforms of opportunity can contribute to identifying ship strike incidents and which species are affected, including those ones known to be hit on a regular basis such as sperm whales (Ritter *et al.*, 2015).

SC/66a/HIM12 describes two web-tools developed to enhance data collection and sharing of distribution and identification of pelagic fauna in the Canary Islands. One of them, Avisteme[1], is a Spanish database of sightings of marine fauna in different regions. It has started with CetAVist: the Cetacean and Seabirds Sighting Net of the Canary Islands. Here, volunteers gather cetacean sightings and associated environmental data along line-transect surveys on board of inter-island ferries. The project includes a training programme for the volunteers to ensure data quality. From December 2012 to February 2015, CetAVist performed 416 surveys by more than 100 observers, gathering more than 1,000 sightings of at least 13 species of cetaceans, some 60% of the sightings were identified to species level. CetAVist thus has proven to be an effective tool for data collection as well as to raise awareness about the issue of ship strikes in local ferry operators.

It was noted that involvement of ferry operators in sighting schemes is a good way to maintain fruitful dialogue with the ferry industry. It was also noted that observations by volunteer observers may not always be reliable and that some form of validation using experienced observers would be valuable. Ritter responded that there had not been any such work but it was hoped that the training programme was sufficient to produce usable data. It was also noted that the platforms (high speed ferries) travel at speeds of 30-40 knots, thus making it a challenge for even experienced observers to identify some species. The Working Group noted the need for further data and also encouraged the real-time reporting of sightings to and from ships within the local area as a possible mitigation tool. The Working Group also **recommended** further studies to: (i) to evaluate the amount of international and local shipping traffic within the Canary Islands PSSA to estimate the relative contribution by vessel types to the overall ship strike risk; (ii) long-term studies to better describe sperm whale distribution and abundance in the archipelago to identify critical habitat, the range of the population, evaluate population level effects of ship strike related mortality and the overlap in distribution patterns of shipping with sperm whales and other cetaceans; and finally (iii) the importance of a continuation of the stakeholder dialogue was highlighted, and a closer collaboration with the IWC, especially through the ship strike data coordinators and the Secretariat, was suggested.

7.2.7 Mediterranean and North Atlantic, fin whales

Panigada presented SC/66a/HIM14 describing a study using satellite telemetry on Mediterranean fin whales to identify critical habitats that might assist mitigation of ship strikes. This paper presents data from different areas of the known range of the sub-population within the central and northwestern Mediterranean, which would be important for helping to develop focused mitigation measures and providing baseline data to measure their effectiveness. Thirteen fin whales were equipped with location-only satellite transmitters in the Pelagos Sanctuary in September 2012, and off the Island of Lampedusa, in the Strait of Sicily, in March 2013 and 2015. To evaluate the movement patterns and associated behaviour of the tagged fin whales, Bayesian hierarchical switching state-space models were applied to the filtered data to infer transiting and area-restricted search behaviours within tracks. To assess the occurrence and identify potential feeding habitats, an ecological niche model was overlaid with the satellite telemetry data. These results confirm that an important fin whale habitat extends westward of the Pelagos Sanctuary area. The high shipping traffic levels occurring in the Strait of Sicily (the main deepwater marine traffic channel connecting the Eastern and Western basins of the Mediterranean) suggest the strong need for appropriate conservation and mitigation measures to minimise human-induced mortalities. The present findings provide further evidence for the importance that the Strait of Sicily plays in the central Mediterranean Sea and supports the proposition to establish an effective seasonal/dynamic protection regime in the Strait of Sicily area, in terms of a Marine Protected Area or a SPAMI[2], with a designated action plan to address actual and potential threats. The reported movements show how the whales move across areas heavily impacted by human activities, that could expose the animals to increased threats, such as ship strikes, and where at present no protection or mitigation schemes are in place. This new information thus stresses the need for consideration of a comprehensive mitigation programme at a Mediterranean-wide scale rather than at a national or small regional scale. It also demonstrates the use of telemetry data

[1]*http://www.aviste.me.*

[2]Specially Protected Areas of Mediterranean Interest.

to assess fin whale critical habitats and areas of high habitat use, where concentrated effort to mitigate human-induced threats such as ship strikes can be prioritised.

In discussion it was noted that the whales presence in the Strait of Sicily appears correlated with oceanographic features that have remained reasonably consistent over the past 20-30 years. Hence there is consideration of establishing a Marine Protected Area there under the auspices of the Barcelona Convention.

Ijsseldijk *et al.* (2014) describes three observations of bow-caught fin whales found and examined in the Netherlands in the period 2011-13. A standard free-ranging cetacean necropsy protocol was followed for each animal. All three cases involved juvenile fin whales, two males and a female, brought into the harbour of Rotterdam on the bow of large container ships between 210 and 338m long. The assumed speed of the vessels ranged between 18 and 23 knots. Large haematomas indicating a functioning circulatory system at the time of death were found in two whales, suggesting evidence of pre-mortem strikes; this remained unclear for the third. However, the third fin whale had recently fed prior to death, making an acute cause of death more likely than a natural cause of death. None of the ship's crews were aware of the presence of the dead fin whales on the bows of their vessels. The apparent increase in bow-caught whales in Rotterdam does not seem to be related to an increase in ship traffic. This study underlines the importance of performing a necropsy on bow-caught whales to try to determine if a collision was post-mortem or ante-mortem. It was also reported that in 2014 another dead juvenile fin whale was found afloat and eventually stranded very close to the port of Rotterdam.

In discussion some members expressed surprise that, in general, so many whales do actually stay caught on the bow of ships. It was noted that this is primarily the rorquals with long slender bodies, but the proportion of the overall number of collisions where whales get stuck on the bow is unknown. It was also noted that, while smaller vessels being on auto-pilot may present a higher risk of collision because they may be slower to take avoiding action, in this case the vessels were of a size that this was unlikely to have played any role in the cases reported here.

7.3 Collaboration with the Commission's Ship Strikes Working Group including consideration of mitigation measures

7.3.1 General overview of mitigation options

The Working Group reviewed the Report of the joint IWC and UNEP-CEP-SPAW Ship Strikes Workshop, hosted by Panama in June 2014 (IWC, 2014). The Workshop reviewed progress on the recommendations from the previous IWC/ACCOBAMS Workshop on ship strikes held in 2010 (IWC, 2011). Given the numerous data gaps, a current high priority is to emphasise to member countries, IGOs and regional organisations the collection and reporting of data to the IWC Global Ship Strikes Database, in order to assist in the development of mitigation measures. As a priority action the Workshop recommended that the IWC build a long-term working relationship with the IMO and representatives should routinely attend relevant sessions of the IMO's Marine Environment Protection Committee (MEPC). More particularly, the Workshop recommended the submission of a 'Substantive Document' to MEPC 68 in May 2015. The document should provide the report of the Panama Workshop, including a summary of its relevant outcomes. The Working Group noted that this had not been done but **agreed** that this would be a useful initiative.

The Workshop reviewed different modelling approaches and recognised the great value of spatial and habitat modelling to identifying areas of potential importance for whales, especially in relation to shipping traffic. It also recognised that it is essential that appropriate datasets and models are used and the limitations explained clearly for managers. Cetacean distribution is highly dynamic and variable. Density or range maps may be developed easily with short data series, but they can be misleading as a basis for management advice. The Workshop noted that the Eastern Tropical Pacific (ETP) dataset is one of the best in the world. It encouraged use of that dataset to explore the effect of censoring the data temporally and/or spatially (e.g. by shortening the data series into different periods and comparing the results with the full dataset) to ascertain how this might affect management advice. It may also be possible to examine the effects of using presence/absence and presence only models. The Workshop also reviewed currently used mitigation strategies and agreed that the only proven, effective mitigation measures are to avoid areas with known concentrations of whales, or reduce speed while transiting those areas.

The Workshop recognised the expertise of the Scientific Committee with respect to many aspects of the ship strikes issue, and it highlighted a number of areas where it can provide advice to other organisations including IUCN and CPPS. The Workshop recommended two aspects of particular relevance: (i) that the Committee establishes an expert group to build upon existing modelling approaches with a view to developing a broad simulation framework that could be used to examine the likely effectiveness of various mitigation strategies; and (ii) investigation of habitat modelling issues by 'censoring' datasets in various ways and comparing the reliability of the predictions against those from the full dataset and the exploration of the relationship between use of presence/absence data and presence-only data.

The Working Group thanked Rojas-Bracho for providing this summary and **endorsed** the Workshop's relevant recommendations. It noted that these recommendations were timely and of immediate interest to this group. In particular, the Working Group asked if any progress had been made on the recommendation to consider 'censoring' the data rich models generated for the Eastern North Pacific, in order to estimate the (minimum) levels of data collection that might be needed in other similar habitats, in order to provide recommendations to managers there. Redfern agreed that this could be a valuable exercise but she felt that the eastern North Pacific ecosystem was not similar enough to her current work off Sri Lanka (see Item 7.2.3) to apply it in that case. The Working Group **recommended** that the censoring exercise go forward and that its results, as well as other similar work, be brought to future meetings. It was noted that IMMAs (Important Marine Mammal Areas), and their possible utility in vessel route planning (i.e. avoiding them) had been discussed, and one member indicated that work using rich datasets on blue whales off the Pacific coast of the USA was helping to inform both the development of the IMMA criteria and the designation of EBSAs (Ecologically or Biologically Significant Areas, under the CBD), and that this process would include censoring of the data to see at what point the areas do not hold up. The Working Group welcomed this information and **agreed** that an expert group on modelling, could assist it in its work and in formulating its advice for the Commission and other relevant bodies. As an example, if a group were formed, it might assist

if the Scientific Committee were to offer its services as a standing body to review proposals for new or modified Traffic Separation Schemes, and other IMO actions, for any implications for whales, as had been recommended in IWC (2014).

SC/66a/HIM01 describes a PowerPoint presentation prepared as part of the work of the IWC ship strike data coordinators as a collaborative effort between IWC and the German based NGO MEER. The presentation gives a short introduction to the issue and highlights the current knowledge as well as knowledge gaps and research needs. It describes different measures, including technical, legal/operational, and educational measures as well as the role of IWC and its global ship strike database. The presentation and associated text (SC/66a/HIM07) is aimed at a wide audience of stakeholders in the shipping sector as well as the general public. It also can be offered to maritime schools to be incorporated in existing curricula.

The Working Group suggested that the presentation is distributed widely through the work of the ship strike data coordinators, and be available through the IWC website. Ritter will work with the Secretariat to achieve this. It was also suggested that it would be useful to have such a presentation in additional languages.

SC/66a/HIM05 provided an opinion on the use of the term 'mitigation' following a cursory review of vessel strike literature that indicated that the term is not used consistently. While education/outreach, and whale detection are important tools to raise awareness, there is limited evidence that these measures reduce the risk of collision. To be determined as mitigation there has to be some evidence that the results of the action will result in a reduction in risk. A variety of actions can be taken with the objective of reducing the risk to large whales. However, it is not clear that the effectiveness of all of these activities can be measured. Alternately, in some cases where the efficacy can be determined, some measures have proven ineffective in reducing strikes and therefore may not be considered as genuine mitigation measures.

There was some discussion of whether there was a need to define what is meant by mitigation in an IWC context. However it was agreed that within the work of the IWC over the years there had been a clear understanding that mitigation involved measures that would reduce ship strike impacts to whales. It was suggested that the ultimate goal should be to eliminate ship strikes but it was recognised that this may not be achievable in most situations. It was **agreed** that the Working Group's evaluation of the effectiveness of mitigation measures would be limited to direct actions like re-routing, changes in speed, or direct methods that alert mariners to enable manoeuvres to avoid strikes, and would not include evaluation of indirect actions like education and outreach.

The IWC has developed a guidance document (Ritter *et al.*, 2014) for organisers of offshore sailing races. An information brochure was prepared by WWF with substantial support from the IWC ship strike data coordinators to inform sailors in the global Volvo Ocean Race (VOR) 2014/15 about ship strikes[3]. The brochure gave advice on aspects including voyage planning, gathering information, possible mitigation measures at sea and about what to do if a collision has occurred. It also contains a map which relates the global route of the ocean race to areas where higher cetaceans presence can be expected. Leslie thanked the IWC for working with the WWF on this effort, and observed that the exercise had had broader conservation impacts as well.

In response to suggestions of other potential 'hot spots' to be added to the map for future races, and similar route planning efforts, Ritter mentioned that one of their primary reference tools was Hoyt's book on Marine Mammal Protected Areas, and that in the future they would investigate the potential use of the results of the Important Marine Mammal Areas initiative being developed by the IUCN Task Force on Marine Mammal Protected Areas. The ship strike data coordinators also felt that it could be valuable to conduct outreach in person at the start of these large Oceanic races.

Another outreach document has been produced by a collaboration between the Canadian NGO (ROMM) and Canadian Authorities (ROMM, 2014). The objective is to raise awareness among ship crews and increase their knowledge of the many cetacean species that are present in the Northwest Atlantic. The guide identifies measures that have been implemented locally and elsewhere in the world to reduce the risk of collisions and also contains maps showing areas where such risks are potentially higher, and where crews should therefore be more vigilant in terms of being on the lookout for cetaceans. The Working Group noted some information in the document that could be improved. Ritter offered to contact the authors with suggestions if a revised version is produced.

Zitterbart *et al.* (2013) describes trials of an infrared (IR) blow detection system which consists of a thermal imaging device mounted on an actively stabilised gimbal in combination with custom data acquisition and processing software. It scans 360° horizontal 18° vertical at five revolutions per second. An automatic detection algorithm was designed to detect temporal contrast changes identified as whale blows where an automatic thermal detection was considered a true positive if it occurred three seconds prior or after a visual cue, or if it was unambiguously validated by retrospective human screening of the IR footage. Within the 0-5km range, the algorithm detected 82% of all blows (303) sighted by cue-counting observers. Within the times of concurrent effort, the camera detected 24 out of 26 whale-ship encounters recorded by marine mammal observers on board. Detection efficiency did not appear dependent on range. Results were obtained for a range of environmental conditions with sea surface temperatures predominantly between -1.8 to +10°C and species consisting mainly of humpback, minke and fin whales. The system is conceived more as an alerting device rather than to operate completely unsupervised and could potentially be used as a tool to alert ship's crews to whales in the path of a vessel.

George suggested that this technology appears to be an improvement from past efforts to detect bowhead whales in Alaska, especially at night and in high sea states. However, the equipment used in the study was very expensive but this may be reduced significantly if modified for a more limited field of view. Herr noted that for the evaluation of whale-ship encounters the success rate of the technology was only compared to a single observer on the bridge. When compared to a dedicated marine mammal observer team located in the vessel's crow's nest, she reported that the technology only identified 42% of the sightings. In addition, the technology was not successful at detecting medium or small size cetaceans without a strong blow. It was also noted that the technology produced a relatively high number of false positives which needed to be validated by an observer. Despite these limitations, the Working Group **agreed** that the evolution of this technology may be promising in certain situations for detecting whales to avoid collisions.

[3]Worldwide Fund for Nature (WWF). 2014. Cetaceans and ship strikes: watch out for whales – Volvo Ocean Race 2014/15. Downloaded from *http://www.wwf.org.uk,* May 2015.

7.3.2 Role of speed

SC/66a/HIM03 models the probability of whale-vessel collisions at various speeds using close encounters (<300m) as proxies for vessel strikes. Data were collected using systematic line transect surveys completed at various speeds between 5 and 20 knots. The authors identify a critical speed threshold of 12.5 knots; where close encounters dropped by over 90% when traveling below this speed. The probability of whale-vessel collisions was found to be higher during months with higher whale densities. The authors currently suggest a speed limit of 12.5 knots during the whale season and plan to expand on the model to include vessel traffic and whale behaviour.

The Working Group encouraged further updates from this ongoing work. It noted that this study represents a valuable approach for evaluating the role of speed in the risk of collision. Once again, the Working Group considered the need for a standard definition of 'near miss' or 'close encounter', and Ritter mentioned that he was working on a definition. Kaufman noted that most of the vessels in the Hawaiian breeding grounds, where the study takes place, are smaller (e.g. <20m) and that therefore the definition of 'near miss' may be different for them compared to those >20m, as one might take mass and maneuverability into consideration. In response to the finding of lone whales showing a higher likelihood to surface in a close encounter it was suggested that this may be due to their frequency of long dives. Next year's study would include behavioural observations from a land vantage point. The Working Group noted the potential for land-based observations to provide information on whale reaction to approaching vessels, further investigation of which had been recommended in IWC (2014), and encouraged such studies.

7.3.3 Evaluation of mitigation measures

A task identified at SC/65b was a bibliography of papers on ship strike mitigation measures as a first step towards a review of such measures by the Scientific Committee. The papers listed in SC/66a/HIM04 relate to mitigation measures that have been implemented (mostly through measures adopted or endorsed by the International Maritime Organization) to address the problem of collisions between large vessels and whales. These mitigation measures that have been implemented for reducing collision risk are essentially limited to either routing away from whales or slowing down. Many measures such as Traffic Separation Schemes create rules that apply to all vessels. Others such as speed restrictions or areas to be avoided (ATBA) often specify a size of vessel to which they apply.

Based on this review and a list of mitigation measures that had been implemented globally that was discussed last year (Ritter and Panigada, 2014), the Working Group created the simple summary table of ship strike mitigation measures in Appendix III. This table is intended for use by the Secretariat and ship strike data coordinators as a first response to general enquiries about mitigating ship strikes.

8. TIME SERIES OF MORTALITY ESTIMATES FOR USE IN ASSESSMENTS

The Working Group recognised that it is not yet in a position to provide time series of mortality estimates with any reliability. It was therefore agreed that the best way to address this agenda item would be for a small group to work on it intersessionally. Double offered to convene a small group of Leaper, Mattila, Ritter and Weinrich, consulting others as necessary to provide regional input. The Terms of Reference would be to review existing literature, data and other resources in order to identify any quantitative (if possible) and qualitative estimates (e.g. reported numbers as minimum estimates) of non-deliberate, human induced mortality for the populations that are currently being assessed by the Scientific Committee. This information would be compiled and submitted to SC/66b in 2016. It was also **agreed** to develop a way of querying the ship strike database to be able to extract cases by population.

9. OTHER ISSUES, INCLUDING ASSESSING MORTALITY FROM ACOUSTIC SOURCES AND DEBRIS

Nothing was discussed under this item.

10. WORK PLAN

The work plan will include the following.

(1) Review progress in including information in National Progress Reports.
(2) Entanglement:
  (a) estimation of rates of entanglement, risks of entanglement and mortality;
  (b) collaboration with commission initiatives on entanglement, including:
    (i) consideration of mitigation measures, including reviewing results of the proposed IWC entanglement prevention workshop (April 2016);
    (ii) assist with communication of key scientific issues related to entanglement;
    (iii) review entanglement issues related to conservation management plans;
    (iv) review output of the small meeting on the development of an IWC entanglement database; and
  (c) involvement with other international organisations which have complementary or overlapping mandates with respect to entanglement.
(3) Ship strikes:
  (a) estimation of risks and mortality from ship strikes;
  (b) collaboration with the commission's ship strikes Working Group including:
    (i) consideration of mitigation measures including review of mitigation measures that have been implemented, tested and reviewed for their effectiveness; encourage papers on using simulations to assess mitigation effectiveness;
    (ii) assist with communication of key scientific issues related to ship strikes;
    (iii) review ship strike issues related to conservation management plans; and
  (c) continuing development and use of the international database of ship strikes:
    (i) review progress by database coordinators; and
    (ii) review progress with reviewing new reports and application of new criteria.
(4) Time series of mortality estimates for use in assessments:
  (a) review the results of the work of the intersessional group compiling information on known quantitative and qualitative non-deliberate human induced mortalities.

11. ADOPTION OF THE REPORT

The report was adopted at 09:30 on Saturday 30 May 2015.

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Appendix 1

AGENDA

1. Convenor's opening remarks and Terms of Reference
2. Election of Chair
3. Adoption of agenda
4. Appointment of rapporteurs
5. Available documents
6. Entanglement
   - 6.1 Progress on including information in National Progress Reports
   - 6.2 Collaboration with Commission initiatives on entanglement, including consideration of mitigation measures
     - 6.2.1 Report of the Provincetown Workshop
     - 6.2.2 Evaluation of mitigation measures
   - 6.3 Estimation of rates of entanglement, risks of entanglement and mortality
   - 6.4 Proposal for entanglement prevention Workshop
7. Ship strikes
   - 7.1 Progress on the global database
   - 7.2 Estimating rates and risk of ship strikes and mortality
     - 7.2.1 Eastern North Pacific blue whales
     - 7.2.2 Abrolhos Bank, Brazil, Great Barrier Reef, humpback whales
     - 7.2.3 Northern Indian Ocean blue whales
     - 7.2.4 Hellenic Trench, Greece, sperm whales
     - 7.2.5 Bryde's whales in Hauraki Gulf, New Zealand
     - 7.2.6 Canary Islands, sperm whales
     - 7.2.7 Other
   - 7.3 Collaboration with the Commission Ship Strikes Working Group including consideration of mitigation measures and plans for future workshops.
     - 7.3.1 General overview of mitigation options
     - 7.3.2 Role of speed
     - 7.3.3 Evaluation of mitigation
8. Time series of mortality estimates for use in assessments
9. Other issues, including assessing mortality from acoustic sources and debris
10. Work plan and budget requests
11. Adoption of the Report

Appendix 2

TERMS OF REFERENCE FOR AN IWC WORKSHOP ON THE PREVENTION OF LARGE WHALE ENTANGLEMENT

INTRODUCTION

Both the IWC and its Scientific Committee have agreed, through the endorsement of a number of technical reports and workshops, that the entanglement of large whales in manmade materials (especially actively fished, line, rope and net):

(1) has been reported for all large (and small) whale species, and may occur anywhere that their distribution overlaps with those fishing activities;
(2) is greatly under-reported;
(3) is a significant conservation issue for some endangered cetacean species and populations, and is a serious welfare issue for all; and
(4) preventing whale entanglements before they occur is the only long-term solution.

Recognising that entanglement may be the greatest cause of mortality related to human activities for many whale populations and also can cause economic loss and human safety concerns, the Commission has recommended that a Workshop focused on the prevention of large whale entanglement, be convened in 2016.

OBJECTIVES

The primary objectives of the Workshop are to review new and existing ideas and practices in order to facilitate member states in achieving the overall goal of preventing or minimising large whale entanglements, recognising that there will be no single universal solution for all fisheries, populations and regions.

The following measures will be reviewed as well as any new or innovative practices that may reduce entanglements:

(1) operational/deployment changes, e.g. seasonal fishing changes, changes in depth or other aspects of gear deployment and/or closures (effort reduction);
(2) methods for alerting, diverting or deterring whales away from gear (e.g. visual, acoustic, behavioural);
(3) effectiveness of gear modifications to reduce the number or severity of entanglements (e.g. weak links, sinking line and other methods of reducing potentially entangling materials in the water column); and
(4) review the effectiveness of intervention (disentangling) to minimise the impacts of those entanglements that are not prevented.

In order to evaluate and, as appropriate, implement any of these measures there is a requirement for information gathering and engagement with stakeholders. The Workshop will bring together relevant biologists, entanglement and fishery experts (including fishers and gear manufacturers/technologists) to examine what is currently being explored and/or implemented, either voluntarily or by regulation to reduce entanglement risk. It will also consider the most effective ways of engaging with stakeholders.

The Workshop will also review methods for gathering data on fishing practices including;

(1) ways to improve data collection and geographical standardisation of data and coverage in order to identify important data gaps and research priorities;.
(2) the status of gear marking at the global level;
(3) the efficacy of gear characterisation and identification guides as a way to better understand local fishing practices;
(4) consideration of any potential negative impacts of any mitigation measures for particular species/fisheries on other marine life including other cetaceans; and
(5) consideration of ways of reducing entanglement risks caused by lost or discarded fishing gear

INTENDED OUTCOMES

The report of the Workshop will, in addition to providing the analyses, review and recommendations listed under the items above:

(1) identify successful and/or promising existing mitigation measures including advice on practical implementation of such measures;
(2) identify priority areas of research directly related to entanglement prevention including studies of whales (e.g. distribution, behaviour, health, physiology.…etc.) and fishing gear (e.g. nature of deployment, low profile, weak rope or links, colour, sound, propensity to become lost/debris and significance of this….etc.);
(3) provide guidance to the Commission as they develop a strategy to:
    (a) provide advice on current effective practices to member countries;
    (b) engage with other relevant IGOs working on this issue (e.g. FAO, CMS, RFMOs….etc.); and
    (c) consider advice for Conservation Management Plans for affected populations and potentially consider the value of developing a threat-based CMP for entanglement.

ORGANISATIONAL AND LOGISTICAL PLAN

The IWC Secretariat will convene a steering committee of both IWC and external experts, who will develop an agenda and list of potential invited participants. The Secretariat will also work with interested Countries, IGOs and NGOs in order to generate a venue and remaining financial support needed to conduct the Workshop. The Workshop is planned for April 2016 (venue TBD).

Appendix 3

SUMMARY TABLE OF SHIP STRIKE MITIGATION MEASURES THAT HAVE BEEN IMPLEMENTED WORLD WIDE

Measure	Situation to which it might be applied	Implementation process (and observations)	Examples
Keeping vessels away from whales			
Permanent routing measures through TSS, ATBA or port approach routes	Long-term patterns of whale distribution are sufficiently predictable and well understood to enable a robust analysis of the risk reduction that might be achieved.	Implemented through IMO or national regulation if within territorial sea. Proposals should follow the IMO process including data on the problem, the risk reduction achieved and implications for shipping (generally well respected by industry).	Bay of Fundy, Canada Boston, USA California, USA Panama Cabo de Gata, Spain
Seasonal routing measures	Similar requirements to permanent routing but applicable where there are strong seasonal patterns in whale distribution.	As above.	Roseway Basin, Canada Great South Channel, USA
Recommended (voluntary) routes	Similar requirements to permanent routing through TSS or ABTA but not mandatory.	Implemented by IMO or coastal state as a non-mandatory measure.	Península Valdéz, Argentina Hauraki Gulf, New Zealand Glacier Bay, USA Ports on US east coast
Short-term (days-weeks) and dynamic routing measures	Implemented in response to short-term observations of whale aggregations or known high risk areas. Need almost real-time reporting systems that can identify such aggregations.	Voluntary measures that need to be communicated to mariners (can be difficult to encourage compliance).	DMAs off US east coast Gibraltar Strait, Spain
Slowing vessels down			
Permanent speed restriction zones	Long-term patterns of whale distribution are predictable and well understood but routing measures are not practicable.	Can be voluntary or mandatory if implemented in national waters.	East coast of USA (mandatory) Glacier Bay, USA Hauraki Gulf, New Zealand
Seasonal speed restriction zones	As above but applicable where there are strong seasonal patterns in distribution.	As above.	Panama California, USA Península Valdéz, Argentina
Dynamic Management Areas for speed restrictions	Implemented in response to short-term observations of whale aggregations or known high risk areas. Need reporting systems that can identify such aggregations.	Voluntary measures that need to be communicated to mariners (can be difficult to encourage compliance).	US east coast
Avoidance manoeuvres			
Real-time alerting tools to warn vessels of the presence of whales or aggregations that allow vessels to alter course or slow down	A rapid reporting network of whale sightings or acoustic detections alerts all vessels transiting an area to the locations of whales so that they can alter course or slow down.	Individually designed and implemented reporting systems.	REPCET, ACCOBAMS, Mediterranean Sea WhaleAlert, Boston USA
Observations from the vessel that allow avoiding action to be taken	Only effective for vessels capable of rapid manoeuvres to avoid whale sightings (e.g. vessels of a few thousand GT or less).	Additional dedicated observers, education and outreach to mariners.	Many initiatives

Further details of the measures given as examples can be found in Ritter and Panigada (2014), with a bibliography of studies relating to these examples, including evaluations of effectiveness in SC/66a/HIM04.

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