Report of the Workshop on Welfare Issues Associated with the Entanglement of Large Whales

Submitted by Australia, Norway and USA

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1. INTRODUCTORY ITEMS

The meeting was held at the Hawaiian Islands Humpback Whale National Marine Sanctuary facility in Kihei, Maui, from 13-15 April 2010.

1.1 Welcoming remarks

Naomi McIntosh, Superintendent of the host site (NOAA's Hawaiian Islands Humpback Whale National Marine Sanctuary) welcomed the participants to the Workshop on the behalf of the conveners, Mattila and Rowles.

1.2 Appointment of Chair

Arne Bjørge (Norway) was appointed chair of the meeting.

1.3 Appointment of rapporteurs

Taylor and Wilkin were appointed rapporteurs for the meeting.

1.4 Review of available documents

E1-6; Moore et al. (2010); Knudsen and Øen (2003); Øen (2003); Coughran (in review); Cassof et al. (in review); NOAA (2007); Øen and Knudsen (2007) were reviewed at the workshop. Other documents available for the information of the participants are listed in Appendix 1.

2. OBJECTIVES FOR THE WORKSHOP

Terms of reference are included in Appendix 2.

The workshop requested that Øen provided a summary of the background to the meeting to the participants. Øen summarized document IWC/60/Rep 6, and informed the participants that at the annual meeting of IWC in Anchorage in 2007, Norway referred to papers describing the increasing global problem of entanglement of large whales in fishing gear or marine debris. Norway suggested this to be an increasing problem with serious animal welfare implications, particularly as whale stocks are generally increasing in size at a time when fishing is increasingly conducted on migration routes and on feeding grounds. In some cases the estimated times to death could be 5-6 months for some animals, and suggested that such situations represented a gross abuse of wild animal sensibility and urged the euthanasia of such animals. In response to the issue raised by Norway, the USA tabled a document that described what it is doing to reduce the entanglement of large whales in its waters and its policy on the euthanasia of entangled large whales. Norway recognised that it is not always possible to disentangle whales and that it is these cases that are of the greatest concern from an animal welfare perspective and believed that approaches to the question of possible euthanasia of entangled whales would benefit from more in-depth discussions and recommended that a one-day workshop be held in association with the 2008 Annual Meeting. This was supported by the Commission and an Organising Committee was established comprising Norway, Australia, USA, Denmark (Greenland) and the Secretariat to develop a draft agenda and plans for the workshop.

When the co-chairs of the organizing committee (Norway and Australia) were developing a draft agenda Australia suggested expanding the workshop to include an overview of current methods used to mitigate the entanglement of large whales and the development of a decision tree under which entangled whales are managed. The organizing committee agreed that, although prevention/mitigation is important, a decision tree for dealing with entangled animals including a thorough overview of disentanglement techniques and the possible euthanasia should be addressed first as a matter of urgency because whales are being entangled now, and will continue to be so until/if effective prevention strategies are developed and at the 2008 IWC meeting, a steering group was appointed to further develop the workshop.

3. ADOPTION OF THE AGENDA

The agenda was adopted with changes and is given in Appendix 2.

4. OVERVIEW OF THE ENTANGLEMENT OF LARGE WHALES

Participants of the Workshop defined some commonly-used specialized words and phrases relating to large whale entanglements and euthanasia, which are listed in Appendix 3. The Food and Agriculture Organization (FAO) has developed standardized abbreviations for types of fishing gear; these are listed in Table 1.

IWC/A10/E2 provided an overview of some of what is currently known about the scope of large whale entanglements worldwide. Some of this was compiled from the National Progress Reports which are submitted annually to the IWC Scientific Committee by member countries. In addition the paper provided a review of some of the documents submitted to meetings of the bycatch subcommittee over the past few years. Summaries of the species, numbers and gear types provided in the progress reports, along with new and/or more up-to-date information provided to this meeting, indicate that all large whales can become entangled in rope and nets, although minke (*Balaenoptera acutorostrata*), humpback (*Megaptera novaeangliae*), gray (*Eschrichtius robustus*), North Atlantic right whales (*Eubalaena glacialis*), and Southern right whales (*Eubalaena australis*) are most commonly reported. It is also clear that whales can become entangled or entrapped (see Section 4.3) in a wide variety of (primarily) stationary or drifting ropes and nets (whether derelict or actively fished), with the most frequently reported consisting of large, trap-type nets such as fyke, set, or pound nets, and box traps (FYK, FPN), gillnets (GN), and various "pot" gear (FPO). Of course this varies globally depending on which gear is most commonly used in particular countries, and it can vary over time as target fisheries change or whale distribution and abundance changes. Several of the potential biases with the data in the reports were noted, including that heavier gear was more likely to "anchor" large whales in place, making them more likely to be observed and reported. Also, in some countries fishers may have strong financial incentive to report entangled whales, while in others there may be no incentive, no awareness, or even perceived disincentives to reporting. In addition to these biases, reports may come from a variety of both experienced and inexperienced sources, and may receive various levels of validation and screening at the country levels prior to final inclusion in the reports to the IWC.

The results of a number of the studies reviewed provide compelling evidence that there are severe limitations to estimating large whale entanglement rates based on either fishery observer programs or opportunistic reporting. It is likely that these methods underestimate the actual rates by a least an order of magnitude, if not more in some areas. In addition, new methods of determining actual mortality rates based on long-term sighting histories, knowledge of entanglement outcomes and inferences from annual entanglement wound acquisition, suggest annual mortality rates that could be having a significant impact on growth rates, and therefore hindering the recovery of some populations, the authors of IWC/A10/E2 highlighted the value of collecting a suite of accurate information from both entangled and disentangled whales, and recommended that these data be collected whenever practical and safe.

Workshop participants acknowledged the data presented are a minimum estimate of observed and reported entanglement rates for member countries submitting National Progress Reports to the IWC. The Workshop **expressed concern** that the numbers presented in the National Progress Reports represented underreporting of entanglements. The Workshop **agreed** with the authors' table summarizing large whale entanglement data with presence/absence information of recorded instances of entanglements by species (Table 2) and noted that this data indicates that entanglements are occurring throughout the geographic range of several species, encompassing breeding, feeding, and migratory routes, and that large whale entanglement is a global concern.

4.1 Key species involved

Species of whales most commonly entangled

Based upon the information presented in IWC/A10/E2, the Workshop noted that minke and humpback whales were the most commonly reported entangled species. Minke whales were primarily reported in the National Progress Reports from Korea and Japan, where marketing of products of entangled whales and the nature of fisheries may be an incentive for reporting the catch. The Workshop **commended** Korea for the very detailed reporting of entangled whales. Minke whales entangled in Korea are genetically sampled and the Workshop noted that all were from the J stock. The high numbers of reported entanglements from Korea and Japan may be partially explained by the high abundance of fishing gear in the migration routes and feeding areas of the species. Minke whale entanglements may be underreported from other geographic areas due to the lack of a strong incentive to report, disincentive due to perceived regulatory actions, different types of fisheries (e.g., gear is "tended" gear where fishers can immediately

release animals), lower level of fishery efforts, release of whales by fishers without intervention by response teams, and inherent detection difficulties due to their cryptic behavior. In addition, the Workshop noted that entanglements of all species are likely underreported globally for many of the same reasons discussed above.

Identification of the most critical interactions occurring (endangered species, etc.)
Participants identified the following species or stocks as the entanglements of the highest concern from a population or conservation perspective:

- Western Pacific gray whales
- North Atlantic right whales
- North Pacific right whales (*Eubalaena japonica*)
- J-stock of minke whales in the Western Pacific
- Other small populations [e.g., bowhead whales (*Balaena glacialis*) in the Northeast Atlantic]

The Workshop **cautioned** against highlighting specific species and interactions of concern to the exclusion of others, as environmental changes such as climate change may alter distribution of whales or fishing effort, resulting in new areas and species at increased risk of entanglement. Also, the Workshop **expressed concern** that information is incomplete for many regions and/or species.

4.2. Priority regions
The Workshop considered entanglement to be a priority issue across the range of several populations of management concern with a confirmed vulnerability to entanglement. As noted above, these included Western Pacific gray whales, J-stock minke whales and North Atlantic and North Pacific right whales. However, available evidence suggests that entanglement is a potential concern in any area in which whales and stationary or drifting gear in the water overlap. Thus, any endangered population should be considered at potential risk from overlap, even in the absence of confirmed reports. Areas of known or potential overlap of whales with gear in the water should also be prioritized when formal reporting and response capability is known to be limited or absent. This may include sub-areas within networks, such as offshore areas with fewer potential observers. An area where a population gathers may also be a strategic location for intervention (i.e., disentanglement) even if entanglements occur elsewhere. Finally, it was noted that changes in species density, species distribution and fishing practices can potentially result in rapid regional changes in entanglement rate. Thus, historic information may not always provide reliable insight into current frequency or impact of interactions, and increasing monitoring may be required in areas previously not sampled [e.g., offshore waters of Newfoundland with increasing pot fishery (FPO) effort].

4.3. Types of Entanglements
Different types of gear interactions (as reported in Table 3) often call for different types of entanglement response. For clarity in discussion different types of whale/gear interactions are recognized and can be broadly characterized as (see Appendix 3):

- Entanglements: involving wraps of line, netting or other materials around body areas. Entanglements may include cases in which animals are towing gear or anchored by gear. Although the most common gear types reported in entanglements were pots (FPO) and gillnets (GN), a large spectrum of gear types were also recorded, such as shark control nets (NSC), marine debris, aquaculture and moorings.
- Entrapments: involving an animal enclosed within a fishing structure or trap. Animals did not necessarily have gear on any body parts but were confined by walls of netting. The most common gear types reported for entrapments included fyke nets (FYK), set and pound nets (FPN).
- Hooks: involving fishing hooks and associated line embedded within body parts. Gear types associated with this form of interaction included recreational fishing gear and longlines (LL).
- Mobile gear: involving wraps of line or capture of an animal in actively towed gear. Gear types might include trawls (TX) and seine (SX). Ultimately some of these interactions may become entanglements as characterized above.

4.4. National Data on Large Whale Entanglements

Workshop participant countries presented data on the numbers of large whale entanglements reported from their waters.

Australia: Over the period 2003-2008 large whale entanglements in Australian waters have included 1 minke, 82 humpback, 3 southern right, 1 Brydes and 4 sperm whales, as summarized in the National Progress Report submitted to the IWC Scientific Committee annual meetings (56-61, 2003-2008). Each of the six Australian States has trained disentanglement teams that responded to these events resulting in successful disentanglement rates ranging from 33% to 90%. Australia has experienced large whale entanglements in man-made materials including gill nets (GN), pots (FPO), traps (FIX), set long lines (LLS), long lines (LL) and shark control nets (NSC). All disentanglement responses are managed under occupational, safety and health legislative framework.

Canada: Between 1979 and 2009, 1232 large whale entanglements were recorded in Newfoundland and Labrador waters. Species involved included primarily humpback whales (988 or 80%) and minke whales (186 or 15%). Approximately 4% of entanglements could not be identified to species. In 13 cases two humpback whales were reported entangled together with a record of three humpbacks entangled together. Cow calf pairs were frequently entangled. Of the 1232 large whale entanglements reported within the Newfoundland and Labrador Region approximately 93% could be assigned to five generic gear types: 1. box traps (FPN); 2. pots (FPO); 3. gillnets (GN); 4. rope (MIS); and 5. other gear (MIS). The entanglement outcomes include: 84% or 703 humpbacks were released alive from fishing gear and 136 or 16% died. In addition, 66 minke whales or 39% were released alive from gear with 103 or 61% dying in gear. From 2003-2008, 177 humpback and 21 minke whales were reported entangled in fishing gear. Reporting of gear entangled whales in the Newfoundland and Labrador Region in inshore waters is assumed to be high however offshore reporting is thought to be lower.

Mexico: Between 2001 and 2010, 39 entangled whales were reported in Mexico, all of them along the Pacific coast. The reports were comprised of 36 humpback whales, two gray whales and one blue whale (*Balaenoptera musculus*). Nine were found dead (6 humpback whales, 2 gray whales and one blue whale), 18 were disentangled and the rest were still entangled when last observed. Gillnets (GN) were the main fishing gear involved (22 cases), followed by ropes (MIS; 5 cases), longlines (LL; 2) and unknown (MIS; 10). The most reports were from Baja California Sur (15), followed by Nayarit (14), Sinaloa (4), Colima (3), and Baja California, Guerrero and Oaxaca with 1. The information sources range from the media (television and newspapers), whale-watching operators, scientist, and tourists, to government agencies as PROFEPA (Environmental agency) and the Navy Secretary.

Norway: There is no organized program for recording, reporting and response to entangled whales in Norway. However, incidental information since 1989 is stored by the Institute of Marine Research. This information include humpbacks (1989: scar on the peduncle; 2006: trapped in lobster pot line (FPO) and released alive; 2007: trapped in gillnet (GN), unsuccessful attempt to release and euthanized; 2009: entangled in rope at a fish farm, released alive) and minke whales (1992: scar on dorsal side).

South Africa: IWC/A10/E6 described an overview of whale entanglements in South Africa. The majority of southern right and humpback whale entanglements in South Africa have been attributed to fishing gear from the rock lobster industry (FPO) and the shark nets (NSC) off the KwaZulu-Natal coastline. Meÿer reported on all known SA records of whale entanglements (1975 - 2009), excluding data from KwaZulu-Natal Sharks Board (KZNSB) which deals exclusively with stationary meshing operations (between Port Edward to Richards Bay, 1981-2009). In the KZNSB nets**,** southern right and humpback whales are caught, mainly between July to October, comprising of humpbacks 61.3% (n=49) and southern right whales 23.8% (n=19). There have also been 357 "suspected whale encounters" annotated separately and presented for the period 2000-2009. CPU of whales in the shark nets for the period 2000-2009 varied considerably between the 38 net installations. Whale catches showed a steady increase from the early 1990s to present. Of the two whale species, 17 southern right whales (89.5%) and 38 humpbacks (77.6%) were released alive. In the rest of the SA coastline**,** records of 96 events between Lamberts Bay and Sodwana Bay indicated "hotspots" located near three main areas; Dassen Island, the Cape Peninsula and Hangklip due to intensive rock lobster fishing. Bi-modal seasonality in whale entanglements occurred with a peak during August to October and a smaller peak in December to February around rock lobster fishing at Dassen Island. In all 93 cases of whale entanglement gear was recovered, material was identified as some form of fishing gear that is stationary and deployed on the bottom. Reported entanglements have increased over the last 20 years, reaching a maximum of 14 incidents in 2008. Six entangled whales that stranded are the only known mortalities of whales (exclusive of the

KZNSB). Concern is expressed for the effect of increased anthropogenic factors on the small and maternally directed subpopulation of the West African population of humpbacks that exist in spring and summer.

United States: The entanglement response networks within US waters include both the Pacific and Atlantic coasts, and the main Hawaiian Islands. Between 1999 and 2009, there were 502 confirmed entanglement cases, including live animals with life-threatening and non-life threatening entanglements, as well as carcasses. Cases were confirmed through reliable witnesses and/or photo- or video-documentation – only half of the initial reports were confirmed to have involved entangled cetaceans as summarized by SC/59/BC2 and Lyman et al., (2007). Confirmed entanglements were documented for right whales (8.96%), bowhead (0.4%), humpback (65.34%), blue (0.2%), fin (4.38%), sei (0.4%), minke (11.16%), gray (4.58%) and unidentified species (4.58%). Entanglement reports were solicited through outreach efforts and dedicated toll-free numbers and responses were mounted for approximately half of these cases. More than120 confirmed entanglements were fully or partially freed of entangling gear through dedicated entanglement response. However, more importantly, data gathered through entanglement response has provided valuable information on mitigating the large whale entanglement threat (e.g. gear modifications aimed at reducing the entanglement problem and understanding population impacts).

4.5. Conclusions and Recommendations

The Workshop noted that even in areas where awareness and response programmes are established the proportion of entangled whales are likely to be underreported. Most areas where there are overlap between fishing operations and cetaceans, awareness and response programmes are not yet in place. This includes important fishing grounds in the Northeast Atlantic, Western North Pacific, waters around South America and most of the Asian part of the Indian Ocean. Therefore, the Workshop **concluded** that entangled whales are severely underreported globally, and **recommended** that coastal nations establish adequate programmes for monitoring entanglement of whales and member countries report to the IWC through National Progress Reports.

The Workshop further **recommended** that particular emphasis should be on areas where fishing operations and other anthropogenic activities that can cause entanglements overlap with the distribution of endangered or depleted populations, e.g. Western gray whales, North Atlantic and North Pacific right whales and J-stock minke whales.

5. OVERVIEW OF THE DISENTANGLEMENT OF LARGE WHALES.

5.1. Current/commonly used methods for disentangling whales

Mattila provided an overview of large whale disentanglement. Initially, one approach to releasing large whales from entanglement was to instruct many fishers to handle entanglements in their own gear. However, many issues including safety, liability, impracticality, and improper release procedures have led to the primary approach for entanglement response being to train and equip rescue teams to respond when an entanglement is reported. In addition, inexperienced rescuers are more likely to leave some gear, often a lethal wrap, on the whale. Mattila then showed some of the basic tools and techniques that are most commonly used around the world, including the adaptation of the historical whaling technique of "kegging". The countries currently employing these techniques, to varying degrees, in a structured program of entanglement response are: Australia, Canada, Mexico, New Zealand, South Africa, the United Kingdom and the United States. He then reviewed some of the newer tools and techniques in current development in the United States, including: sedation, spring-loaded cutting blades and tail harnesses. He ended with a description of some of the methods used to coordinate, inform and update network members, and the desired experience levels of candidate rescuers. The latter included identifying candidates with experience around whales, operating small boats, handling ropes under high tension, and safety at sea, including a "level head" when operating in potentially dangerous situations.

Mattila clarified that post-response monitoring and follow-up is opportunistic based upon resightings, which relies upon good photographic documentation and a genetic sample obtained during the response effort. Other participants described the technique of establishing a control line between the response vessel and a support vessel for additional safety.

Moore et al. (2010) aimed to sedate North Atlantic right whales to enhance operations for the removal of fishing gear from North Atlantic right whales at sea, when the animals are evasive to approaches of the disentanglement boat. Following initial trials with beached whales, a sedation protocol was developed for North Atlantic right whales. Titrated intra muscular injections to achieve sedation were undertaken on two free swimming North Atlantic right whales. Mass was estimated from sighting and necropsy data from comparable right whales. A series of trials lead to

the use of midazolam (0.1 mg/kg) and butorphanol (0.1 mg/kg) in two darts 10 minutes apart. This gave a statistically significant increase in respiratory frequency an hour after injection, with increased swimming speed and marked reduction of boat evasion that enabled decisive cuts to entangling gear.

The Workshop **agreed** that the use of sedatives represents a managed risk but may provide additional benefits for the safety of responders and enhance animal welfare, may be a valuable tool in disentanglement response, and **recommended** that the technique should be explored further.

Participating countries in attendance provided an overview of response activities, disentanglement network structure, equipment availability, trained personnel, and additional information.

In all but one country attending the meeting (Brazil), previous occurrences of entangled large whales had resulted in some kind of disentanglement response. The reasons that motivated responses to entangled whales vary by country and are summarized in Table 4.

Five nations at the workshop (Argentina, Brazil, Mexico, Norway, and Korea) have no formalized large whale disentanglement response network. In these countries, responses were conducted by marine mammalogists, whale-watching operators, divers, fishers, governmental representatives (Navy, Coast Guard, and Environmental Secretary), and the general public. Documentation of events and responses is opportunistic and variable, and specialized disentanglement equipment is not available (except for limited equipment in two locations in Mexico). Major identified challenges included the need to develop an efficient and trained disentanglement network, and to attempt to prevent entanglements of large whales.

Four nations at the workshop (Australia, Canada, South Africa, and United States) have formalized large whale disentanglement response networks, although the response area represents varying percentages of each country, from localized regions to the majority of the nation's coastline. While there are differences, these networks share many commonalities including: established legal authorization to conduct disentanglement operations; coordinated communications via e-mail, websites and phone trees; established training programs; established risk assessment and safety protocols, including the development of action plans for individual cases; partnerships with veterinarians; support (although at times limited) from governments, non-governmental organizations, and local communities. All groups have specialized tools and caches of equipment for disentanglement response; in Australia, the United States, and select areas of Canada, this equipment includes satellite telemetry buoys to track the movement of entangled whales at sea, which enhances the ability of the team to respond and enhances safety by allowing responders to cease operations if the situation, needed resources or risk level require, and yet continue on another day when the those have been satisfactorily resolved. Documentation of entangled animals and disentanglement response activities is extensive, and generally used to help prevent future entanglements. None of the countries polled have established plans for euthanasia of entangled whales at sea. Major identified challenges to overall response efforts included: ensuring safety of human responders; maintaining or increasing response capabilities; increasing public awareness to improve reporting; maintaining or increasing funding; extensive coastline or offshore entanglements that hinder response; and improving investigations into gear for the prevention of entanglements.

The Workshop **agreed** that documentation of animals following response efforts was a high priority. Current methodologies employed include documentation through individual identification by photography and collection of a genetic sample, and collaboration with researchers to document those animals following the disentanglement. The Workshop **recommended** that documentation efforts continue and expand, while maintaining human safety. The Workshop noted that, while implantable tags are not currently utilized, technological advances could result in their availability and use in the future. Assessing post-entanglement survival is also addressed in Section 6 below.

The participants acknowledged that information dissemination to both the disentanglement responders and the general public is an important element of disentanglement response. Media attention to entangled animals and disentanglement operations was noted to result in increased public awareness and reporting of entangled animals and may prevent inexperienced efforts to respond to entangled whales. Within-network communication is enhanced by private websites where responders can share information including photographs and case reports. These web sites, along with email discussion groups, have also greatly enhanced communications between networks in different countries to the benefit of all.

5.2. Risk assessments

Smith provided an overview highlighting that responses to entangled large whales are inherently risky due to the variable nature of entanglements, the size and behavior of whales, environmental conditions, and varying responder experience levels. Utilizing a risk assessment model, attempts have been made to identify, quantify, and potentially mitigate the risks associated with both an overall response, as well as the actual risk to the whale. By examining specific criteria such as, responder experience level, complexity of operation, animal behavior, operating distance from shore, resources available, boat and crew fitness, and environmental conditions it allows the risks associated with the overall operation to be evaluated. By examining the following criteria, number of lines on the whale, degree of constriction of lines, age class of whale, any gear associated with the entanglement, i.e. presence of pot trap or netting, etc., number of wraps of line on whale, number of whale body parts involved, and degree of cyamid coverage it allows the risks associated with the whale to be evaluated. Through identification and quantification of risk factors one can implement measures such as: training, experience, and authority levels; risk assessment/Green, Amber, Red (GAR) analysis; telemetry packages; protocols for equipment and Incident Command System (ICS) structures; documentation; assessment; and medical intervention in order to mitigate the levels of risk involved in an entanglement response. Closely related is the development of a decision tree for determining when human intervention is warranted and utilizing the information gleaned from the risk assessment to populate the decision tree. The Workshop **commends** the developers of the presented risk assessment and **recommends** further development of the concept.

Participants discussed the utility of the ICS in many different operations, as it is scalable to the scope of the operation (e.g., 1 or 2 people filling multiple roles in a straightforward, uncomplicated response or encompassing many people representing different organizations across space and time for very complex situations) and provides participants with a known organizational response framework. It was noted that the use of ICS (or another organizational framework) can also ensure that adequate planning and safety are incorporated into the decision-making process, so that decisions are not made in haste or due to external forces such as public or media pressure, and that the decision to not respond is always considered. The Workshop also **agreed** that the ultimate solution to the issue of large whale entanglements is prevention.

Landry provided information documenting the entanglement in fishing gear in most baleen whale species in the Gulf of Maine and in at least two species, humpback and North Atlantic right whales, which indicates that entanglement involves substantial percentages in both populations. Although only a small number of these animals are documented while entangled and an unknown number die from their entanglements, information gathered during disentanglement intervention remains one of the best means for better understanding and ultimately mitigating the problem of entanglement. Standardized disentanglement techniques used by the Atlantic Large Whale Disentanglement Network have been applied to humpback and North Atlantic right whales with varying degrees of success. Landry looked at narrative accounts, photographs and video documentation to determine differences of disentanglement outcomes between the two species, from 1997 to 2002. A disentanglement event was defined as an on-water response where a live, entangled animals was assessed and intervention was deemed necessary and possible. Disentanglement outcome was categorized as: no gear removed; partial disentanglement with life-threatening gear remaining; partial disentanglement with no life-threatening gear remaining; and all gear removed. Seventy-seven percent of North Atlantic right whale disentanglement events (n=30) involving 15 individuals had negative outcomes (no gear removed or partial disentanglement with life-threatening gear remaining). Seventy-five percent of humpback whale disentanglement events (n=20), involving 19 individuals, had positive outcomes (all gear removed or all life-threatening gear removed). This difference between species was significant ($X=13.00$, $df=1$, $p=0.0003$). Significant difference was also found when these events were pooled for their individual entanglements. Disentanglement led to positive outcomes in 41% (n=17) of the North Atlantic right whales and 79% (n=19) of the humpback whales (Fisher's exact test, $P=0.04$). Landry believed the variability may be due to the more powerful and dangerous nature of North Atlantic right whales combined with the character of their entanglements. Safety and management implications were discussed.

Landry clarified that the definition of successful outcome was the change of the entanglement configuration from life-threatening to non-life-threatening. He also noted that most of the gear identified from North Atlantic right whales was from the feeding grounds in the western north Atlantic.

The Workshop noted that animal behavior, and therefore associated risks to response personnel, may vary greatly depending upon the species, age class, and behavior state (e.g., breeding, feeding or migrating) of the entangled animal.

5.3. Improving Disentanglement Operations

Mattila commented that some aspects of improving disentanglement operations were reported in Mattila et al. (2007), which focused on important scientific information that could be safely gathered during the disentanglement process. This included careful documentation of the species, individual (i.e. photo-ID and/or genetic sampling), wounds, general health (e.g. visual and behavioral assessment, as well as biological assays), gear type and origin, and entanglement configuration. It was noted that it was these data that were used in many of the papers reviewed for this workshop, and that continued collection allowed the refinement of the decisions made regarding the most appropriate responses to entangled whales, and could lead to overall mitigation of large whale entanglement and its associated welfare impacts. Rowles noted that these data were currently used in the U.S. to inform management decisions. It was **agreed** that the collection of information, during disentanglement operations, that could lead to the prevention of large whale entanglement was a high priority in addressing the associated animal welfare issues. The Workshop **recommended** responders collect and archive gear removed from entangled whales for future assessment.

The Workshop noted that an essential component of improving disentanglement operations was improved reporting, especially by fishers, as they are often the most likely to be the first to spot an entangled whale.
The Workshop further **agreed** that with the growing regulatory pressures on fisheries, in many areas, there was actually a growing disincentive for reporting entanglements, due to fear that it could lead to increased regulation, and **encouraged** countries to explore the use of mechanisms, such as independent gear compliance monitoring and considerations for fishers who follow all national reporting protocols and are using legal fishing procedures. The Workshop noted that disentanglement operations can be relatively rare and responders isolated, and **recommended** that communication networks be expanded and improved, particularly between countries with disentanglement responders.

5.4 Conclusions and Recommendations

Given evidence presented at this workshop, any country that has coastal whale populations and stationary and/or drifting fishing gear, but is not aware of large whale entanglements, should consider that there is potential for them to exist. Therefore the Workshop **recommends** that those countries enact mechanisms to investigate the extent of possible incidents. This could be done through scar based studies, interviews with fishermen, whale watching operators, and others, thorough examination of existing stranding data, etc. The Workshop **recommends** that these countries establish response capability, drawing from experience in other countries.

The Workshop has identified human safety, the welfare of the entangled animal and the conservation status of the species as important aspects to take into consideration, and therefore **recommends** that a response network that can monitor and respond appropriately and safely to entangled whales be established.
Given that decisions about response are often made in emotionally charged situations, the Workshop **recommends** that when establishing a response network countries learn from the experience of others that have ongoing successful and functional response networks.

1. The Workshop **strongly recommends** that the IWC urges member fishing nations to establish entanglement monitoring programs, with an eventual goal of entanglement prevention, mitigation, and response programs. One way that some countries might begin such monitoring would be to involve existing marine mammal stranding networks and expand their response capabilities to include disentanglement, following receipt of appropriate training.
2. The Workshop **recommends** that countries utilize active fishers and observer programs (e.g., Norwegian observers and whalers) to record gear on the animals and to take photographs to record scars and other signs of previous entanglement.

6. EFFECTS OF ENTANGLEMENTS ON WHALES

6.1. Damages and wounds commonly seen on entangled whales

Cassoff et al. (in prep) describes the available history, observations at necropsy and subsequent analyses in a series of 21 cases involving 5 species of whale that died following entanglement. This enabled a compilation of the manners in which entanglement can be lethal. These cases include drowning with entanglements involving multiple body parts, and the inability of the animal to surface. Other cases are much more protracted with entanglement

impairing foraging resulting in starvation after many months, or systemic infection resulting from infected wounds seeding septic emboli, and hemorrhage or debilitation due to severe tissue damage. Damage can include laceration of large vessels, embedment in growing bone, occlusion of the nares, and massive periosteal proliferation of new bone attempting to wall off the encircling, constricting lines. These data show that serious baleen whale entanglements are not only an issue for the conservation of populations, but also of major animal welfare concern for each affected individual.

The Workshop **recognized** that entanglements may produce 1) external wounds in the absence of significant internal damage, 2) external wounds with internal damage and 3) internal damage in the absence of significant external damage. Individual cases may have a combination of these lesions which may result in acute or chronic impacts. External injuries range from minor skin abrasions to deep lacerations and/or amputations. The majority of external injuries tend to be focused at the primary gear attachment site(s), which include the mouth, flippers and tail. However, external damage can involve any body part, including those that are not specifically wrapped and the entanglement can result in significant internal damage to any organ and the musculoskeletal system. This can result from line movement, drag, weight, or struggling (exertional). Where multiple body parts and/or heavy gear are involved, constriction and laceration can proceed as taut lines saw with draw length exceeding tissue compliance (Winn et al., 2008).

Based on visual assessments of live free swimming and examination of dead animals, external injuries can be crudely characterized as follows:

- Minor: Focal abrasions and lacerations which are limited to the epidermis.
- Moderate: Extensive epidermal abrasions and/or lacerations that extend beyond the skin into the blubber or fibroelastic tissue, but not as far as muscle.
- Severe: Injuries penetrating muscle or bone, amputations and/or other significant deformities with the potential to prevent normal behavior.

In free swimming animals it is often very difficult to discern the depth and extent of injury from visual observations.

The Workshop noted that entanglements may also produce physiological effects apart from observable wounds, as described in Cassoff et al. (in prep) or when gear impedes normal movement or feeding. In the short term, such events may result in exhaustion or in physiological sequelae to exertion or muscle damage and capture myopathy or direct destruction of muscles. In the longer term, entanglement has the potential to impact body condition and health. Persistent injuries and physical restraint can result in chronic stress, impaired health and other sub-lethal effects (as on reproduction). Entanglements may result in acute mortality (esp. drowning) or chronic disease due to infection, malnutrition, tissue trauma or hemorrhage, potentially resulting in death many weeks to months later.

The Workshop **commended** the work currently underway to assess the relative frequency of injuries, impacts and outcomes [for example, Provincetown Center for Coastal Studies (PCCS), New England Aquarium (NEAq), Woods Hole Oceanographic Institution (WHOI)].

Rowles presented NOAA (2007), the final report of a 2007 workshop titled, "Determining Serious and Non-serious Injury of Marine Mammals." The goal was to refine the criteria in use to determine which human-caused injuries to marine mammals: 1) were likely to have a serious impact on survival or reproduction; 2) were unlikely to have a serious outcome; and 3) for which the outcome cannot clearly be determined. By evaluating new information on human-caused injuries in marine mammals and survival of certain individuals or species of marine mammals, experts revised the criteria used for entangled large whales to include evaluations of the type of entanglement, the extent of wounds, the body part of injury, and the sex, age, and condition of the entangled animal. The National Marine Fisheries Service is further refining these criteria to ensure consistent and transparent evaluation of the injuries caused by human interactions. The criteria for categorizations and outcomes of entanglement injuries might be useful in decision making for entanglement responses.

The Workshop **acknowledged** that this effort was a helpful way of considering relative impacts of different entanglements, and incorporated some of this approach into the development of the decision tree (Section 8). The Workshop **agreed** that sampling of breath and exhaled particles from entangled and released animals represented an underutilized tool that should be pursued. Information obtained from these studies regarding the health status of

entangled and released animals could be used to inform decision-making and improve our understanding of impacts of entanglements. It was also noted that adequate baseline or reference samples from non-entangled animals would need to be obtained.

6.2. Survival of entangled whales

IWC/A10/E3 evaluated entanglement frequency and survival in humpback whales from the well-documented population in the Gulf of Maine, on the Atlantic coast of the United States. The author focused particularly on cases in which individuals were first reported alive, or survived un-witnessed events, and applications to date of those data. Since 1997, entanglement injuries have been monitored on the free-ranging population to better understand entanglement frequency, affected population segments and reporting rates. These data suggest that humpback whale entanglement rates are substantially under-reported in this region, despite a well-established reporting and response network. Both eye-witnessed and inferred events indicate that juveniles are preferentially affected. Preliminary analyses suggest that juveniles are also involved in more severe entanglements, as judged by gear configuration and resulting injuries. Previous mark-recapture statistical studies (SC/60/BC1) suggest that entangled juveniles have a lower probability of survival than unexposed juveniles, although these results are currently being explored with additional data. A range of factors that potentially affect entanglement outcome (including gear severity, injury severity, animal condition and mitigation efforts) are also currently being investigated and will contribute to mark-recapture studies of entanglement survival and fecundity. Mortality rates are particularly difficult to estimate because not all carcasses are detected and cause of death is often unknown. However, scar-based studies of survivors (SC/61/BC3) can yield alternate estimates of entanglement mortality counts and rates, in combination with other data. An unbiased entanglement survival rate is integral to such estimates and estimates require further refinement.

The Workshop **recommended** that all coastal nations should endeavor to collect more complete baseline data regarding every reported entanglement, and responders should record a personal narrative of the event and their impression of the animal and its prognosis. Further, the Workshop **encouraged** disentanglement networks to standardize data collection. The Workshop also stressed the importance of follow-up and, in particular, post-release monitoring through telemetry of animals following disentanglement interventions.

Knowlton presented a summary of North Atlantic right whale entanglement interaction data. For data analyzed from 1980-2006, 78.1% of the population showed evidence of interaction based on scarring or gear presence. The average annual rate of entanglement is 27% of adequately photographed animals. Studies to assess survival and fecundity based on gear and injury severity levels are presently underway in collaboration with PCCS and WHOI. Preliminary analysis of 50 animals considered to have life-threatening entanglements (defined in this study as tight wraps or >1 body length of gear trailing) showed that disentanglement significantly improved the chances of an individual being resighted. Visual health assessment studies (Pettis et al. 2004) indicate that severely emaciated right whales are rarely resighted after reaching that stage (only 1 of 10 resighted). However, of these 10 animals, 4 were entangled and not disentangled, one had been previously entangled for four years and became emaciated a year after giving birth to a calf and one had been shipstruck. Therefore, it remains unclear whether a severely emaciated animal that is disentangled could potentially survive.

The Workshop noted that body condition was a good indicator of the health status of the animal in right whales, but might not be for other species, and depending on the degree of emaciation can be difficult to assess. The Workshop also noted the value of both of the primary methodologies for measuring body condition: qualitative (via assigned scores from experts after examination of photographs or of the animal) or quantitative (via photogrammetry measurements).

Moore et al. (2006) reported that severe entanglements can span many months before eventually resulting in the death of entangled right whales. The known or suspected duration of the entanglement should be incorporated into the decision-making process (see decision tree in Section 8). The author also noted that confirmed fatal entanglements are likely under-detected, as right whales that experience a significant decline in body condition may become negatively buoyant and sink after death. Furthermore, the workshop recognized that balenopterid species are usually negatively buoyant, thus entanglement in these species are inherently unlikely to be counted, and therefore there is likely to be a global underestimate of the prevalence of lethal entanglement of balenopterid species.

6.3 Risk assessments: Whales after disentangling
The Workshop listed several possible entanglement response scenarios:

1) The whale is not deemed a candidate for disentanglement.
2) The whale is a candidate for disentanglement and is completely disentangled.
3) The whale is a candidate for disentanglement, but is only partially disentangled. Persisting gear may or may not be life-threatening. Gear may be shed or not without further intervention.
4) The whale is a candidate for disentanglement but disentanglement was not possible.

For each entanglement response scenario, any one of the following outcomes may apply:

1) The whale retains minor or reversible injuries and survives without significant impact. Individually-identified whales may or may not be re-sighted. If the health can be assessed on re-sighting over time, results may suggest stable or improving condition. The whale, however, may still experience a subsequent entanglement event (witnessed or not) or die from other causes.

2) The whale retains injuries/conditions that are not apparently immediately life-threatening, but its health and/or fitness are impaired in the short or long-term. Injuries/conditions may or may not be evident at the time of release. Individually-identified whales may or may not be re-sighted. If health can be assessed on re-sighting over time, results may or may not conclusively indicate declining condition.

The whale, however, may still experience a subsequent entanglement event (witnessed or not) or die from other causes. The role this entanglement event may play in susceptibility to other causes of death is not known
.
3) The whale retains injuries/conditions that will lead to death over the short or long term. These may or may not be evident at the time of sighting or release. The carcass may or may not be recovered after death.

The Workshop identified key health data to collect during entanglement responses to better understand the severity and possible outcome of events. The following were all considered potentially informative: body condition, skin condition, proliferation of cyamids, location and apparent severity of injuries, whale responsiveness and species-specific health indicators (such as rake marks at nares for North Atlantic right whales). Appendix 4 provides specific recommendations for data that can be reliably obtained during most disentanglement operations. These data should be supported by photographs and video whenever possible.

In order to better understand survival or condition of the animal during or post entanglement, suitable data should be collected to re-identify the whale with or without gear, and whether alive or dead.

It may be possible to achieve this with above-water photographs or video, but underwater imagery may be necessary to document key features. A biopsy sample and molecular genetic analysis may be used to identify an individual (if corresponding data exist for the free-ranging population), to match it to a subsequent live sighting or to match it to a carcass that has lost its pigmentation.

6.4. Conclusions and Recommendations
The Workshop **commended** the detailed work and approaches provided on survival of entangled whales and pathology of injuries provided in the presentations and papers. The Workshop **recognized** that entanglements may produce 1) external wounds in the absence of significant internal damage, 2) external wounds with internal damage and 3) internal damage in the absence of observable external damage.

This variability makes field assessments of specific pathology and physical or physiological injury in the animal difficult. The workshop **recommends** prioritizing necropsy of entangled and previously entangled whales to better document the internal consequences of the external assessment and the history of the entanglement. Recognizing the importance of such information on future prevention and mitigation measures and the role that such information would play in response decisions, the Workshop **recommended** standardized data be collected on the entanglement, the injuries, and the health of the individual, and when possible survival studies be conducted in other regions or on other species in which whale entanglements are observed. As part of the data collected, the Workshop strongly **recommended** the collection of individual identification data to ascertain the ultimate outcome of these events. In

addition, the Workshop recognized that although health metrics and health status trends are critical to decisions on condition and outcome of entanglement cases, there are few current standardized methods being developed, validated and used for various species and in different geographic areas. The Workshop **recommended** further development and validation of assessment and condition indices for large whales.

7. EUTHANASIA OF WHALES THAT CANNOT BE DISENTANGLED OR WILL NOT SURVIVE AFTER DISENTANGLEMENT

7.1. Identification of those situations for which euthanasia should be considered or recommended

As discussed in the American Veterinary Medical Association Guidelines on Euthanasia (AVMA 2007), euthanasia is the act of inducing humane death in an animal in a manner to minimize pain and distress. There are situations involving free-ranging wildlife when euthanasia is not possible from the animal or human safety standpoint, and killing may be necessary. Conditions found in the field, although more challenging than those that are controlled, do not in any way reduce or minimize the ethical obligation of the responsible individual to reduce pain and distress to the greatest extent possible during the taking of an animal's life (AVMA 2007).

7.2 Decision Criteria for Euthanasia

The first tool to mitigate the welfare issues of entanglement is to develop entanglement avoidance strategies. The second tool is disentanglement. The tool of last resort is euthanasia. Availability of euthanasia should in no way obviate the responsibility to undertake entanglement avoidance and mitigation measures. If an animal cannot be disentangled and is not likely to shed the gear over time, the decision to euthanize should be made on a summed appraisal of the following parameters: 1. If the whale is stranded; 2. If the whale cannot swim and is not improving over time; and 3. If the entanglement has resulted in an injury sufficiently serious, persistent and deteriorating such that the animal is judged to have a very low likelihood of medium to long-term survival. The overall health status of entangled whales may be evaluated by scoring the relevant health parameters of the animal (more information in decision tree footnotes) at the time of observation or over time. A positive answer to only one of the evaluation criteria may not be sufficient cause. If disentanglement of the whale is possible, disentanglement activities should be conducted and the whale monitored for progression or regression of the above parameters whenever feasible. All decisions, and choice of method for euthanasia, should be made in the framework of the IWC Entanglement/ Euthanasia workshop guidelines and in consultation with a veterinarian and biologist - both with large whale experience and after approval by the relevant government official(s).

7.3 Methods for the euthanasia of entangled whales

IWC/A10/E1 discussed the issue that when large whales are entangled and unable to disentangle themselves, or be disentangled by humans, these cases can become protracted, with constriction of multiple body parts, soft tissue laceration, embedment in bone, and hemorrhage. This can lead to failure to feed, infection and emaciation. Euthanasia might be considered for such terminal cases in the interests of animal welfare. This paper reviewed possible methods that have been used at sea in subsistence and commercial whaling, and on the beach in the management of large whale strandings. It strived to review pertinent literature and data on the topic and lay out the advantages and disadvantages of each method and its potential applicability to euthanasia of such cases at sea and on the beach. None of this obviates the over-riding need for better entanglement avoidance measures. The paper included a tabulation of beach euthanasia cases from the US east coast, and of the advantages, disadvantages, applicability and related issues for each method.

IWC/A10/E4 describes two cases of humpback whales (10 and 4 meters of total length) that stranded and were euthanized using barbiturates. The use of Midazolam as a pre-anesthetic agent was useful to reduce the stress of the animals, reduce their movements and possibly increase safer access for the administration of additional agents into the veins of the tail. The use of thiopental as a euthanasia agent requires a fast administration of the drug for a smooth induction to avoid tremors and excitement that could injure people or the animal.

Øen (2003) described a 12.5 m long stranded sperm whale (*Physeter macrocephalus*) that was euthanized using a rifle calibre .458 with full-jacketed round nosed bullets. The rifle was aimed at a spot about 65 cm behind the eye and about 30 cm above a line between the flipper and the eye. Two rounds were fired and the second round was fired perpendicularly to its side. When hit with the second round, the whale shivered and immediately expired, the flippers relaxed and after a few seconds the corneal reflexes had vanished. The whole operation had taken some 5 minutes and shows that when correctly aimed, a rifle of calibre .458 with full-jacketed round nosed bullets may be used for emergency situations to euthanize sperm whales of a size up to 12.5 m.

Knudsen et al. (1999) described the position of the brain in relation to external features of the whale such as blowhole, eye and flippers. The paper is used for the purpose of guidance and education of whalers and other personnel that needs to euthanize or kill common minke whales (*Balaenoptera acutorostrata*) with rifle.

Coughran et al. (in prep) described a method for the safe and effective euthanasia of large beached humpback whales using directional explosives. A formed explosive charge is placed on the cranium detonating a focused implosion resulting in the instant death of humpback whales greater than 7 meters. Issues relating to the wider application of this method to other species of baleen whale and large odontocete species are discussed along with key safety implications for the safe use of this method.

Øen and Knudsen (2007) described the results of *post mortem* shipboard gross examination of 29 minke whale brains after being shot with rifles calibre .375 and .458 with round-nosed, full-metal jacketed bullets after being hit with a harpoon grenades but not being deemed dead by the hunters. Twenty two of the brains were fixed *in situ* and light microscopic examined later. The results show that the two types of bullets are fully capable of penetrating the skull and spinal bones of common minke whales and fatally damaging the central nervous system, resulting in immediate or very rapid loss of consciousness.

Knudsen and Øen (2003) described a study of brains from 37 minke whales killed with harpoon grenades containing 30 g of pressed penthrite as explosive. The grenade is designed to detonate 60-70 cm inside the animal. The study was undertaken to characterize the neuropathological changes caused by the penthrite blast and evaluate its role in the loss of consciousness and death in hunted whales. The brains were examined shipboard and later subjected to gross and light microscopy examination. The results showed that depending on where the grenade detonates it may cause shock wave-induced acute traumatic brain injury (TBI) in addition to the damage to other organ systems. It was concluded that if the grenade detonated in an area ranging from the mid-thorax and forward to the skull, near 100% of the whales lost consciousness and died instantly or very rapid. Detonation in more distant areas of the body resulted in injuries resembling acceleration-induced diffuse traumatic brain injury and TBI was registered also when the grenade detonated at the interface between thorax and abdomen. The study concluded that even if several vital organs were fatally injured in most whales, the neurotrauma induced by the blast-generated pressure waves were the primary cause for the immediate or very rapid loss of consciousness and death.

In light of these papers, the Workshop discussed the applicability of each method to at sea (Table 5) and beached (Table 6) whales for which the decision had been made to undertake euthanasia. Each table established acceptable, conditional and unacceptable methods for right, humpback, gray, minke and large balenopterid whales, and the limitations of each method. Tables 4 and 5 briefly describe limitations that include availability of training or trained personnel, and the Workshop recognizes that suitable training with practice on dead whales may not be available and should therefore be excluded if experienced operators/training are not available. The tables were presented in plenary session and edited as agreed by the Workshop.

The Workshop recognized that conditions on the beach and at sea may preclude a consistent euthanasia quality comparable to that achievable in the controlled atmosphere of a veterinary medical facility. Recognizing this, criteria used for acceptable, conditionally acceptable, and unacceptable methods were adapted from those defined by the AVMA (AVMA 2007) as follows: acceptable methods are those that consistently produce a humane death when used as the sole means of euthanasia; conditionally acceptable methods are those techniques that by the nature of the technique or because of greater potential for operator error or safety hazards might not consistently produce humane death; and unacceptable techniques are those methods deemed inappropriate under most conditions or that posed a substantial risk to the personnel applying the technique. Reasons for this include size of the animal relative to the method. The AVMA guidelines also include discussion of several adjunctive methods, which are those methods that cannot be used as the sole method of euthanasia, but that can be used in conjunction with other methods to produce a humane death. Use of pre-euthanasia sedation, when possible, can enhance the welfare of the animal in distressful conditions, and can enhance the suitability of any conditionally-acceptable euthanasia method. In evaluating methods of euthanasia, the workshop discussed such aspects as the: (1) ability of the method to induce loss of consciousness and death while minimizing additional pain, distress, anxiety, or apprehension; (2) time required to induce loss of consciousness; (3) reliability and availability of the method; (4) the training required; (5) safety of personnel; and (6) compatibility of the method with the species and age/size of the animal.

The Workshop **agreed** that most beached baleen whales are terminal and under most circumstances, always when the animal is still in the surf, it is both inhumane to the whale and dangerous to response personnel to attempt to refloat and release a stranded whale. If attempts are made to refloat or the animal has had at least one tidal cycle to refloat itself, euthanasia should be considered as the most humane option. The Workshop **recommended** that in order to ensure the safety of response personnel, attempts at euthanasia should not be conducted when a whale is in surf and should be conducted only when a whale has been stabilized, is above the tide line, or out of the surf.

In contrast to whale killing methods designed for harvesting, whether in an industrial or a native hunt setting, euthanasia of whales for humane reasons is by its nature a less preplanned and pre-ordained undertaking. Increasingly in various parts of the world, biologists, wildlife managers and veterinarians are called upon to euthanize large whales in distress. The Workshop recognized that acceptability of the various potential methods will be driven by cultural, ethical and practical constraints and differences. It was thus hard to summarize recommendations with global acceptability. Therefore, the Workshop focused the list of methods, summarized in Table 5 for euthanasia at sea of swimming or anchored whales and Table 6 for euthanasia of large whales on a beach on those that are in hand in various parts of the world with the goal that in whatever way is practical and locally acceptable, the goal of euthanasia could be optimally pursued. The Workshop also recognized that all the methods listed as acceptable or conditionally acceptable will not necessarily be so recognized globally. Finally, the Workshop **recommended** that euthanasia only be contemplated if the appropriate method for a rapid and humane death is available.

7.4. Conclusions and Recommendations

The Workshop **concluded** that there currently are appropriate techniques available for euthanasia of whales in distress, both stranded and at sea. However, methods differ according to species, size of the animals, and environmental conditions. The Workshop **recommended** that euthanasia of entangled non-stranded whales should only be applied in situations where all of the following parameters apply: (1) there are no options available to disentangle a severely entangled whale; (2) the injury to the entangled whale is sufficiently serious to compromise the likelihood of the animal's survival in the medium to long term; (3) the chosen euthanasia method does not compromise the safety of personnel administering the method; and (4) that the application of the euthanasia method ensures that the death of the whale is as rapid and pain free as possible. The Workshop **recognized** that there are certain situations where safe and efficient euthanasia of large whales is not practically possible even in situations in which the animal is stranded in the surf.

8. DEVELOPMENT OF A DECISION TREE FOR LARGE WHALE ENTANGLEMENTS.

8.1. Decision Tree

IWC/A10/E5 examined the possible criteria that may be considered when determining if a response action (disentanglement, euthanasia, etc.) is warranted. Oftentimes, there is a sense of urgency to respond to the report of an entanglement based on the perceived need to "do something" rather than responding based on criteria of the entanglement. Multiple nationality entanglement response programs were consulted in order to determine suitable criteria, i.e. human safety, resources available, risk assessment, distance from shore, entanglement configuration and level of constriction, etc. that were considered prior to launching a response. If human intervention was deemed appropriate, what types of responses were available, i.e. monitor, satellite tag deployment, disentanglement, or euthanize, based on critical decision points. Determination of suitable response options is critical in order to identify, understand and mitigate risks associated with launching a directed response.

The Workshop **agreed** that there were three important aspects to consider while developing the large whale entanglement response decision tree:
1. risk to human responders
2. welfare of entangled whale
3. conservation of the population of the entangled whale

The Workshop developed a generalized decision tree (Figure 1) that will be an informative tool that can be modified to fit the specifics of any given situation (species, location, responder capabilities, resources, etc.).

8.2. Conclusions and Recommendations

The Workshop recognizes that development of the large whale disentanglement response decision tree is a dynamic process and **recommends** that development and refinement of the tree be continued as responders gain new knowledge and experience.

9. DATA COLLECTION AND REPORTING

The Workshop **agreed** that documentation of large whale entanglements was a high priority, and **recommended** expanding such efforts where it would not compromise human safety. The Workshop **recommended** that gear removed from entangled whales be analyzed and archived where possible, and that the information obtained be used to prevent future entanglements. The Workshop also **recommended** that any animal that has been entangled receive a complete necropsy upon death when feasible, particularly for those animals that are euthanized. Finally, the Workshop **recommended** that each country should observe the request for information on large whale entanglements when submitting National Progress Reports.

10. SYNTHESIS AND MAIN RECOMMENDATIONS

The Workshop noted that disentanglement may mitigate some of the effects of a prevailing problem that is global and increasing. However, disentanglement or euthanasia alone does not prevent the problem. The Workshop therefore, **recommended** that the IWC initiate a process to prevent the entanglement of cetaceans in marine debris and fishing gear. To begin this process the workshop **recommended** that the IWC sponsor a workshop on current efforts to prevent entanglement. The Workshop recognized that analyses of the gear involved and the entanglement could ultimately lead to the prevention of large whale entanglement. Therefore the Workshop **recommended** as a high priority that debris and fishing gear removed from cetaceans during disentanglement operations be collected, analyzed or appropriately archived for future assessment if real time analyses are not possible.

Because prevention is not imminent, the Workshop focused on operations that would be important from an animal welfare perspective based on current knowledge of entangled whales.

First, based on the information presented and summarized, the Workshop acknowledged that entanglements are occurring at varying rates throughout the geographic range of all large whale species, encompassing breeding, feeding, and migratory routes. Secondly the Workshop **expressed concern** that the numbers of entangled whales presented in the IWC National Progress Reports represented severe underreporting of entanglements. Therefore, the Workshop **recommended** that coastal nations establish adequate programmes for monitoring entanglement of whales and that IWC member countries make a concerted effort to report through National Progress Reports. Monitoring of entanglement could be done through scar based studies, interviews with fishermen, whale watching operators, or more thorough examination of existing stranding data, etc. The Workshop further **recommended** that particular emphasis should be on areas where fishing operations overlap with the distribution of endangered or depleted populations (e.g. western gray whales, North Pacific and North Atlantic right whales and J-stock minke whales).

The Workshop strongly **recommended** that the IWC urge member nations, to establish entanglement response capabilities, drawing from experience in other countries, where whale distributions and fisheries overlap. Given the evidence presented at this workshop, any country that has coastal whale populations and stationary or drifting fishing gear, but is not aware of large whale entanglements, should consider that there is potential for them to exist. Therefore the Workshop **recommended** that those countries enact mechanisms to investigate the extent of possible incidents.

The Workshop **strongly recommended** that response programmes be established in areas where entangled whales are observed. Based on current knowledge, the Workshop developed an assessment and decision tree for large whale disentanglement. Recognizing that assessment of the large whale disentanglement response is a dynamic process, the Workshop **recommended** that development and refinement of the tree be continued as responders gain new knowledge and experience. The Workshop identified human safety, the welfare of the entangled animal and the conservation status of the species as important aspects to take into consideration. Given that decisions about response are often made in emotionally charged situations, the Workshop **recommended** that, when establishing a response network, countries utilize the experience of others that have ongoing successful and functional response networks.

The Workshop noted that animal behavior, and therefore associated risks to response personnel, may vary greatly depending upon the species, age class, and behavior state (e.g., breeding, feeding or migrating) of the entangled animal. The Workshop **agreed** that the use of sedatives represents a managed risk which may provide additional

benefits for the safety of responders and enhance animal welfare, and therefore be a valuable tool in disentanglement response, and **recommended** that the technique should be explored further.

The Workshop **concluded** that in cases where an entanglement is considered to be lethal and disentanglement is not feasible, euthanasia should be attempted. Currently there are appropriate techniques available for euthanasia of whales in distress, both stranded and at sea. However, methods differ according to species, size of the animals and environmental conditions. The Workshop **recommended** that euthanasia should only be applied in situations where: (1) the chosen method does not compromise the safety of personnel administrating the method and (2) that the application of the method ensures rapid and humane death to the whale.

The Workshop **agreed** that most stranded baleen whales are terminal and under most circumstances, (always in areas of surf), it is both inhumane to the whale and dangerous to response personnel to attempt to refloat and release a stranded large whale. If the whale does not refloat on its own after one tidal cycle, euthanasia should be considered as the most humane option. The Workshop **recommended** that in order to ensure the safety of response personnel, attempts at euthanasia should not be conducted when a whale is in surf and should be conducted only when a whale has been stabilized or is above the tide line.

The Workshop **commended** the detailed work and approaches provided on survival of entangled whales and pathology of injuries presented during the meeting. The Workshop **recognized** that entanglements may produce: (1) external wounds in the absence of significant internal damage, (2) external wounds with internal damage and (3) internal damage in the absence of observable external damage. This variability makes field assessments of specific pathology and physical and physiological effects in the animal difficult. The Workshop **recommended** prioritizing necropsies of entangled and previously entangled whales. Recognizing the importance of such information on future prevention and mitigation measures and the role that such information would play in response decisions, the Workshop **recommended** standardized data be collected on the entanglement and the health of the individual, and when possible survival studies be conducted in other regions or on other species not currently studied but in which whale entanglements are observed. As part of the data collected, the Workshop **recommended** the collection of individual identification data to ascertain the ultimate outcome of the event. In addition, the Workshop **recognized** that although health metrics and health status trends are critical to decisions on condition and outcome of entanglement cases, there are few current standardized methods being used for various species and in different geographic areas. The Workshop **recommended** further development and validation of assessment and condition indices for large whales.

11. OTHER BUSINESS

The Workshop received the sad news that Dr. Jon Lien died on April 14, 2010. Jon was an enthusiastic global pioneer of the disentanglement of large whales entangled in fishing gear, which he practiced in Newfoundland, Canada. His work was essential to alerting scientists, managers and the general public to the threats that marine debris and fishing gear pose to large whales. He was a source of inspiration and knowledge to many Workshop participants, who have established response teams for whale rescue operations around the world. The participants, who had just the day before recognized Jon as the first person to establish a response network, paused for a moment in silent memory.

The chair thanked the conveners, the hosts of the workshop and Uncle Kimokeo Kapulehua for his blessing and welcome and insight into Hawaiian culture. The chair also recognized the various subgroups that had worked on particular efforts, especially the decision tree. The Workshop participants thanked the chair and the rapporteurs for their efforts. Participants also extended thanks to Øen for shepherding the workshop from conception to convening.

12. ADOPTION OF REPORT

The report was adopted at 5:20 PM on 15 April 2010.

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Robbins et al., 2009. Estimating entanglement mortality from scar-based studies. Unpublished report to the Scientific Committee of the International Whaling Commission, Madeira, Portugal. SC/61/BC3.

Winn JP, Woodward B, Moore MJ, Peterson ML. 2008. Modeling whale entanglement injuries: An experiemental study of tissue compliance, line tension, and draw-length. Marine Mammal Science. 24: 326-340.

Appendix 1

LIST OF AVAILABLE DOCUMENTS

IWC/A10/E1 Moore, 2010. Overview of euthanasia of large whales.
IWC/A10/E2 Mattila & Rowles, 2010. A review of large whale entanglement.
IWC/A10/E3 Robbins 2010. A review of the frequency and impact of entanglement on Gulf of Maine humpback whales.
IWC/A10/E4 Marcondes and Groch. 2010. Report of the euthanasia of two humpback whales using barbiturates.
IWC/A10/E5 Smith and Rowles, 2010. Development of a decision matrix for large whale entanglements.
IWC/A10/E6 Meÿer, Best, Anderson-Reade, and Kirkman. 2010. South African national report on entanglement of whales including species, locations, types of entanglement, gear types and release attempts.

IWC/A10/FI1 Clapham et al., 2003. Report of the intersessional working group on large whale entanglement.
IWC/A10/FI2 Moore et al., 2010. Sedation at sea of entangled north Atlantic right whales (*Eubalaena glacialis*) to enhance disentanglement.
IWC/A10/FI3 Knudsen & Oen, 2003. Blast-induced neurotrauma in whales
IWC/A10/FI4 Oen, 2003. Euthanasia of a stranded sperm whale with calibre .458 round nosed full-metal jacketed rifle bullets.
IWC/A10/FI5 Coughran, 2010 (in prep). Humane euthanasia of beached humpback whales using explosives.
IWC/A10/FI6 Cassoff et al., 2010 (in prep). Pathobiology of lethal entanglements in baleen whales.
IWC/A10/FI7 NOAA 2007. Differentiating serious and non-serious injury of marine mammals: report of the serious injury technical workshop.
IWC/A10/FI8 Oen & Knudsen, 2007. Euthanasia of whales: the effect of .375 and .458 calibre round-nosed, full metal-jacketed rifle bullets on the central nervous system of common minke whales.
IWC/A10/FI9 Read et al., 2006. Bycatch of marine mammals in U.S. and global fisheries.
IWC/A10/FI10 Johnson et al., 2005. Fishing gear involved in entanglements of right and humpback whales.
IWC/A10/FI11 Mattila and Lyman, 2006. A note on the entanglement of large whales in marine debris. SC/58/BC2.
IWC/A10/FI12 Robbins et al., 2007. Reliability of eyewitness reports of large whale entanglement. SC/59/BC2.
IWC/A10/FI13 Robbins et al., 2009. Estimating entanglement mortality from scar-based studies. SC/61/BC3.
IWC/A10/FI14 Moore et al., 2006. Fatally entangled right whales can die extremely slowly.
IWC/A10/FI15 Mattila et al., 2007. Scientific information that can be gained through large whale disentanglement. SC/59/BC1.
IWC/A10/FI16 IWC, 2003. Report of the workshop on whale killing methods and associated welfare issues.
IWC/A10/FI17 Knudsen, 2005. A review of the criteria used to assess insensibility and death in hunted whales compared to other species.
IWC/A10/FI18 Lyman, 2009. A preliminary investigation of gear entangling humpback whales, *Megaptera novaeangliae*, in the North Pacific.
IWC/A10/FI19 Ledwell and Huntington, 2008. Incidental entrapments in fishing gear and strandings reported to the whale release and strandings group in Newfoundland and Labrador and a summary of the whale release and strandings program during 2008.
IWC/A10/FI20 Knowlton et al., 2008. Analysis of scarring on North Atlantic right whales (*Eubalaena glacialis*): monitoring rates of entanglement interaction 1980-2004.
IWC/A10/FI21 FAO Fishing descriptions and codes.
IWC/A10/FI22 Baird et al., 2002. An evaluation of gray whale (*Eschrichtius robustus*) mortality incidental to fishing operations in British Columbia, Canada.
IWC/A10/FI23 Hawaiian Islands Humpback Whale National Marine Sanctuary marine mammal response binder.
IWC/A10/FI24 Kraus, 1990. Rates and potential causes of mortality in north Atlantic right whales (*Eubalaena glacialis*).
IWC/A10/FI25 Neilson et al., 2007. Non-lethal entanglement of humpback whales (*Megaptera novaeangliae*) in fishing gear in northern Southeast Alaska.
IWC/A10/FI26 Robbins and Mattila, 2001. Monitoring entanglements of humpback whales (*Megaptera novaeangliae*) in the Gulf of Maine on the basis of caudal peduncle scarring.

IWC/A10/FI27 Robbins et al., 2006. Preliminary minimum estimates of humpback whale entanglement frequency in the North Pacific Ocean based on scar evidence.
IWC/A10/FI28 Wiley et al., 1995. Stranding and mortality of humpback whales, *Megaptera novaeangliae*, in the mid-Atlantic and southeast United States, 1985-1992.
IWC/A10/FI29 Woodward et al., 2006. Experimental modeling of large whale entanglement injuries. SC/59/BC15.
IWC/A10/FI30 Lambertsen, 2005. Extraordinary susceptibility of baleen whales to marine debris and commercial fishing gear. SC/58/BC7.
IWC/A10/FI31 Landry et al., Needle in a haystack: evidence of a low reporting rate of entangled whales.
IWC/A10/FI32 Knudsen et al. 1999. The position of the brain in the minke whale in relation to external features. IWC/51/WK13

Appendix 2

AGENDA

1. INTRODUCTORY ITEMS
1.1. Appointment of Chair
1.2. Appointment of rapporteur(s)
1.3. Review of documents

2. OBJECTIVES FOR THE WORKSHOP

3. ADOPTION OF THE AGENDA

4. OVERVIEW OF THE ENTANGLEMENT OF LARGE WHALES
4.1. Key species involved
- Species of whales most commonly entangled
- Identification of the most critical interactions occurring (endangered species, etc.)

4.2. Priority regions
4.3. Types of Entanglements
- Categories/classes/types of entanglements
  - Entanglements in floating or movable gears
  - Entanglements in immovable or anchored gears
- Types of gears regularly causing entanglements

4.4. National Data on Large Whale Entanglements (input from member governments)
- National reports on number of whales entangled each year, including species and locations and type of entanglement.
- National reports on entanglement release attempts, times to death and types of entanglements that have led to death.

4.5. Conclusions and Recommendations

5. OVERVIEW OF THE DISENTANGLEMENT OF LARGE WHALES.
5.1. Current/commonly used methods for disentangling whales
- Network structure
- Methodology
- Equipment
- Personnel
- Training

5.2. Risk assessments
- Risk assessments: Personnel
  - Known and possible risks for personnel in conjunction with disentanglement operations.

5.3. Improving Disentanglement Operations
- Information sharing and communication networks

5.4 Conclusions and Recommendations

6. EFFECTS OF ENTANGLEMENTS ON WHALES
6.1. Damages and wounds commonly seen on entangled whales
- Superficial wounds of minor severity?
- More severe damages or wounds?
- Emaciation/physical exhaustion?

6.2. Survivorship of entangled whales

6.3 Risk assessments: Whales after disentangling
- o Methods for evaluation of the health condition of the entangled whale
- o Types of wounds and the wound healing process in whales
- Possible scenarios after disentanglement:
  - The whale survive with negligible damage to organs
  - The whale might survive, but is severely crippled
  - The whale will not survive and will die from its wounds/exhaustion/starvation

7. EUTHANASIA OF WHALES THAT CANNOT BE DISENTANGLED OR WILL NOT SURVIVE AFTER DISENTANGLEMENT

7.1. Identification of those situations for which euthanasia should be considered or recommended
- o Whales that cannot be disentangled or will not survive after disentanglement due to exhaustion or because vital organs are severely hurt or damaged.

7.2. Methods for the humane euthanasia of entangled whales
- o Types of weapons and equipment vs species of whales
- o Training of personnel

7.3. Conclusions and Recommendations

8. DEVELOPMENT OF A DECISION MATRIX FOR LARGE WHALE ENTANGLEMENTS.

8.1. The development of a decision matrix (or "decision tree") to follow once an entangled whale is reported could be considered. This would draw on discussions under item 6 and include, for example:
- reporting mechanisms,
- response options;
- critical decision points;
- decisions to intervene or monitor;
- type of intervention – disentanglement or euthanasia.

8.2. Conclusions and Recommendations

9. DATA COLLECTION AND REPORTING

10. SYNTHESIS

11. OTHER BUSINESS

12. RECOMMENDATIONS

TERMS OF REFERENCE FOR REVIEW PAPERS FOR THE WORKSHOP ON WELFARE ISSUES ASSOCIATED WITH THE ENTANGLEMENT OF LARGE WHALES

Overview of Entanglement of Large Whales

Overview of Survivorship of Large Whales (Jooke Robbins, Amy Knowlton)

- Review of data on survivorship of large whales in relation to species and gear type where possible
- Humpback and right whales in the US Atlantic Coast will be used as an example

Overview of Entanglement of Large Whales (David Mattila lead, Teri Rowles, Ed Lyman, Jamison Smith, Doug Coughran, Wayne Ledwell, Mike Meyers, Jorge Urban)

- Review the global species of large whales that are entangled in fishing gear with reference to region and gear type
- Review the nature, scale and severity of entanglement types
- Review data on health consequences, including pathology of entanglements

Overview of Disentanglement of Large Whales

Overview of the Disentanglement of Large Whales (Dave Mattila-lead, Doug Coughran, Wayne Ledwell, Ed Lyman)

- Review of current disentanglement techniques, including:
    - Network structure (information sharing, communications and outreach)
    - Report assessment and reliability
    - Assessment of the severity of entanglement and welfare implications for the whale
    - Tracking equipment
    - Disentanglement equipment and methodologies
    - Safety protocols and training
    - Documentation, follow-up and review procedures
    - Disentanglement success rates by species, region and gear types

Overview of Euthanasia of Large Whales

Euthanasia (Teri Rowles-lead, Egil Oen, Doug Coughran, Nick Gales)

- Overview of goals of euthanasia
- Mechanisms for humane euthanasia (physical and chemical)
- Equipment needed
- Risks and benefits of each method
- Human safety and training required
- Appropriateness for situations
- Carcass recovery and handling

Overview of Decision Matrices for entangled Large Whales

Development of Decision Matrix for Large Whale Entanglement (Teri Rowles-lead, Nick Gales, David Mattila, Doug Coughran)

- Review of international decision matrices for disentanglement actions, including a discussion of:
    - Assessment of report and decision options
    - Visual assessment of animal (entanglement type and gear type)
    - Assessment of options based on environmental conditions and available resources
        - No action needed
        - Tag and track for later action
        - Take immediate action
- Review of data to inform decision points within the matrix

Appendix 3

GLOSSARY

Document: The process of gathering information about the entangled whale (i.e. species, images for individual identification and assessment of health and wounds, skin or other samples for genetic and/or health assays, behavior, etc.), the entanglement (images of the location and configuration of wraps), and the gear (through imaging and retrieval).

Entanglement: wraps of line, netting or other materials around body areas. Entanglements may include cases in which animals are towing gear or anchored by gear.

Entanglement response: Any one of a series of potential planned actions taken in response to receiving a report of an entangled whale. It can include some or all of the following: Careful screening and documentation of the report; on site assessment and documentation of the event; tagging or immediate disentangling of the animal; post-disentanglement documentation; euthanasia if the animal will not survive without other intervention; post response follow-up (e.g. finalize report, track identity of entangling gear, etc.)

Entrapments: involving an animal enclosed within a fishing structure or trap. Animals did not necessarily have gear on any body parts but were confined by walls of netting.

Euthanasia: The term euthanasia is derived from the Greek terms eu meaning good and thanatos meaning death. A "good death" would be one that occurs with minimal pain. Euthanasia techniques should result in rapid loss of consciousness followed by cardiac or respiratory arrest and the ultimate loss of brain function while minimizing distress and anxiety experienced by the animal prior to loss of consciousness. With wildlife, particularly free swimming entangled whales, the goal is to balance the ideal of minimal pain and distress with the reality of the many environments in which euthanasia will be performed. Euthanizing agents cause death by three basic mechanisms: (1) hypoxia, direct or indirect; (2) direct depression of neurons necessary for life function; and (3) physical disruption of brain activity and destruction of neurons necessary for life. (AVMA 2007)

Gear: Any manmade material (i.e. rope, net, cable, chain, anchor, buoy….etc) which is used to deploy devices in the ocean for the purposes of catching fish, conducting research, anchoring boats…..etc. In this report it is limited to the types which could entrap or entangle a whale.

Mobile gear: gear which is actively towed through the ocean, anywhere in the water column
Stationary gear: gear which is anchored or otherwise attached to the bottom, where it is intended to stay.
Drifting gear: gear which is not anchored and is intended to drift with the currents
Tended gear: gear in which the fishers remain in the vicinity of their gear while it is in the water
Hooks: involving fishing hooks and associated line embedded within body parts.

Incident Command System (ICS): a set of standard response and operation procedures, integrated into a common organizational structure designed to improve emergency response operations of all types and complexities and reduce risks.

Kegging: Is the process of attaching drag (usually buoys, small boat, or sea anchor) to a line attached to the whale, in order to prevent it from diving, slow its forward progress, and control any sudden movements (e.g., tail slash).

Killing: Causing the death of an organism which may or may not be done in a manner to reduce pain and distress.

Life-threatening: an entanglement which could possibly kill or do grave harm to the whale.

Monitor: to continue to attempt to relocate a whale in order to document and assess its entanglement and/or health status.

Tagging: The use of telemetry (GPS, satellite, or VHF transmitters) or visual buoys (i.e., a buoy attached to increase visibility of the gear and animal) to allow responders to find the whale remotely and in real-time for subsequent response attempts. Tags may be secured directly to the body of the whale or tethered to the gear that the whale is towing; telemetry units are housed in specially-designed buoys.

Appendix 4

EXAMPLE HEALTH DATA COLLECTION FORMAT

- Body condition: normal, thin, emaciated (circle one). This would be assessed relative to what is common in that species and population, given factors such as the season and individual reproductive state.

- Skin condition: normal or circle one or more of the following: pale (or discolored for species), sloughing, pitted

- Cyamid proliferation: normal or circle one of the following: abundant at the wound, blowholes or widespread

- Injury location and depth: identify and classify on body diagram, if possible. Otherwise describe the location on the body in as much detail as possible. Provide any additional details under comments, below.

    - Categorize wound depth as one of the following: epidermis only, extending into blubber* (or penetrating flippers** or fluke beyond the skin), or extending into muscle, bone or body cavity.
    - For each attachment site, describe the surface profile of the wound as depressed, flat or raised.
    - *For injuries that penetrate blubber, indicate blubber color: white/yellow, pink/red, green/blue/black
    - **For injuries to flukes and flippers, estimate the percentage of penetration

- Odors: indicate and describe unusual odors noted during disentanglement (from the wound, the gear or the blow)

- Whale activity level/responsiveness: select one of the following non-responsive, low (i.e., minimal or delayed response to stimuli), average (i.e., nothing noteworthy), high (i.e., fast, highly evasive, aggressive, surface active). Assess activity at first approach (assessment), during disentanglement and at release.

- Species-specific indicators of health. Indicate the presence or absence of things like rake marks at nares for right whales.

- Comments/detail: Provide as much detail as possible about the apparent health status of the individual. Include overall sense of animal state and any unusual details, such as observed emissions (vomit, feces, urine, blood).

Table 1. Food and Agriculture Organization abbreviations for fishing gear.

SURROUNDING NETS		**FALLING GEAR**	
With purse lines	PS	Cast nets	FCN
One-boat operated purse seines	PS1	Falling gear (not specified)	FG
Two-boat operated purse seines	PS2		
Without purse lines (lampara)	LA	**GILLNETS AND ENTANGLING GEAR**	
		Set gillnets (anchored)	GNS
SEINE NETS		Driftnets	GND
Beach seines	SB	Encircling gillnets	GNC
Boat seines	SV	Fixed gillnets (on stakes)	GNF
Danish seines	SDN	Trammel nets	GTR
Scottish seines	SSC	Combined gillnet-trammel nets	GTN
Pair seines	SPR	Gillnets and entangling gillnets (not specified)	GEN
Seine nets (not specified)	SX	Gillnets (not specified)	GN
TRAWLS		**TRAPS**	
Bottom trawls	TBB	Stationary uncovered pounds nets	FPN
Beam trawl	OTB	Pots	FPO
Otter trawls (side or stern)	PTB	Fyke nets	FYK
Pair trawls	TBN	Stow nets	FSN
Nephrops trawls	TBS	Barriers, fences, weirs, etc	FWR
Shrimp trawls (not specified)	TM	Aerial traps	FAR
Midwater trawls		Traps (not specified)	FIX
Otter trawls (side or stern)	OTM		
Pair trawls	PTM	**HOOKS AND LINES**	
Shrimp trawls	TMS	Handlines and pole-lines (hand operated)	LHP
Midwater trawls (not specified)	TM	Handlines and pole-lines (mechanised)	LHM
Otter twin trawls	OTT	Set longlines	LLS
Otter trawls (not specified)	OT	Drifting longlines	LLD
Pair trawls (not specified)	PT	Longlines (not specified)	LL
Other trawls (not specified)	TX	Trolling lines	LTL
		Hooks and lines (not specified)	LX
DREDGES			
Boat dredges	DRB	**GRAPPLING AND WOUNDING**	
Hand dredges	DRH	Harpoons	HAR
LIFT NETS		**HARVESTING MACHINES**	
Portable lift nets	LPN	Pumps	HMP
Boat-operated lift nets	LNB	Mechanised dredges	HMD
Shore operated stationary lift nets	LNS	Harvesting machines (not specified)	HMX
Lift nets (not specified)	LN		
		MISCELLANEOUS GEAR	MIS
		RECREATIONAL FISHING GEAR	RG
		GEAR NOT KNOWN OR NOT SPECIFIED	NK
		SHARK CONTROL NETS	NSC
		DERELICT FISHING GEAR	

Table 2. Summary of large whale entanglement data. Data is from either National Progress Reports submitted to the IWC Scientific Committee annual meetings (56-61), generally covering the years 2003-2008, or summaries by country representatives present at the meeting (IWC/A10; indicated in the country column with an *). Indicated is presence/absence of reported entanglement; these may represent a single animal or many hundred.

	SPECIES										
COUNTRY	Minke	Humpback	Northern Right	Southern Right	Fin	Brydes	Gray	Sei	Bowhead	Blue	Sperm
Argentina	■										
Australia	■	■		■		■					■
Brazil		■		■		■					
Newfoundland and Labrador, Canada*	■	■	■		■		■		■		
Denmark	■	■							■		
France					■						■
Iceland	■	■									
Ireland		■									
Italy		■									■
Japan	■	■	■		■	■	■	■			■
Korea	■	■			■						
Mexico*		■					■			■	
Netherlands											
New Zealand											
Norway*	■	■									
Spain		■									■
South Africa*	■	■		■		■					■
Sweden											
UK	■	■			■						
USA*	■	■	■		■	■	■	■	■	■	■

Shaded squares represent documented entanglements
Empty squares represent species not reported entangled in 2003-2008

Table 3. Types of manmade materials reported to have entrapped or entangled large whales. Summarized from National Progress Reports* submitted to the IWC Scientific Committee annual meetings (56-61), generally covering the years 2003-2008**. FAO gear type abbreviations can be found in Table 1.

	FAO GEAR TYPE														
COUNTRY	SV	SX	TX	TMS	GND	GN	FPN	FPO	FYK	FSN	FIX	LLS	LLD	LL	NSC
Argentina													■		
Australia†						■		■			■	■		■	■
Brazil						■									
Denmark						■	■	■							
France						■									
Iceland†				■		■									
Ireland								■							
Italy					■	■									
Japan						■	■				■				
Korea	■	■	■		■	■	■	■	■	■				■	
Netherlands															
New Zealand			■												
Norway															
Spain					■			■						■	
Sweden															
UK						■		■							
USA			■		■			■				■		■	

* Some countries either submitted reports to each meeting, but bycatch data was incomplete (e.g. Mexico and Chile), or did not submit reports to all of the meetings summarized (e.g. South Africa, Peru, Portugal)
** Some countries experience a delay in compiling (e.g. USA data is from 2001-2006).
† Both Australia and Iceland reported whales entangled in "aquaculture"

Shaded squares represent gear that was documented to cause entanglements between 2003-2008
Empty squares represent gear that was not documented to cause entanglements between 2003-2008

Table 4. Responses by participant countries to the question: What part (if any) do the following rationales play in your country's response to entangled large whales?

	Argentina	Australia	Brazil	Canada	Korea	Mexico	Norway	South Africa	United States
Conservation (e.g., assist the recovery of a critically endangered population)	No	Some	-	Some	Yes (Western gray whales)	No	No	No	Yes
Prevent a "take" against a management limit (e.g., PBR, quota, etc.)	No	No	-	No	No	Yes	No	No	Yes
Welfare of the animal involved	Yes	Yes	-	Yes	No	Yes	Yes	Some	Yes
Gather information in order to minimize future entanglements	No	Yes	-	Some	Yes	Some	Some	Yes	Yes
To assist fishermen and prevent them and/or the public from harming themselves	No	Yes	-	Yes	Yes	Some	Yes	Yes	Yes
To prevent danger or damage to property (e.g., gear, boats)	Yes	Yes	-	Yes	Yes	No	Some	No	Some

Table 5. Potential methods for large whale euthanasia of entangled animals at sea (swimming or anchored).

Method		Species				
		Right	Humpback	Gray	Minke	Large Balaenopterid
Explosive Harpoon[1]	Suitability:	A	A	A	A	A
	Limitations:	Availability, qualified users[2], suitable vessel needed, not easily portable				
Darting gun[3]	Suitability:	A	C	C	U	A
	Limitations:	Availability, qualified users[2], size of whale, safe if penthrite but not black powder				
Rifle (>0.4" caliber)	Suitability:	U	A <7m**, U >7m	C	A	U
	Limitations:	Qualified users[2], bullet choice & caliber appropriate for species and size				
Lance[4***]	Suitability:	U/C	U/C	U/C	U/C	U/C
	Limitations:	Qualified users[2], last choice, enhanced by sedation, choice of anatomical target				
Pharmacological Agents (e.g., Potent narcotics such as etorphine)	Suitability:	A	A	A	A	A
	Limitations:	Qualified users[2], Availability, safety, secondary toxicity, carcass disposal				

A = Acceptable: C = Conditionally Acceptable (sedation would enhance but its limitations are cost and training): U = Unacceptable

[1] An explosive harpoon is a whaling craft which fastens (harpoon) and kills (grenade) the whale simultaneously using explosives that are ignited by a triggering device when the harpoon is passing into or through body of the whale. The grenade – the explosive device with triggering devices – is mounted on the tip of the harpoon. Grenade harpoons are deployed from harpoon guns or cannons mounted on boats.

[2] Qualified users means that the method requires appropriately trained, licensed personnel who are operating with anatomical knowledge of the species

[3] Darting gun is a hand deployed whaling implement mounted on a wooden pole, which plants a harpoon in the whale and simultaneously fires a time delayed grenade to kill it. It is darted from close range. It was developed and used for the 19th C American Whale Fisheries of bowhead whales. Today, slightly modernised darting guns in are the primary weapon in the Alaskan Eskimos subsistence hunt of bowhead whales.

[4] A lance is a sharp double sided blade on a long pole that has historically been used by whalers to kill hunted whales (ref). The lance is used to exsanguinate the animal by cutting into the thorax hitting great vessels and/or heart.

**= follows New Zealand protocol

*** Using a sharp tool such as the lance or a knife to exsanguinate an animal. For many countries, this method of euthanasia is unacceptable in the absence of a stunned, sedated, anesthetized, or moribund animal. However it was recognized that in some countries, particularly those in which whaling included this technique, and in certain circumstances, exsanguination using such a tool might be the best available method. Lancing or exsanguination should be the last choice when no other options exist and its use would be enhanced by the prior sedation, anesthesia or other means which rendered the animal unconscious.

Table 6. Possible methods for euthanasia of large whales (entangled or not) stranded on the beach.

Method		Species				
		Right	Humpback	Gray	Minke	Large Balaenopterid
Implosion*	Suitability:	A	A	A	A	A
	Limitations:	Limited availability of explosives, qualified users[1]				
Rifle (>0.4" caliber)	Suitability:	U; A calf	A <7m**, U >7m	A	A	U
	Limitations:	Qualified users[1], bullet choice & caliber appropriate to species and size				
Lance[2] or other tool for exsangination***	Suitability:	U/C	U/C	U/C	U/C	U/C
	Limitations:	Qualified users[1], last choice, enhanced by unconscience animal				
Pharmacological agents (i.e., barbiturates)	Suitability:	A	A	A	A	A
	Limitations:	Qualified users[1], drug availability, safety, carcass disposal and expense				

A = Acceptable; C = Conditionally Acceptable (sedation would enhance but its limitations are cost and training); U = Unacceptable

[1] Qualified users means that the method requires appropriately trained, licensed personnel who are operating with anatomical knowledge of the species

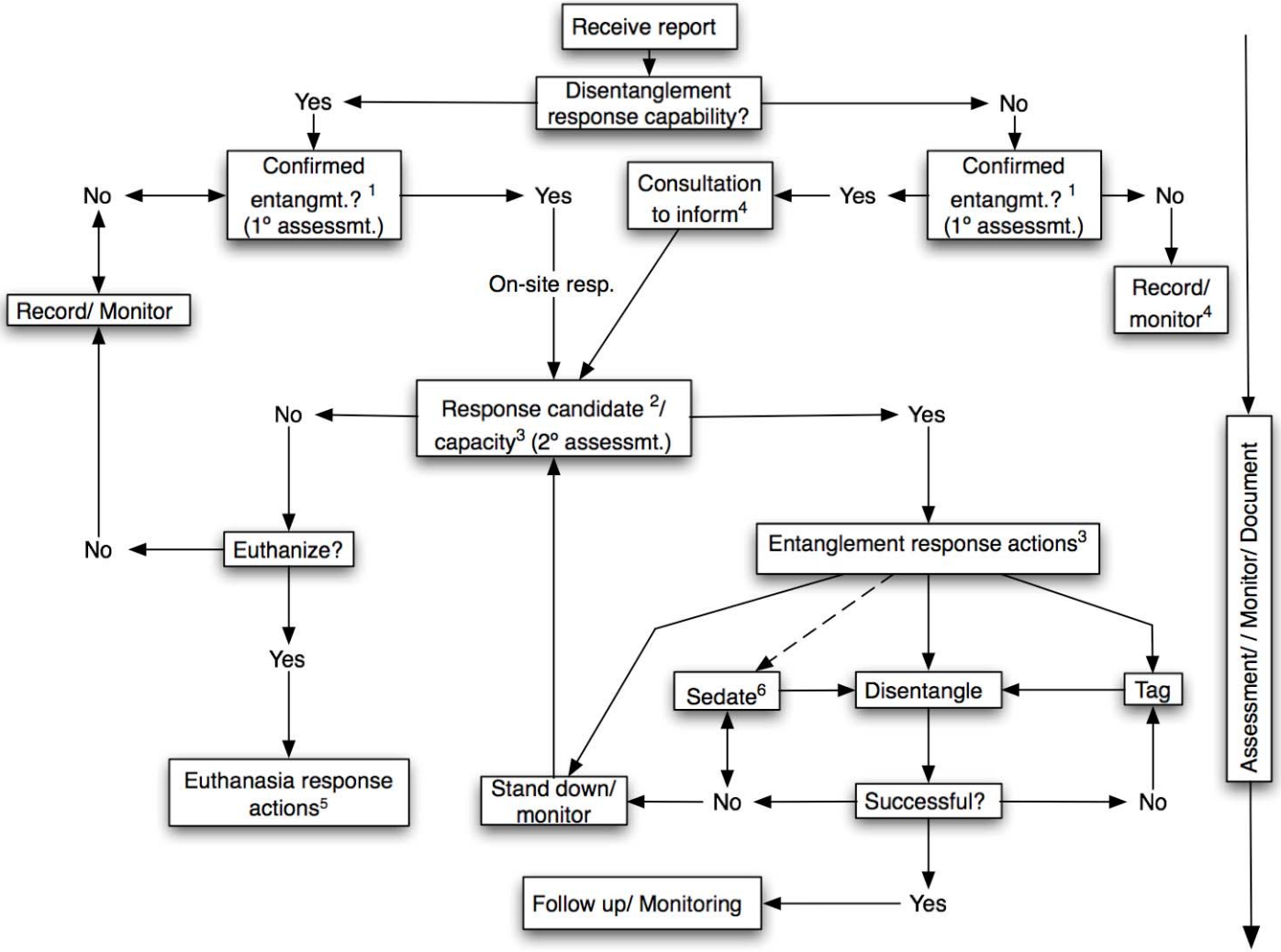
[2] A lance is a sharp double sided blade on a long pole that has historically been used by whalers to kill hunted whales (ref). The lance is used to exsanguinate the animal by cutting into the thorax hitting great vessels and/or heart.

*follows Australian protocol

** follows New Zealand Protocol

*** Using a sharp tool such as the lance or a knife to exsanguinate an animal. For many countries, this method of uthanasia is unacceptable in the absence of a stunned, sedated, anesthetized, or moribund animal. However it was recognized that in some countries, particularly those in which whaling included this technique, and in certain circumstances, exsanguination using such a tool might be the best available method. Lancing or exsanguination should be the last choice when no other options exist and its use would be enhanced by the prior sedation, anesthesia or other means which rendered the animal unconscious.

Figure 1. Decision tree for large whale entanglements. Note: Assessment/Monitor/Document are essential and ongoing throughout all aspects of the tree.



Revision date: April 15, 2010

[1]Confirmation of entanglements
As not all entanglement reports may be reliable entanglement sightings are generally confirmed through non-leading questions and/or photo- and video-documentation, as well as information from reliable observers (such as biologists, fisheries observers, etc.) as described in SC/59/BC2.

[2]Criteria to determine if an animal is a response candidate
Gear Configuration/Characteristics:

- Likelihood of whale shedding gear without intervention
- Type of gear, i.e. rope, netting, monofilament line, longline with hooks, etc.
- Status of entanglement, i.e. anchored, towing gear (aka free-swimming)
- Amount of gear: on animal; trailing; and potential to complicate

Impact on population or stock:

- Endangered status/ population level

Impact or likely impact of entanglement resulting in grave harm or mortality to individual

- Existing (present) body condition/ health status:
    - Body condition, i.e. emaciated, skinny, nuchal depression
    - Rake marks
    - Body coloration
    - Degree of cyamid coverage (species specific)
- Potential to impact animal:
    - At least one body area completely wrapped
    - More than one body area involved
    - Potential of injuries, i.e. will they worsen over time
    - Severity of injuries, i.e. cutting into blubber
    - Age class
    - Impeding whale behavior, i.e. mobility, feeding
    - Dynamics of other animals, i.e. mother/calf, other adults, predators
    - Location or time of year (is or will animal likely be fasting?)
    - Reproductive status (pregnant or lactating?)

Due to the diversity found in entanglement cases this list is not ranked or exhaustive.

[3]Capacity to respond/Response options:

- Risks to humans
- Appropriate personnel (either on-site or from other response personnel)*
- Resources available, i.e. vessels, equipment, etc.
- Environmental conditions, i.e. time of day, sea state, location and distance from shore, etc.

* Due to the inherent dangers involved with disentanglement managers should consider establishing training regimens and specialized equipment in regions where there in an overlap between whales and gear.

[4]Consultation to inform options:
Once an entanglement is confirmed managers should consult with other response networks to evaluate an entanglement case and appropriate response. In areas where an appropriate, safe entanglement response is not possible managers should consider the criteria for determining the potential lethality of an entanglement prior to further action as not all entanglements are likely to lead to death. Euthanasia should only be considered if an entanglement is likely to lead to death and the severity of individual welfare is high.

Re-evaluate options

1. Seek advice from an established network (contact list of potential external advisors)
    a. Is the animal anchored or moving?
    b. Are there personnel with appropriate background for assessing the situation available? Can they stay with the whale?
2. Obtain objective description/video/documentation
3. Develop an action plan for your specific situation in consultation with external advisor
4. If in consultation the animal is clearly doomed, consider a euthanasia plan (if capability exists in country)
5. If in consultation there seems to be a possibility for disentanglement (ie. Configuration of entanglement, existing local capacity (personnel, equipment, etc), then link back to the left side of the decision tree within the framework of locally developed action plan

Countries should be encouraged to establish entanglement monitoring. One model might be to inform, train and advertise an existing stranding network

[5]**Criteria for Euthanasia Response Options:**
The first tool to mitigate the welfare issues of entanglement is to develop entanglement avoidance strategies. The second tool is disentanglement. The tool of last resort is euthanasia. Availability of euthanasia should in no way obviate the responsibility to undertake entanglement avoidance and mitigation measures. Assuming it cannot be disentangled, the decision to euthanize should be made on a summed appraisal of the following parameters:

1. If the whale is stranded;
2. If the whale cannot swim;
3. If the entanglement has resulted in catastrophic appendage damage or such damage is imminent;
4. If the entanglement has resulted in compromised respiration or a seal of the blowhole or such compromise or seal is imminent; and
5. If the entanglement has resulted in severe constriction that cannot be removed from a vital body part or such constriction is imminent.

This may be evaluated by scoring the health status of the animal. A positive answer to only one of the evaluation criteria may not be sufficient cause. If disentanglement of the whale is possible, disentanglement activities should be conducted and the whale monitored for progression or regression of the above parameters whenever feasible. All decisions, and choice of method for euthanasia, should be made in the framework of the IWC Entanglement/ Euthanasia workshop guidelines and in consultation with a veterinarian and biologist - both with large whale experience and after approval by the relevant government official.

[6]**Sedation**:
Sedation in large whales is still in the development stage for different species, age classes, animal status, and in different situations (hence the dashed line). It was shown to work well in one entangled right whale case and the drug delivery device has performed well in the field on both stranded and free-swimming animals. In all cases sedation will be most effective if the animal is not excited prior to the administration of the drug(s). The ideal scenario would be to sedate the animal on the first approach of the day when the animal may be less excited and the greatest effect of the drug(s) may be achieved.