DISENTANGLEMENT WORKSHOP

BOSTON, MA
MARCH 27-28, 2003

Report of the Workshop on Large Whale disentanglement: Learning from the Past and Moving Towards the Future

Hosted by:
National Marine Fisheries Service
Northeast Regional Office
Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930-2298

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INTRODUCTORY ITEMS

The workshop was convened by the U.S. National Marine Fisheries Service (NMFS) and was held at the Wyndham Hotel in Boston, on March 27th and 28th, 2003. The workshop was chaired by Greg Donovan (Head of Science, International Whaling Commission - IWC). Phil Clapham served as rapporteur. The Agenda is given as Annex A and the List of Participants and Observers as Annex B.

David Gouveia of the NMFS Northeast Regional Office welcomed participants to the meeting and to Boston. In welcoming the Chair, who had traveled from the UK, he thanked the International Whaling Commission for allowing him time to participate. He particularly thanked Jonathan Wendland for organizing the workshop, and also expressed appreciation for the valuable help given by Teri Rowles, Phil Clapham, Kathy Scola, Mary Colligan and others.

Gouveia noted that NMFS does not regard disentanglement as the solution to the problem of large whale entanglement, but rather as a stop-gap measure while more permanent mitigation measures (notably gear modification) are developed. He indicated that the purpose of the workshop was to improve large whale disentanglement logistics, techniques and operations, and in that regard to obtain the views of individual participants.

The Chair noted the interest of the IWC in the entanglement of large whales. A recent report and overview of this subject from the IWC Scientific Committee is attached as Annex C; it will be published in the 2003 supplement to the *Journal of Cetacean Research and Management* (Clapham *et al.*, 2003). The IWC also has a strong interest in the conservation of the North Atlantic right whale. It has hosted and participated in a number of workshops on this species in recent years (e.g. see reports in Best *et al.*, 2001[1]). He referred to the IWC Scientific Committee's repeated view that 'by any management criteria applied by the IWC in terms of either commercial whaling or aboriginal subsistence whaling, there should be no direct anthropogenic removals from this stock'… and 'that it is a matter of absolute urgency that every effort is made to reduce anthropogenic mortality to zero.'

The report below does not necessarily follow the chronological order of discussions and interventions. It has been edited by the Chair and Rapporteur in order to produce a document that is of most value to non-participants as well as participants. In particular, the excellent presentations given by David Mattila (an overview of entanglement and disentanglement issues), Michael Moore (a synopsis of the previous disentanglement technologies workshop) and Harry Brower (behavior of bowhead whales during the Alaskan subsistence fishery) have been used to present the introductions to the relevant items of the agenda rather than being reported individually. Participants had been informed that for legal reasons, all comments/potential solutions must be submitted by individuals and that the aim was not to develop consensus advice. However, for readability, the report at times uses such terms as 'most participants agreed' – it would be tedious and unhelpful if 20-30 individual names had to be associated with particular comments. Similarly, no attribution is made for generally accepted facts. Readers of this report are therefore reminded of the legal view on consensus advice. After the meeting, the Chair developed his summary of the main issues raised and discussed at the meeting.

BACKGROUND

Entanglement of cetaceans in fishing gear and other man-made material is a major problem worldwide (Perrin *et al.*, 1994). Use of synthetic net and rope, introduced in the middle of the 20th century, together with enhanced fleet and gear mobility, worsens the problem of large whale entanglement (Clapham *et al.*, 2003). In the United States, prior to the mid-1980s, entangled large whales were primarily seen on the east coast by fishermen tending their gear. These observations were occasionally reported to authorities who in turn notified a local volunteer stranding organization. Often the volunteer network was inexperienced and ill-equipped to safely handle the rescues, especially those involving entangled, free-swimming large whales. The entanglement problem slowly became more widely known as a few species (the common minke, humpback and North Atlantic right whale) washed ashore dead

[1] Best, PB, Bannister, JL, Brownell, RL Jr and Donovan, GP. 2001. *Right Whales: worldwide status. J. Cetacean Res. Manage (special issue 2)*, International Whaling Commission, Cambridge, UK, i-iv+309pp.

in entangling gear and some researchers recognized the need to assist entangled whales. Thus, in 1984, in an effort to improve the success rates of large whale disentanglements, researchers from the Center for Coastal Studies (CCS) began a pilot program focused on how to safely rescue large whales from entanglements.

Over the next decade CCS and its cooperators continued working on the development of its program to safely disentangle both anchored and free-swimming large whales. Virtually any species of large whale can be involved in entanglements and entrapments, [Note: right whales do become entrapped in fixed fishing gear like herring weirs in Canada, there are several incidences documented over the last 20 years], and that these can involve any type of fixed fishing gear. Of the four whale species found in New England waters, 55% of reported entanglements involved humpback whales, 29% North Atlantic right whales, 12% common minke whales and 4% fin whales. In New England, 80-90% of entanglements involve free-swimming whales.

In 1995, the National Marine Fisheries Service (NOAA Fisheries) entered into its first contract with CCS to disentangle large whales. Under the current Letter of Authorization from NMFS, disentanglements can be attempted only if the entanglement is judged to be life-threatening, if there is supervision from an authorized individual; all incidents are required to be documented and reported. Disentanglement is a difficult and dangerous process and not to be undertaken lightly.

Over the years much progress has been made in large whale disentanglement methods and techniques and the Disentanglement Network has grown to include coverage along the entire U.S. East Coast and Canada. Currently, the "East Coast Disentanglement Network" consists of more than 500 civilian, governmental and voluntary members. A major campaign of outreach and education has been conducted to increase awareness of entanglements and foster additional sources of information from the field. Most Disentanglement Network members are trained "first responders" located in strategic locations along the U.S. East Coast including feeding and calving grounds, and/or other areas historically known to have large whale entanglements. Extensive dedicated rescue programs exist only in eastern U.S. and eastern Canada (primarily Newfoundland); however disentanglements of large whales have been attempted on an occasional basis in several other places in the world, from Oman to New Zealand (Clapham *et al*., 2003).

The priority of the NOAA Fisheries is to implement fishery management measures that reduce the potential for entanglement. The goal is to eventually prevent all entanglements. In the meantime, there will be some level of entanglements on an annual basis. Disentanglement provides an opportunity to potentially prevent serious injury or mortality of entangled large whales. Although this is a valuable mitigation measure, particularly for critically endangered species, such as the North Atlantic right whale, where every possible measure to prevent serious injury and mortality must be pursued (e.g. IWC, 2001[2]), it is **not** the solution. It does not prevent entanglements and is only useful in certain circumstances when animals are observed and able to be disentangled. In addition there are two examples of right whales (1102 and 2030) so badly entangled that despite heroic attempts, the animals could not be rescued. Nor does a complete disentanglement guarantee the survival of the whale (i.e.3107). However, despite these acknowledged limitations, it is still crucial to make all efforts to ensure that disentanglement is as effective a tool as possible until a solution that prevents entanglement in the first place is found.

Mayo noted that CCS has recently conducted a thorough review of all disentanglement procedures. This review identified three areas in which critical needs for assistance and improvement exist. The first is a need for effective methods to safely and completely immobilize severely entangled, healthy whales. The second is improvements in locating, standing by and tagging reported entanglements. The third need is a requirement to increase the number of individuals authorized to conduct Level 4 (i.e. complete) operations.

I. DETECTION, FIRST RESPONSE AND STANDING BY

The objective of this portion of the meeting was to identify ways to increase: (1) the detection rates of entangled animals; (2) the initial response to reports of entangled whales; and (3) the probability that the initial reporter stands by the animal until a disentanglement team or other authority (e.g. the Coast Guard or state marine patrols) arrives. Particularly under poor environmental conditions, animals can be lost within minutes if there is no one standing by.

[2] International Whaling Commission. 2001. Report of the Scientific Committee. *J. Cetacean Res. Manage.* 3 (suppl.): 1-374.

Potential problems here concern (1) the level of reported first observations of entangled animals; (2) the quality of such reports and associated communication problems; and (3) the level of standing by. Even experienced observers may miss the fact that observed animals are entangled. Studies of entanglement scars (Robbins and Mattila, 2003) indicate that far more whales are entangled every year than are reported. For both North Atlantic right and humpback whales off the eastern USA, the number of reported incidents is estimated to represent between 10% and 20% of the actual total.

A. Initial detection and reporting

Mattila and others noted that first reporting has diminished in recent years. In particular, fewer fishermen are reporting whales than did so a few years ago. The issue of co-operation with fishermen to the whole issue was considered to be sufficiently important to warrant a new agenda item (see section VI). The concern was also expressed that possible revisions of flight protocols following the recent (January 2003) crash of a right whale survey plane off Florida may limit the extent to which aerial surveys can provide information (see Annex D). Representatives from CCS and the Northeast Fisheries Science Center (NEFSC) indicated that they did not expect a significant reduction in disentanglement assistance from their aerial survey programs. Many commented on: (1) the great contribution made by aerial surveys in detecting entangled whales, confirming the severity or otherwise of entangled whales reported by others and in standing by reported whales; and (2) the need to try and ensure that at the very least, the current level of effort is maintained.

Given the difficulties noted above about determining whether observed animals (especially right whales) were entangled or not, Mayo, amongst others noted that it was difficult to detect entangled animals unless they were observed from a reasonably close distance and/or for some period of time. He and Kraus also commented on the value of good quality photographs of any encounters; often signs of entanglement missed in real time by observers were subsequently observed in photographs. Mayo also noted that many animals were not observed to be carrying gear until they were ‘beyond hope’. In this regard, McKiernan urged that NMFS reconsider the US regulation that currently prohibits whalewatching vessels from approaching right whales closer than 500 yards, since this effectively precludes detection of entanglements and thus has eliminated a major source of reporting. Kraus concurred, noting that any potential increase in harassment of right whales was heavily outweighed by the possible early reporting of entangled animals. Given the support for this view by many participants, a working group under McKiernan was established to discuss this issue further. They agreed with a proposal sent to NMFS some years ago by the Massachusetts Division of Marine Fisheries; this proposal requested that NMFS authorize certain whale-watching vessels to document right whale sightings at distances closer than 500 yards. A summary of the proposal is attached to this report as Annex E.

During these discussions on how to improve overall detection rates, Mayo commented that given the evidence from scarring of the prevalence of entanglements, there may be considerable utility in tasking a dedicated vessel/aircraft to examine large aggregations of right whales (say, 50 or more animals in one place) to try to determine if any of the animals were carrying gear. Many participants agreed, and it was added that any such surveys should always photograph all encountered whales (which could in most cases be accomplished at the same time that an entanglement assessment was being undertaken).

B. Standing by

When a whale is reported, standing by is essential; in the past, whales have sometimes been lost only moments after a responder has left the scene. For commercial operations (e.g. whalewatching and fishing vessels), ‘standing by’ has financial implications. For research and survey operations, there may be additional consequences, including the cost, loss of research time and opportunities, and trade-offs between protection from shipping (e.g. the EWS surveys) and standing by to secure a location on and entangled whale. The speed of attendance by responsible personnel (e.g. Coast Guard vessels, state marine patrols, researchers etc) is key to ensuring that reported entanglements are not lost. As discussed under Section VI, knowledge that they are not expected to remain with an animal for extended periods may also help to encourage reporting of entanglements by commercial operations. Aerial backup is especially important in this regard. Several participants noted the potential value of having telemetry gear on selected fishing vessels (i.e. those that had participated in a training program). If practical, this would certainly decrease the time needed to stand by and allow later tracking of the animal.

C. Response times

A number of factors combine to determine the response time to notifications of possible entanglements. These include (1) the quality of the initial report[3]; (2) the communication time between the involved parties; (3) the prevalent environmental conditions; (4) the availability of resources (personnel and equipment) to respond.

Mattila reported that the average response time of the CCS disentanglement team (report to on-water mobilization) was 77 minutes. The 77 minutes is for local responses within the Northeast region. It is the average amount of time needed for a fully equipped rescue team to leave the dock after the call has been made. If a Florida or Bay of Fundy response was included the times would be of a different magnitude. Landry noted that a large portion of this time consisted of interrogating the reporting individual (using questions on a standard CCS reporting form) to try to obtain a reliable indication of the nature of the incident and extent of any entanglement. The Coast Guard also uses the CCS form in dealing with reports to and from Coast Guard vessels.

Many participants agreed with the suggestion that ideally, initial reporters should be patched directly through to an experienced person (e.g. CCS personnel), rather than their reports being given via a third party. Hartley also requested that any organization involved in an entanglement incident should designate a single person to communicate with others in order to minimize duplication and subsequent confusion. Such measures would improve the quality of the resulting assessment and the speed of an appropriate response.

The transmission of near real-time good quality photographs or video images of possible entanglements would also improve the quality of the initial report. This may be possible for professional reporters (e.g. Coast Guard, state marine patrols). Hughes noted that it would be very helpful if the Coast Guard (which has good photographic equipment on board) could be provided with some simple advice on how to take good photographs of entangled whales and representatives from CCS agreed to draw up such guidelines. Mayo and Moore stressed the value of videotaping where possible.

The practicalities of communication methods available have a great influence on the determination of an appropriate and timely response. Methods used currently include cell phones (service not available in all areas, e.g. eastern Maine), VHF radio and single-sideband. Todd noted that public methods of communication (e.g. VHF) effectively announce the presence of a whale to the public; this may result in curious boaters arriving at the scene and hindering the rescue effort. Slay noted that use of an external cell phone antenna resulted in ability to use a cell phone anywhere in the Bay of Fundy, where coverage is otherwise sporadic.

Good weather forecasting is essential in determining the feasibility of a response. In this regard, Todd noted the value of the Gulf of Maine Ocean Observing System (GOMOOS) buoy system in the Gulf of Maine and suggested that a closer collaboration be developed with this program (which would potentially allow GOMOOS to raise additional funds on this basis and thereby expand their coverage).

The final major factor governing response time is the availability of resources. This is discussed further under Sections II and V below.

II. GETTING TO THE WHALE

The objective of this portion of the meeting was to highlight the difficulties of getting disentanglement teams to entangled whales and to identify improvements to existing strategies and/or new strategies. The factors discussed in Section IC also apply here and so are not repeated.

McLellan suggested that first-responder kits be distributed in as many places as possible to increase the probability that reported whales can be assessed and tracked. He also suggested that effort be concentrated on areas where gear known to entangle whales occurs. However, it was noted by some others that there is little information on the origin of gear from entanglements. They believed that reporting of entanglements was much more likely to reflect whale survey effort. McKiernan and others stressed that with limited resources, monitoring and disentanglement effort needs to be prioritized and targeted. For example from knowledge of the distribution and timing of both whales and

[3] Several participants gave examples of the poor quality of reports from the public, and the importance of proper (non-leading) interrogations of reporters. By contrast, fishermen and whale-watching vessels usually give reliable reports.

fishing effort along the coast, resources could be distributed accordingly. A working group to discuss the topic of resource limitations was established under Lyman. See Annex D.

In addition to prioritizing limited resources based on the species involved, distribution of animals and gear, and reporting effort, the working group outlined some potential solutions for limited resources under the categories of personnel and platforms. In regard to personnel, participants agreed that more level four responders (and to a lesser degree additional level 2 and 3s) were needed at CCS and the network as a whole to establish additional viable teams along the East Coast. It was generally agreed upon that more staff (at the higher levels) should be dedicated, fulltime (at least as it applied to prioritization of species, distribution and effort listed above), regularly trained, have general as well as specific skill sets (knowledge of: documenting whales, whale behavior, fishing gear, disentanglement protocols, seamanship, etc), and be compensated for their efforts. Possibilities for compensation discussed included salary, retainers, contracts, and by event. With increased depth of personnel, disentanglement teams could be staged in hotspots (based on species, distribution of whales and gear, and reporting effort) and CCS personnel would have more capability to respond to remote events providing greater coverage and training capability, but at the same time not diminishing their own home coverage. Participants also agreed upon the value, and continued involvement of fishermen in the disentanglement effort.

In regard to platforms, it was agreed upon that more platforms, with at times greater range and speed were needed. Potential solutions were the chartering and retaining of fishing vessels in key locations, the use of state and federal platforms, including the USCG, and the acquisition of dedicated platforms. One platform that should be prioritized is a dedicated, offshore, rapid response vessel operated by CCS to increase their range and time of response in a region that meets all the requirements for delegating limited resources. Aerial platforms, having shown their worth in the disentanglement effort both in terms of finding entangled whales and supporting disentanglement efforts, were included in the discussion. Like vessels, aerial platforms may have to be retained in key locations (as applied to prioritization of species, distribution and reporting effort) in order to assure their availability. Minimum requirements for aircraft and pilots such as those used in existing aerial survey contracts (i.e. DMF, NEAq) should be used to establish a list of potential aviation responders.

In addition to the availability of suitable vessels in terms of seaworthiness, speed, endurance and maneuverability, a further limitation on the offshore range of response relates to insurance restrictions. CCS has internal policies and insurance which stipulates backup requirements and other items at certain distances. Hughes suggested that CCS and others consider getting vessels inspected by the Coast Guard Auxilary, since inspection often results in discounts and easing of restrictions from insurance companies.

III. ON SCENE WITH THE WHALE

The objective of this portion of the workshop was to identify improvements in existing assessment, monitoring and restraint strategies, and to identify potential new strategies.

A. Assessment of the past and future condition and health of the whale; assessing severity of the entanglement; monitoring strategies

Assessment of the seriousness of entanglements by CCS includes consideration of:

(1) the location of the gear on the whale;

(2) how tight the gear is wrapped; the type of gear;

(3) the size/age of the animal; and

(4) the whale’s condition (health);

(5) and the whale’s behavior.

Criteria for intervention also exist in terms of what is “acceptable” risk, but Mattila stressed that disentanglement is dangerous under almost any circumstances.

Aerial views provide an excellent means of assessing an animal without the necessity of very close approaches. In addition to photographs from survey planes, use of a pole cam, or a camera/video system mounted on an aerostat can be valuable.

The present policy is that disentanglement is only attempted where the gear is considered life-threatening to the whale. Todd questioned whether this policy should be revised in light of the possibility that simple entanglements may pick up additional gear and become more serious. Mattila responded that the potential for an entanglement to attract additional gear was also included in the CCS assessment of any incident. He noted a number of disadvantages in attempting to deal with simple entanglements, including: risk to personnel; potentially increased stress to the whale; the possibility that gear added to the animal for restraint might remain and thus complicate the entanglement. Kraus added that scarification studies indicated that most right whale entanglements are shed. Therefore, confining interventions to potentially lethal entanglements was a good policy. NEA has recently developed a reasonably reliable technique for determining the condition of a right whale from photographs[4]. However, it is difficult to follow the health status of individuals over short time periods using this technique. Knowlton agreed that the current policy is sensible but suggested that additional analysis of the outcome of all entanglements might provide insights into how reliable initial assessments of prognosis are; Moore noted that he had a proposal to do this, involving assessments of past cases by veterinarians, pathologists and other specialists.

Mayo suggested that disentangling apparently healthy whales should be attempted if the type of entanglement was usually associated with a negative outcome. Brown commented that satellite tagging of healthy entangled animals might provide a means of regularly monitoring their condition, but noted that there was controversy about the impact and reliability of implantable satellite-monitored tags (e.g. see IWC, 2001). O'Hara added that tagging seriously injured animals might permit retrieval of the carcass when the animal dies; however, Mattila noted that emaciated animals sink, taking the tag with them (this is assumed to have occurred with Churchill). Kraus noted that the success rate of implantable satellite tags is relatively low because of damage related to right whale behavior; thus, a towed tag may be more effective. The lasso system developed by Becky Woodward may provide a way of attaching such tags.

Mattila noted that an analysis of humpback whales indicated that mature female humpback whales with entanglement scars have a significantly lower (*insert value*) reproductive rate than females without scars, inferring significant sub-lethal effects to entanglements, even if the entanglement is shed.

Assessment of stress levels using biochemical analysis of biopsy samples or samples of defecation appears to be practicable; methods have been developed by NEA (Roz Rolland) and the Southwest Fisheries Science Center (Andy Dizon's lab). However, only the fecal sample tests have been validated at this point.

Collecting concurrent behavioral information from sampled whales is an important component of any resulting stress assessment; a standardized data form for such behavioral observations should be developed. Rowles noted that any such data collection should also be conducted for disentangled whales to provide a "normal" control sample. A working group under Landry was set up to discuss this issue further; the group agreed that a behavioral data form should be developed for this purpose. Landry volunteered to undertake this task and circulate a draft to interested individuals for comment.

B. Restraining the whale for disentanglement

Moore summarized a 2001 workshop on disentanglement technologies (see Annex F[5]) that had been co-sponsored by the Center for Coastal Studies, New England Aquarium and Woods Hole Oceanographic Institution, and was partially funded by the Northeast Consortium. The details from that report are not repeated here. In almost all cases, entangled animals need to be restrained in some way if successful disentanglement is to occur. In summary, four major areas of development were listed: (1) better aerial and underwater assessment; (2) better fluke restraint;

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[4] Rowles noted that recent experience had substantially improved reliability of health assessments and the interested reader is referred to the report of the immediately preceding workshop on bowhead and North Atlantic right whale health (insert reference).

[5] The full workshop report is available on the Internet at: www.whoi.edu/science/B/people/mmoore. It summarized issues of assessment, restraint and cutting.

(3) development of a "Robocyamid" package with assessment, sedation and cutting functions; and (4) a rope-ascending device to image and perhaps cut flipper and rostrum wraps. Aspects of these are discussed below and under Section IV.

1. Mechanical techniques

Kegging (attaching a line affixed with numerous large floats to the entangling gear) remains the primary means of restraining entangled free-swimming whales. Anchoring whales is possible under the right conditions, but this carries the risk of the anchor picking up additional gear. Ledwell stated in Newfoundland, uncooperative humpback whales entangled close to shore occasionally have been towed into shallow water for disentanglement only because after repeated attempts to remove the gear the whales proved to be too wild.

Right whales are very different from humpback whales; they are often uncooperative, are extremely powerful, and have resisted efforts to restrain them by towing with a modest-sized vessel (and indeed invariably tow the vessel itself). Clapham suggested that existing data be examined to determine whether the reaction of a right whale was related to the sex or maturational class of the whale, since mature males might be expected to be more aggressive; if an age class or sex effect existed it might influence disentanglement strategy.

Several participants suggested that restraining a right whale by the head might be a more effective (and less harmful to the animal) method than a tail restraint. In Newfoundland disentanglements, Ledwell noted, any ropes which are through the mouth and act as a bridle are the last that are cut, since with this rope it is often possible take control of the whale. Brower noted experience with bowhead whales in the Alaskan subsistence hunt whales (by Alaskan Eskimos) supports this theory. Additionally he stated bowhead whales are more likely to be pacified when harpooned in the head or lip than elsewhere. Use of a small sub-epidermal toggle attachment device might serve this purpose without inflicting serious injury, which may not be the case with attachments to gear around the tail. George's observations from the Alaskan bowhead whale subsistence hunt indicates that injuries in this area can be minor and easily healed (like those from implantable tags): Healthy whales have been found with old harpoon heads encapsulated in this region (such as in the photo of an injury to the dermis of whale 92B2; a large female carrying a very old stone harpoon point). If this technique is the only way to rescue a whale from a lethal entanglement, the potentially positive outcome presumably outweighs any potential short-term pain or harm. The use of hoop nets around the head, which has been successfully tried on white whales, is not considered practicable (and may be dangerous) with large whales.

It is not clear whether kegging can seriously exacerbate injuries in the caudal region. It is important that this be examined thoroughly where possible. Pathology analysis of right whale #3107, entangled around the tail stock, indicated that the line had lacerated arteries, which had subsequently been sealed with scar tissue. It is conceivable that adding additional tension to a line embedded around the peduncle could sever major blood vessels and cause the whale to bleed out; while this is not known, the possibility further highlights the need to experiment with restraint methods that are focused on the head region. It was noted that little is currently known about blood clotting mechanisms in any mysticete; experience with bowheads in Alaska suggests that at least in this species there is no intrinsic clotting.

2.Chemical techniques

The experience of a previous attempt to sedate a large whale (Churchill) is summarized in Brunson *et al.* 2002 (Annex G) was discussed. The drugs used were chosen on the basis of safety for the whale and also the human personnel involved. The drug currently being employed (Medazolan) is extremely expensive and has a relatively short life. Although the effectiveness of this attempt is open to interpretation, the delivery technique and knowledge of the appropriate dosage are now much improved. However, it is still not known whether a drug dose that renders an animal tractable is below that which would incapacitate the animal and potentially stop it from maintaining equilibrium. Experience with other large mammals also reveals considerable individual variation in response to drug concentrations. Moore reported a design for a multiple-dose delivery device has been completed, although Rowles noted that there was some health concern regarding multiple doses in the same location. Monitoring of whale behavior prior to, during and after sedation was not adequately conducted during the Churchill event, and this is essential for any future attempts; use of the digital tag (DTAG) developed by the Woods Hole Oceanographic Institution (WHOI) would significantly improve the quality of these data as would the development of standard behavioral data collection methods discussed above.

O'Hara questioned whether the current delivery system distributed significant quantities of the drug in the dermal area rather than in the muscle where it is targeted, and suggested testing this on dead animals. He also cautioned that the theoretical impact of a sedative can easily be overridden by a whale's reaction to the procedure.

In summary, Donovan noted that development of a reliable system for chemical sedation was clearly seen as very important, while recognizing that there are significant problems still to be resolved.

C. Animal welfare issues

The extent to which pain and suffering are associated with serious entanglements is not known, nor how this may modify the responses of whales to rescue attempts. O'Hara noted that many animals subject to injury show no observable signs of pain or suffering. Brower noted that if Alaskan hunters had encountered an animal in the condition of Churchill, they would have attempted to kill it to relieve its suffering. It was recognized that the question of whether euthanasia may be appropriate under some circumstances for free swimming entangled whales requires further discussion; at present this would not be contemplated in the USA.

Slay suggested that an animal such as Churchill, which was clearly going to die without intervention, should be used as a test to push the limit on sedation drug dosage, since this might have resulted in a successful disentanglement; if the whale died as a result, the outcome would not have been different from the inevitable.

A working group was established under Mayo to discuss the issue of pain that may be inflicted during disentanglement events. Participants agreed with the conclusion that operational decisions on disentanglement management should maximize the potential for problem resolution and hence individual survival. Short-term pain exacerbation is acceptable if those activities remedy the problem, but anything that precipitates significant further damage and decline is unacceptable. Therefore, it is essential that animal control systems be developed that are independent of the entanglement-induced lesion(s) and resultant pain sources.

IV. TECHNIQUES OF DISENTANGLING

The objective of this portion of the workshop was to highlight existing disentanglement techniques and to identify new techniques to improve the release rate of entangled whales.

A. Behavior of bowhead whales during hunts

Harry Brower Jr., a whaler from Barrow, gave a presentation on approach and following techniques used by Alaskan natives when hunting bowhead whales. These involve camouflage and very quiet approach, with crews following a float (often attached to floating line) after the whale is harpooned, or using footprints (*qaala*) to follow the track of an unseen animal. Native hunters have found that if a boat crosses a footprint, a whale can detect (hear) this and will react accordingly; consequently, hunters avoid moving into or across the track of the animal. In at least one incident, a boat following a harpooned whale crossed a footprint; the whale reacted by turning, then opened its mouth and crushed the boat.

Hunters prefer to approach the head of the whale because it affords a better opportunity for a strike, but also because the head is much less dangerous than the tail. Hunters avoid the tail area at all times. Hunters believe that bowheads are very dependent upon vision; in calm water, they use the surface as a mirror to see reflections at some distance. Bowheads appear to have a blind spot directly ahead of them.

Harpooned animals dive longer swim faster and move further. Whales never exhibit aggressive behavior towards a boat prior to being struck, but are often aggressive afterwards. Whales sometime get snagged in lines through rolling or thrashing.

Hunters have found that females tend to be more aggressive than males, and younger animals are much harder to kill than older, larger ones. Older animals tire more easily and tend to turn less swimming in a more predictable manner. Prior to the imposition of catch regulations, hunters could take mothers and calves, and found that mothers were often extremely aggressive in defense of their young. Others agreed that one should be particularly cautious around females with calves.

These considerations were kept in mind when discussing the following items.

B. Approaching whales

Knowlton commented that two types of approach have been used to attach telemetry buoys to entangled whales: the quiet technique, and a more rapid approach that forces the whale down, causing it to surface at shorter intervals. With humpback whales, exhausting them into tractability is often possible; this does not appear to be as easy with right whales. Brower noted that the first approach (prior to the whale being 'potentiated') is often the easiest and is thus the most important. Most agreed with this, no matter what the species concerned. It is important that any standby vessel maintain some distance from the whale so that the animal is not disturbed, thus preserving the first approach for the arrival of the rescue boat.

Slay stressed the importance of planning ahead to maximize what can be done with this first opportunity. There was considerable discussion of this. Many participants agreed with the view that what can and should be achieved on this first approach is very much case-specific. For example, whether it is decided to attempt to cut a line on the first approach will depend on whether enough is known about the entanglement to determine that the line to be cut is critical; and whether cutting it appears to be practicable (for example, if the line is deeply embedded or not). Ledwell noted that with tight wraps (usually on anchored whales), they often attempt to embed a gaff under the line, which makes subsequent work to cut the line easier. If making a cut does not appear to be wise or practicable, the first approach should probably concentrate on attempting to tag the whale; this is likely to be the best course of action in most cases. Mayo stressed the importance of having the best possible information and undertaking careful planning before attempting to use the first approach to cut a line.

Cutting a head wrap should only be attempted if there is certainty that no other entanglement point exists (e.g. a flipper wrap). Cutting the head line will reduced future ability to control the animal or to attach a telemetry buoy. Although there is currently no way to deal with a tight flipper wrap, maintaining flexibility and the ability to control or attach to the whale is important. Knowlton noted that removal of flipper wraps may be more important in younger animals, where growth will likely worsen the condition, than in fully mature whales. Lyman suggested that attaching a sharp grapple or other tool to a line may result in the eventual separation of the line through attrition, at the same time it will enable additional time with which to better assess the whale's entanglement and condition.

A suggestion to use the pulpit of a tuna boat in tagging or disentanglement was generally discounted, given the risk of entangling trailing gear in the propeller and the vulnerability of the vessel to a tail slash or other proximity problem. Another suggestion regarding jet propulsion engines rather than outboards on the rescue boat was rejected because of the poor maneuverability of such drives at slow speeds.

Mayo related a story of using a tuna spotter plane to direct a boat; the spotter was able to observe the whale through its entire dive cycle and could place the vessel right next to the animal when it surfaced. The whale appeared confused and milled at the surface, although when it eventually dove it descended to a depth at which the plane could no longer see the animal. Although it is logistically difficult to have a plane associated with rescue attempts, on occasion it has been done successfully in the past. A plane has been able to locate a whale during a rescue attempt and has directed a rescue boat onto the whale. This aircraft involvement is clearly valuable when practical.

C. Disentanglement tools

Currently, a wide variety of tools (including knives, grapples and other items) are used in disentanglements (see illustrations in Clapham *et al.* 2003, Annex C). The utility of these in different situations is accepted, and discussion focused on potential new techniques.

Similar to Lyman's idea above, Todd suggested that what was needed in the disentanglement tool box was a "piercing gaff" type of tool, specifically designed to get under a tight line even at the expense of cutting into the whale. Brower suggested that a modified version of a spade-like flensing tool (a *tuuguaun*) could be very effective in cutting tight ropes. Johnson indicated that the weight and balance of the pole handle to a gaff or knife was an important component to its effectiveness; she suggested that asking advice from tuna or swordfish harpooners might provide valuable information about weighting of poles.

Slay demonstrated the prototype of a custom spring-loaded blade that is designed to cut through (from above) line that is so tightly embedded in a whale that it is impossible to get a blade underneath it; the length of the blade could be adjusted depending on the desired depth of the cut. Ledwell replied that you needed control of a rope to cut it due to the extreme strain created by the whale on it and a fish gaff is an effective tool for this. Mayo indicated that it would be very useful to design a gas-driven knife that automatically closes around and severs a rope upon impact; if the blade was built wide and long enough, it would effectively deal with hidden lines.

Deep cuts into whales should be made after due consideration of the potential damage to the animal, which will depend on the location on the body and tissues involved. Care should be taken to avoid cutting into areas (e.g. the peduncle) where major blood vessel may be close to the surface. Damage to bone is less of a concern; such damage is acceptable if it occurs as part of an action to cut and remove an embedded line and thereby potentially initiate a healing process.

V. HUMAN SAFETY, EXPERIENCE AND TRAINING

The objective of this portion of the workshop was to highlight safety, experience and training strategies for large whale disentanglement and to identify improvements and/or new strategies. Peter Borrelli (CCS) provided a brief description of the difficulties and problems relating to insurance. The Chair noted that this was an important issue that affected the ability and efficiency of disentanglement efforts but not one that a scientific workshop could comment upon in any useful way.

A. Safety issues

Mattila noted that because of the dangers involved in disentanglement, few individuals are currently authorized to undertake these operations. It is a given that human safety is the first priority in any disentanglement event. Basic safety techniques and policies for disentanglements were summarized by Mattila, and in both Clapham *et al.* (2003; Annex C) and in a CCS policy document[6] (Annex H).

The strong caveat and basic philosophy given in Clapham *et al.* (2003; Annex C) is reiterated here:

> First and foremost, it is absolutely critical to recognize that disentangling large whales from fishing gear is a dangerous task that should never be undertaken lightly or by inexperienced individuals.
>
> Whales are very large, powerful animals. Errors in judgment on the part of either the whales or the people attempting to help them can result in serious injury or death. In recent years, the press has reported several incidents in which well-intentioned but inexperienced individuals have attempted to remove fishing gear from humpback whales, notably by getting into the water with the animal concerned. That no one has yet died from such an encounter is more a matter of good fortune than anything else.
>
> Anyone attempting to disentangle a large whale should, at a minimum, possess great seamanship skills and common sense. Indeed, seamanship - which includes the ability to safely handle lines and other equipment, as well as the boats being used - is equally important in whale rescue as experience with whale behavior. With appropriate care and knowledge of some of the techniques outlined below, competent fishermen can successfully disentangle whales of some species as long as they attempt this with caution and common sense. However, having some knowledge of whale behavior is obviously desirable in such situations.

Morin noted that one member of the disentanglement crew is designated as the "safety officer" whose job it is to constantly monitor the situation to be aware of potential safety problems. It was noted that in Australia, rescue crews routinely include individuals with some medical training, and it was suggested that EMT or similar level training be incorporated into disentanglement personnel. Ledwell noted that in Newfoundland, the rescue boat is usually attached to a second vessel or stationary fishing gear and a release person is dedicated to pull back the rescue boat if necessary; this allows them to work with the outboard engine up and thus avoid any risk of cutting the whale or propellor entanglements. This is less practical in New England, where (unlike in Newfoundland) most entangled whales are not anchored. However, the preferred support vessels (the Coast Guard) have trained medical personnel present.

CCS protocols integrate safeguards for the disentanglement operation with those for vessel safety in general; for example, the support vessel is required to maintain visual contact with the rescue boat at all times. Todd stressed the

[6] It was recognised that such a document is continually updated in the light of experience.

importance of adequately documenting (preferably with video) each disentanglement attempt, and also conducting a thorough debriefing afterwards.

Rowles explained that the current permit situation for disentanglements is that all activities are covered under a single permit issued to the NMFS Marine Mammal Stranding Program. The advantage to this is that any liability or lawsuits arising from disentanglement would be handled by the US Department of Justice. Currently, NMFS is exploring the idea of nominating additional co-investigators under this permit.

There was some discussion of the question of the acceptability of in-water rescue attempts. Clapham *et al.* (2003) had stated:

> Many individuals involved in disentanglement strongly advise against getting into the water with an entangled whale under almost any circumstances, and note that no whale is worth the risk involved in such a scenario. The potential for a diver to become entangled in the fishing gear on the animal is very real, with obvious fatal consequences should the whale decide to dive. On the occasions when individuals have entered the water (usually to get a better look at the nature of the entanglement underwater so as to plan the best disentanglement strategy), they have been very careful to first remove any objects (belt, clips et cetera) which could become snagged in the entangling fishing gear.

Moore noted that some fishermen-led disentanglements in Australia have involved individuals getting into the water as the only practical way to release southern right whales (pers. comm. from Steve Burnell). Kraus felt that no option should be excluded. This notwithstanding, in general, getting into the water with an entangled whale is potentially extremely dangerous and not to be recommended, especially with mobile (non-anchored) whales. Some participants felt that there may be individual situations in the future when in-water operations should not be entirely discounted, as long as extreme safety procedures were observed.

Mattila noted that this concern about inexperienced individuals is one reason why the CCS protocols for disentanglement are not widely advertised. Landry reported a recent incident from Panama where individuals disentangled a whale using information found on a CCS web site; he wrote to the individuals concerned and requested that they take a link off their webpage that linked to the CCS protocols. Johnson added that this problem is exacerbated by a widespread public perception of whales as harmless animals.

B. Experience and training

Mattila reported that CCS does have determined criteria for selecting individuals to be trained to deal with disentanglements. These include level-headedness under pressure, experience with whale behavior and small boats, knowledge of fishing gear and lines under heavy load, availability, and insurance. Individuals are recruited at four levels, with a concomitant level of training for each. The first level includes individuals who are willing to report entanglements if seen. The second level includes those who are willing and able to more actively help with locating and documenting entanglements. Level three involves individuals who are able to attach tags, give hands-on assistance in a disentanglement effort, and also to attempt simple disentanglements. The fourth level is restricted to people who are capable of supervising any entanglement. Advancement from one level to the next is dependent upon experience and positive evaluations of performance at the previous level.

Mayo reported that a plan is in place to train additional individuals, and many more are authorized to initiate a "first response" to assess an entanglement and, if appropriate, attach a telemetry buoy to the whale. Cooperative agreements have been developed with the Coast Guard and state marine patrols to assist with disentanglement reporting and logistics (e.g. from fishermen).

It was widely acknowledged by CCS and others that the primary problem in the disentanglement network at present is the paucity of Level 4 responders. At present only three Level 4 responders exist (Mayo CCS, Mattila NOAA, and Lyman MASS DMF). Mayo noted that the CCS aim is to have at least three more two-person Level 4 responders in place in the near future. However, there remains considerable conservatism in recognizing individuals as sufficiently experienced and skilled to qualify for this level. In large part this is due to the difficulty of providing hands-on experience to individuals and observing first-hand their seamanship skills, common sense and ability to judge whale behavior. However, the major impediment to increasing the numbers of Level 4 responders has been the fact that CCS was solely responsible (under NMFS permit) for disentanglement activities, and that allowing non-CCS staff to disentangle whales was considered an unacceptable risk.

Ultimately, NMFS (not CCS or any others) has the responsibility for categorizing individuals as Level 4 respondents, although the agency takes advice from CCS and other experienced personnel, as appropriate. Conway suggested establishing a formally constituted independent committee of experts to evaluate candidates for Level 4 assignment. Donovan noted that from presentations and discussions at this workshop, at least three personnel from the New England Aquarium and one from the College of the Atlantic appeared to have extensive experience in disentanglement of at least right whales, although it had been impractical for them to have been observed by CCS level 4 personnel; they have been allocated the equivalent of level 4 by Canada. Consideration should be given as to whether NMFS should recognize their experience and their acceptability to Canada, by designating them as Level 4. This would broaden the pool of Level 4 and hence the potential for further personnel able to make recommendations to NMFS.

Mayo suggested that NMFS and CCS (and others as appropriate) should agree upon the extent of training and experience required for all four levels of responders; if individuals meet these criteria, NMFS can then accept them at the appropriate level. Currently the lack of such an agreement, and the fact that CCS - not NMFS - is burdened with responsibility for individuals working within the network, is hindering recognition of additional Level 4 responders (including several individuals who are widely recognizing as having the skills and experience necessary for this designation). In discussion, it was widely recognized that developing the arrangement suggested by Mayo should be a major priority for NMFS.

The idea of apprenticeship programs to give individuals experience is recognized as valuable, but requires a significant commitment of time on the part of potential apprentices. Todd and others emphasized the need to select apprentices with strong existing seamanship skills.

Conway urged that protocols and training be standardized in all areas, including between the US and Canada. This would allow for much easier coordination of effort, and exchange of individuals between areas as needed.

VI. DOCUMENTATION AND PUBLIC OUTREACH

A. Documentation

Current documentation of entanglements was summarized by CCS staff and comments were requested[7]. Donovan noted that it would have been useful if the documents could have been distributed to participants in advance so that a more thorough discussion and review could have taken place at the workshop. He suggested that there may be value in convening a small specialist workshop to carry out such a review in the future.

A narrative with photographs and drawings (when available) is produced. The website acts as the principal repository for narrative reports (http://www.coastalstudies.org/entanglementupdate/entanglement~update.htm). This refers only to eastern USA disentanglements. It was suggested that similar narratives should be posted for efforts from other countries and that all such sites should include cross links.

Knowlton suggested adding the ability to provide visual depictions of where on the whale gear is located. Distributing reporting forms more widely would be useful, and more detailed analysis of existing data should be conducted to gain insights into entanglements. Integrating into a single database all data and analysis (including that of gear type in cases where gear is recovered) for every entanglement is important. It is also important to collect additional data on the healing process and condition of successfully disentangled whales, as well as links between gear type and scars.

Conger indicated that thorough photographic documentation of as much of any whale's body as possible was important for analysis of entanglement scarring.

B. Outreach

There are two aspects to the CCS website approach: that to provide information to the public (which need not be particularly detailed); and that of value to entanglement teams. The latter is a private site and Mayo noted that Bob

[7] Copies can be obtained from CCS and are available (?) on their website (if so include link).

Bowman has developed the CCS web site; numerous participants expressed appreciation for his efforts, and agreed that the site was well designed and extremely useful.

Morin described a training video developed for the Coast Guard, and Hughes indicated that the Coast Guard might be able to incorporate this into their regular training schedule. Suggestions were also made as to the value in CCS personnel attending Coast Guard training exercises.

CCS also distributes information packets to over 500 mariners. Despite apparent lack of interest at certain trade fairs etc., Johnson and other stressed the value in participating at such events. It was pointed out that even the presence of a ‘stand’ can remind mariners of the importance of the issue. The need for scientists to engage in informal discussions with individuals was stressed; this should not comprise ‘lecturing’ but rather listening and discussion. Perceived arrogance by scientists is a recurring problem in developing co-operative relationships with professional mariners and fishermen.

Johnson reported from her surveys that there are many misconceptions about entanglements among the public, and also among individuals who as members of animal welfare organizations, Take Reduction Teams and the like, are potentially in a position to directly influence public policy on this issue. Finding ways to correct these misconceptions, identifying a forum in which to present accurate educational information, is potentially important to the disentanglement program and other whale-fisheries issues.

It was also noted that following up entanglement reports by communicating outcome or other information to reporting individuals is usually much appreciated and should be routinely undertaken.

C. Cooperation with fishermen

It was accepted by all participants that fishermen have much to contribute to this issue at all stages of the process:

(1) in observing and reporting disentangled animals;

(2) in standing by until disentanglement teams can reach the animal;

(3) in participating in and providing advice and help to disentanglement events;

(4) in assisting in the development of gear modifications.

An outreach program to fishermen has existed for some time, including training many individuals as Level 1 responders. However, several participants noted the reduced cooperation from fishermen in recent years. Johnson believed that it was not that fewer fishermen were reporting because they believed they would suffer legal repercussions from the particular entanglement; but rather it was because of wider issues related to entanglement-related restrictions of fishing, such as reporting of whales leading to dynamic fisheries closures (DAM). Many participants agreed and felt that this situation was not likely to improve in the current regulatory environment. In particular, they noted that the present implementation of DAMs was unlikely to protect right whales but guaranteed to upset fishermen. Clapham commented that this reinforced the need for the agency to concentrate heavily on gear modification research as a way of potentially reducing or eliminating entanglement risk while preserving fishermen’s livelihood. He noted that even if many fishermen become trained in disentanglement techniques, it will not solve the overall problem since most entanglements are not observed at the time they occur and most whales swim off with gear; thus, right whale entanglement rates will likely remain high relative to population size.

Johnson agreed, but commented that involving fishermen in disentanglements is a very good publicity exercise which potentially translates into goodwill in other areas.

The importance of the need for dialogue and the avoidance of ‘arrogance’ was again stressed. The identification of ‘key’ individual fishermen who are interested and can influence other members of the fishing community is extremely important as witnessed by the work of Mackie Greene in the Bay of Fundy.

Makcie noted a recent incident in which a fisherman was denied permission by NMFS to disentangle a whale in his own gear, and asked whether this could be changed in future. Rowles responded that dealing with marine mammals in gear was permitted under the Marine Mammal Protection Act (MMPA), but not for endangered species under the Endangered Species Act (ESA). Moore questioned whether it was possible to modify the ESA to permit fishermen to disentangle whales in their own gear.

VII. ADOPTION OF REPORT

The Chair thanked all of the participants for their hard work and co-operation in completing a very full Agenda, as well as NMFS for funding the workshop, Clapham for rapporteuring and Wendland and others for the organization. He suggested that it would be appropriate for the report to be adopted by e-mail. He would work with the rapporteur to complete a draft of the report for review by 2 April. Participants would then have one week to ensure that the comments they made were fairly reflected in the report. Comments should be sent to Jonathan Wendland who would incorporate changes unless he felt they may be controversial; in which case he would consult with the Chair and rapporteur. He hoped that the report would be a valuable reference document and aid NMFS and others in improving and modifying disentanglement efforts throughout the world. He reiterated, however, that disentanglement is not the cure for the problem of North Atlantic right whale conservation. Increased and determined efforts are needed to arrive at eliminating entanglements.

The Workshop thanked the Chair for his efficiency and good humor in ensuring the agenda was completed. They agreed that whenever they saw him in the future they would buy him a large Guinness – but not on Government funds, of course!

Annex A **Workshop Final Agenda:**

Workshop on

The NOAA Fisheries Disentanglement Workshop

Large Whale Disentanglement: Learning from the Past and Moving Toward the Future

Improving large whale disentanglement logistics, techniques, and operations

Boston, Massachusetts March 27-28, 2003

Wyndham Hotel

Background

Entanglement of large whales in fishing gear and other man-made material is a major problem worldwide (Perrin *et al*., 1994). Use of synthetic net and rope, introduced in the middle of the 20^{th} century, together with enhanced fleet and gear mobility, worsens the problem of large whale entanglement (Clapham *et al*., 2002). In the United States, prior to the mid 1980's, entangled large whales were primarily seen on the east coast by fishermen tending their gear. These observations were occasionally reported to authorities who in turn notified a local volunteer stranding organization. Often the volunteer network was ill equipped to safely handle the rescues, especially those involving entangled, free-swimming large whales. The entanglement problem slowly became more widely known as a few species (minke, humpback, and the northern right whale) washed ashore dead in entangling gear. It became apparent to a few researchers that something needed to be done to assist entangled whales. Thus, in 1984, in an effort to improve the success rates of large whale disentanglements, researchers from the Center for Coastal Studies (CCS) began a pilot program focused on how to safely rescue large whales from entanglements.

Over the next decade CCS and its cooperators continued working on the development of its program to safely disentangle both anchored and free-swimming large whales. In 1995 the National Marine Fisheries Service (NOAA Fisheries) entered into its first contract with CCS to disentangle large whales. Over the years much progress has been made in large whale disentanglement methods and techniques and the Disentanglement Network has grown to include coverage along the entire U.S. East Coast and Canada. Currently, the "East Coast Disentanglement Network" consists of more than 500 civilian, governmental, and voluntary members. Most Disentanglement Network members are trained "first responders" located in strategic locations along the U.S. East Coast including feeding and calving grounds, and/or other areas historically known to have large whale entanglements. Extensive dedicated rescue programs exist only in eastern U.S. and eastern Canada (primarily Newfoundland); however disentanglements of large whales have been attempted on an occasional basis in several other places in the world, from Oman to New Zealand (Clapham *et al*., 2002).

Introduction

Interactions between fishing gear and large whales can result in the entanglement of these animals. The priority of the NOAA Fisheries is to implement fishery management measures that reduce the potential for entanglement. The goal is to eventually prevent all entanglements. In the meantime, there will be some level of entanglements on an annual basis. Disentanglement provides an opportunity to potentially prevent serious injury or mortality of entangled large whales. This is a valuable mitigation measure, particularly for critically endangered species, such as

North Atlantic right whales, where every possible measure to prevent serious injury and mortality must be pursued. It is important to note that this tool is of limited utility because it does not prevent entanglements and is only useful in certain circumstances when animals are observed and able to be disentangled. However, despite these acknowledged limitations, it is still crucial to make all efforts to ensure that disentanglement is as effective a tool as possible.

AGENDA

Objective:

The objective of this workshop is to identify potential improvements in logistics, techniques, and operations of large whale disentanglement to safely increase the release rate and survival of entangled large whales. Discussions occurring during the course of the workshop have the goal of obtaining the views of individual participants. NOAA Fisheries does not seek to develop consensus advice from workshop participants as a group.

March 27th

0900 Welcoming Remarks:

Moderator Introduced: Greg Donovan, Head of Science, IWC

0930 Opening Presentation: David Mattila, Science and Rescue Coordinator

Hawaiian Islands Humpback Whale National Marine Sanctuary, and former Director of Disentanglement Program, Center for Coastal Studies

Overview of Large Whale Disentanglement

a) Types of large whale entanglements
b) Difficulties encountered in the past
    i. First response and standing by
    ii. Getting to the whale
    iii. On scene with the whale
    iv. Techniques of disentangling
c) Human safety, experience and training (top priority to be addressed at the end of the workshop)

Session I First Response and Standing By

Objective: *Identify strategies to improve initial response to reports of entangled whales and increase probability that initial reporter stands by.*

Topic A: Initial Response

1. Identify past difficulties
    a. Few stand by
    b. Delayed back up

c. Poor environmental conditions (weather, sea state, daylight)
d. Resource constraints
e. Slow reaction time and plan development (NOAA Fisheries, Coast Guard, Disentanglement Crew)
f. Communication problems including cross communications aerial, vessel, ground
g. Quality of on scene assessment
h. Conflicts for whale watching industry

Discuss potential solutions*

Session II Getting to the Whale

Objective: *Highlight the difficulties of getting to entangled whales and identify improvements to existing strategies and/or new strategies.*

Topic A: Improve Speed and Range of Response

1. Identify past difficulties
   a. Resource limitations
      i Vessel type and availability
      ii. Plane type and availability
   b. Insurance restrictions regarding range of vessels
   c. Environmental conditions
   d. Poor communications

Discuss potential solutions*

Session III On Scene with the Whale

Objective: *Identify improvements to existing assessment, monitoring, and restraint strategies and identify potential new strategies.*

Presentation: Dr. Michael Moore, Research Specialist, WHOI

Synopsis of last disentanglement technologies workshop

Topic A: Improve Assessment Techniques for Determining the Condition/Health of the Whale and the Severity of the Entanglement

1. Whale condition

*All comments/potential solutions must be submitted by individual participants. Group consensus advice cannot be accepted.

a. Identify the key elements for assessing an entangled whale's health and condition
b. Identify past difficulties encountered in condition assessments
    i. Difficulties with eyewitness accounts
    ii. Quality of photo documentation
c. Discuss potential improvements for assessing whale condition*

2. Severity of entanglement
    a. Identify the key elements for assessing the nature of the entanglement
    b. Identify past difficulties with entanglement assessments
    c. Discuss potential improvements for assessing the entanglement*
    d.

3. Whale safety
    a. Discuss importance of veterinarian perspectives in action plan development*

Topic B: Improve Entanglement Monitoring Strategies (Pre, During, and Post Rescue)

1. Identify entanglement monitoring strategies
    a. Survey techniques (aerial and vessel), Search and relocate
    b. Photo documentation (discrete and in a time series)
    c. Tagging
    d. Notice to mariners and reports from boaters

    Discuss potential improvements for entanglement monitoring strategies*

Topic C: Restraining the Whale for Disentanglement

1. Review existing types of restraints
    a. Physical
        i. Kegging
            Control line
            Tail harness
    b. Chemical
        ii. Sedation

2. Review failures and successes of existing restraints

3. Identify potential improvements for existing restraints and ideas for new restraints*

Topic D: Documentation and Public Outreach

1. Review reporting data
    a. Complete standardized report forms and enter information into relational database/
    b. A narrative with photographs and drawings (when available) is produced. The web site (http://www.coastalstudies.org/entanglementupdate/entanglement~update.htm)

acts as the principal repository for narrative reports.

2. Review current documentation to support scar analysis and monitoring efforts of right whales.
   a. Document entanglements with above and below water images.
   b. Debrief NOAA Fisheries about gear removed from animals (gear is turned over to NOAA Fisheries for documentation purposes).
   c. Provide NEAQ with documentation about individual right whales to be included in right whale catalog (maintained at NEAQ).
   d. Provide humpback whale documentation to Gulf of Maine humpback whale catalog (maintained at CCS).

3. Review areas of public outreach
   a. Internet public (www.coastalstudies.org)
   b. Private web site
   c. Fish Expos
   d. U.S. Coast Guard Seminars
   e. Electronic Newsletter
   f. Information packets
      i) Annual information packets to over 500 mariners
   g. Unplanned events
      i) Fisheries associations
      ii) NEIT
      iii) State Marine Patrols etc.

March 28th

0830 **Presentation**: Harry Brower Jr., Invited Hunter
Behavior of bowhead whales during hunts along coastal northern Alaska

Session IV Techniques of Disentangling

Objective: *Highlight existing disentanglement techniques and identify new techniques to improve release rate of entangled large whales.*

Topic A: Approaching Entangled Large Whales

1. Identify and discuss different types of approaches*
   a. Entangled/wounded whale behavior
   b. The element of surprise and the importance of the first approach
   c. Actual approaches
      i. "On the fly"
      ii. Approach from behind and just outside of the danger zone

2. Discuss potential improvements for approaches or new strategies for approaching entangled whales*

Topic B: Disentanglement Tools

1. Review existing disentanglement tools and discuss potential improvements and innovations*

Session V. Human Safety, Experience, and Training

Objective: *Highlight existing safety, experience, and training strategies for large whale disentanglement and identify improvements and/or potential new strategies.*

Topic A: Ensuring Safety of Rescuers During a Disentanglement Effort

1. Review existing safety procedures

2. Identify potential improvements for existing safety procedures*

Topic B: Experience Levels for Disentanglers

1. Identify criteria to define level of experience

2. Identify potential improvements for defining experience levels*

Topic C: How to Train Present and Future Disentanglers

1. Identify existing training strategies
   a. Simulations
   b. Mock tail
   c. Observing
   d. Hands on (i.e., Apprenticeship Program)

2. Identify past difficulties with existing training strategies

3. Identify potential improvement to existing training strategies and/or new training strategies*

Annex B **List of Attendees:**

Allen	Ben	Participant
Borrelli	Peter	Observer
Brown	Moira	Participant
Clapham	Phil	Participant
Conger	Lisa	Observer
Conway	Jerry	Participant
Dodge/Dwyer	Kara	Observer
Donovan	Greg	Chair
George	Craig	Participant
Gouveia	Dave	Observer
Greene	Macky	Participant
Hartley	Dana	Participant
Higgins	John	Participant
Huges	Wade	Participant
Jensen	Aleria	Observer
Johnson	Tora	Participant
Kenney	John	Participant
Knowlton	Amy	Participant
Kraus	Scott	Participant
Landry	Scott	Observer
Ledwell	Wayne	Participant
Ludwig	Laura	Observer
Lyman	Ed	Participant
Mase	Blair	Observer
Mattila	Dave	Participant
Mayo	Stormy	Participant
McLellan	Bill	Participant
McKiernan	Dan	Participant
Moore	Michael	Participant
Morin	Dave	Participant
Newton	Craig	Participant
O’Hara	Todd	Participant
Rowles	Teri	Participant

Schneider	Michael	Observer
Slay	Chris	Participant
Smith	Jamie	Observer
Todd	Sean	Participant
Wendland	Jonathan	Observer
Zoodsma	Barb	Participant

REPORT OF THE INTERSESSIONAL WORKING GROUP ON LARGE WHALE ENTANGLEMENT

Members: Clapham (Chair), Berggren, Leaper, Mattila, Robbins. [Also participating: P. Hamilton, W. Ledwell, J. Lien, C. Mayo, G. Salvador and S. Todd.]

The following information has been extracted from SC/54/BC2.

The Working Group was convened in response to Resolution 2001-4 (IWC, 2002) viz that the Commission:

> REQUESTS the Scientific Committee to provide to the 54th Annual Meeting of the Commission a summary of its work in recent years on the most feasible methods to mitigate the incidental capture of large cetaceans in fishing gear, and ways in which entangled large cetaceans may be removed from fishing gear with minimal risk to rescuers.

INTRODUCTION

Entanglement in fishing gear of cetaceans and other wildlife is a major problem worldwide (Perrin *et al*., 1994). The introduction of synthetic net and rope in the middle of the 20th century, together with enhanced fleet and gear mobility, greatly exacerbated this problem. Entanglement may be a serious factor affecting the recovery of small populations. For example, it is known to be a significant source of mortality among the critically endangered North Atlantic right whale (*Eubalaena glacialis*), whose failure to recover is largely attributable to anthropogenic impacts (IWC, 2001, pp.33-35; Knowlton and Kraus, 2001). There is also evidence from scarification data that the reproductive success of female humpback whales (*Megaptera novaeangliae*) is negatively impacted by a history of entanglement (Robbins and Mattila, 2001).

Concerns have also been expressed about the status of the minke whale stock in the Sea of Japan due to the levels of fisheries bycatch (Baker *et al*., 2000).

Several types of fishing gear are involved in entanglement. These include a number of different types of gillnet fisheries and trap fisheries (e.g. for crab and lobster) involving bottom-set gear marked by surface floats. In the North Atlantic, at least, these are probably the two single-largest types of fishery involved in entangling whales. In Japan and Korea, set or trap net fisheries have the highest reported levels of large whale entanglement. Fishing weirs, seines, trawls, long line, scallop cable and other gear have also been implicated in some cases. Fixed or anchored gear of almost any type represents a major entanglement threat; this can also include gear used for non-fishing purposes, such as shark exclusion nets off beaches.

Any part of the trap and gillnet gear can be involved in a serious (life-threatening) entanglement (Clapham, pers. comm.). This includes the groundline (the line between each trap or between the net and the anchors), the endline (the line going from the end of the string of traps or net panels to the surface), and the buoyline (the end section of the endline which terminates in one or more buoys at the surface). Fig. 1 shows a diagram of a typical set-up for trap gear and gillnet. Furthermore, many parts of an animal's body can be involved in the entrapment. This includes the mouth, head, flippers, peduncle and tail.

[Fig. 1 here]

Disentanglements of large whales have been attempted on an occasional basis in several places in the world, from Oman to New Zealand. Extensive dedicated rescue programmes are in place only in eastern Canada (primarily Newfoundland), as well as in the Gulf of Maine and elsewhere on the US east coast; these programmes have undoubtedly reduced large whale mortalities in the areas concerned. Canadian disentanglements began in the 1970s, while the US programme was started in 1984; these efforts are led by Memorial University (St John's, Newfoundland) and the Center for Coastal Studies (Provincetown, Massachusetts), respectively. It is recommended that anyone with a serious interest in establishing a disentanglement programme elsewhere in the world contact both of these institutions for advice, since they have freed well over a thousand large whales from entanglements in various types of gear.

The Natal Sharks Board in South Africa has also developed specialist whale rescue teams to assist in releasing whales from shark nets. These teams have been successful in releasing approximately 80% of entangled baleen whales alive (Peddemors, 2001). Another disentanglement network has been established in West Australia.

Attempts to establish disentanglement programmes also need to take into account the legal implications of the regulations regarding cetaceans for each country. In countries where there is a market for cetacean products, education programmes to enable fishermen to identify protected species (which should be released alive if possible) may also be required.

Because of the considerable experience with this problem in eastern North America, this document briefly reviews entanglements in this region, with an emphasis on methods of disentangling large whales. It should be noted, however, that some members of the Working Group were concerned that producing a 'manual' for whale disentanglement would encourage inexperienced individuals to undertake this work, at considerable risk to themselves. The Group noted that it is very difficult to 'teach' disentanglement without providing hands-on experience. Consequently, this report is written with these major caveats in mind.

ENTANGLEMENT: RATES AND MORTALITIES

Entanglement of large whales in fishing gear is a major problem on the eastern seaboard of the United States. In particular, entanglement affects humpback whales and North Atlantic right whales. Other species are also observed entangled to a lesser extent, including minke whales (*Balaenoptera acutorostrata*), fin whales (*B. physalus*) and blue whales (*B. musculus*).

Off Newfoundland, humpback and minke whales are the two species most often involved in entanglements. However, over the past several decades a total of 11 different species have been entrapped and released from fishing gear. Between 1978 and 2000, approximately 1,150 reports of entangled whales were received by Memorial University. Prior to 1990 most entanglements of humpback and minke whales were in cod traps (47%). Groundfish gillnets entrapped 37% of reported humpback entanglements and 30% of minke whales (Lien *et al*., 1990). The nature of the Newfoundland fishing industry has changed since the collapse of groundfish fisheries in the early 1990s. Effort has been dramatically reduced through reducing the number of fishermen, fish quotas and fishing seasons and continuing moratoria on groundfish stocks. The industry has changed focus from traditional small boats under 35 feet in length that used fixed fishing gear near shore to bigger offshore boats that fish snow crab and turbot to the 200 n.mile limit and beyond. There are now approximately 10,000 fishermen registered in Newfoundland holding a variety of licenses. Because of reduced quota, few cod traps have been fished since the early 1990s and almost all inshore entrapments occur in gillnets. However, an entrapment problem is emerging with the offshore fleet. Throughout the 1990s reports in offshore turbot and crab gear have been increasing.

Two studies have used photographic documentation of entanglement scars on the bodies of live whales to estimate the rate at which whales become entangled. Robbins and Mattila (2001) estimated from scarring around the caudal peduncle that at least 71% of humpback whales in a sample of 99 animals from the Gulf of Maine had been entangled at one time or another, and that, on average, between 10% and 31% of the population had such encounters each year. Using similar methods, Hamilton *et al.* (1998) estimated that 61.6% of the North Atlantic right whale population has been entangled in fishing gear. A subsequent study by Knowlton *et al.* (2001) indicates that between 10% and 28% of the right whale population contacts fishing gear each year (a remarkably similar percentage to that from the humpback whale study). Both studies found that while juvenile whales were significantly more likely than adults to become entangled, animals from the latter age class were also susceptible to such events.

Entanglements vary in severity from trivial to lethal. Mortality due to entrapment may vary by species. In Newfoundland, mortality of reported entrapments was 16% in humpbacks but 70% in minke whales (Lien, 1994). Robbins and Mattila (2001) estimated from scarring data that 1% to 3% of humpback whale entanglements in the Gulf of Maine were severe; however, the mortality rate from entanglement is unclear, since studies of this type can observe only surviving whales. It is apparent from the scarring data that, in many cases, humpback and right whales become only briefly entangled in line or other gear which is quickly shed, leaving minor rope scars. For large whales, it is likely that many entanglements are not immediately fatal, since the animals are often powerful enough to carry large amounts of gear away with them. In these cases, however, the ability of the whales to move and feed may be compromised by the weight of gear, and death may eventually occur months later as a result of starvation. In other cases of severe entanglements, the line or other gear may create a pathway for chronic infection, and this can also lead to the eventual death of the animal.

Some fishing gear (notably that involving long strings of large traps) is heavy enough to render an entangled whale immobile, and if the entanglement occurs below the surface, death will inevitably result. This has been frequently observed off eastern Canada, where significant numbers of humpback and minke whales have been killed by such entanglements.

DISENTANGLEMENT

General approach and caveats

First and foremost, it is absolutely critical to recognise that disentangling large whales from fishing gear is a dangerous task that should never be undertaken lightly or by inexperienced individuals.

Whales are very large, powerful animals. Errors in judgment on the part of either the whales or the people attempting to help them can result in serious injury or death. In recent years, the press has reported several incidents in which well-intentioned but inexperienced individuals have attempted to remove fishing gear from humpback whales, notably by getting into the water with the animal concerned. That no one has yet died from such an encounter is more a matter of good fortune than anything else.

Anyone attempting to disentangle a large whale should, at a minimum, possess great seamanship skills and common sense. Indeed, seamanship - which includes the ability to safely handle lines and other equipment, as well as the boats being used - is equally important in whale rescue as experience with whale behaviour. With appropriate care and knowledge of some of the techniques outlined below, competent fishermen can successfully disentangle whales of some species as long as they attempt this with caution and common sense. However, having some knowledge of whale behaviour is obviously desirable in such situations.

Before any attempt is made to disentangle a whale, an objective assessment should be made of the seriousness of the entanglement. It is important to realise that not all entanglements are serious. Attempting to free a whale from an entanglement that is not life-threatening is unnecessary and potentially dangerous - the more so because the whale is likely to be stronger and healthier than an animal that has been involved in a protracted and serious entanglement event. ‘Non life-threatening’ is not always easy to define in the field, but broadly includes entanglements involving simple, non-constricting wraps of line or net that do not appear to pose an infection risk and which are not accompanied by a quantity of heavy trailing gear.

Other factors to consider in such an assessment include the age (relative size) of the animal (e.g. the potential for it to grow into a loose wrap of gear); where the gear is on the animal (considering the relative risk to rescuers versus the risk of the process making the situation worse); and - even if the gear is not heavy - does the existing gear pose a significant threat to further entanglement, either on another body part or in other gear that the whale may swim through.

If, in the best judgment of the individuals on the scene, the entanglement is not serious, no attempt should be made to remove the gear. Such attempts represent too great a risk to the people (and the whale) involved, for no good reason.

The reactions of whales to rescue efforts vary considerably by species. When properly dealt with, humpback whales can be relatively tractable, particularly if they have been the victim of a prolonged entanglement and are thus tired or otherwise in sub-standard physical condition. Considerable experience with this species off the eastern coast of North America has indicated that most humpbacks are unlikely to react to rescue efforts with overt aggression and evasion; however, some animals have proven to be exceptions to this. Minke whales are always evasive. However, any animal of this size, no matter how docile it may seem, has the potential to inadvertently kill or injure a human being; a startled whale may thrash or make some other sudden unexpected movement of the tail, flippers or head, and the sheer size of the moving body part involved represents a serious danger to anyone in close proximity to the whale.

Some other species may not be as cooperative as humpback whales. Experience has shown that right whales often respond with considerable aggression to disentanglement attempts; this behaviour, together with the fact that right whales are much more powerful than most other mysticetes, makes this species particularly dangerous for potential rescuers. Indeed, in one case in the Gulf of Maine in 2001, a disentanglement team from the Center for Coastal Studies would not consider a rescue attempt on an adult male right whale unless the animal was sedated[1].

It is strongly recommended that, where possible, potential rescuers wear appropriate protective gear. This includes a helmet (a US football helmet with the face guard removed is a good option) and a life jacket; immersion suits (e.g. those manufactured by *Mustang* or *Stearns*) provide both flotation and protection from cold. In addition, the individuals concerned as well as the rescue boat should be as free as possible of any non-essential gear that could become entangled in a line. They should also carry with them a small closed knife (such as a parachute knife) attached to their body with a lanyard capable of extending to arm's length; this would be used to cut oneself free of gear in an emergency situation.

Many individuals involved in disentanglement strongly advise against getting into the water with an entangled whale under almost any circumstances, and note that no whale is worth the risk involved in such a scenario. The potential for a diver to become entangled in the fishing gear on the animal is very real, with obvious fatal consequences should the whale decide to dive.

Whenever possible, the vessel involved in the disentanglement operation should be accompanied by a second, standby boat. This is very important for safety reasons, and in case additional assistance is required.

Approaches to disentanglement

Anyone reporting an entanglement should be encouraged to stand by the animal concerned if this is possible. Many entangled whales cannot be freed because their location is not monitored after the initial report, and the whale is lost.

Methods of disentangling large whales depend in part on the type of entanglement, notably on whether the whale is stationary or free-swimming. In the Gulf of Maine, most entangled whales fall into the latter category; off Newfoundland, there have been many cases of whales which were essentially anchored in gear. In Newfoundland if a whale is freely swimming the first step in any rescue effort is to stop the whale. This has been done by attaching additional ropes to entangling lines on the animal and attaching them to a large vessel. When assistance was not available from a large vessel, depending on the bottom characteristics, an anchor was used. Other techniques for dealing with free-swimming whales are described in a separate section below. General approaches to disentanglement are given here.

Many entanglements involve the mouth of the animal. In mysticetes, line tangled in the baleen is quite common; while this is sometimes pulled through the baleen from the drag of the trailing line or other attached gear, this process may be arrested by knots, floats or some other obstruction on the line.

Tight wraps of line or net around an appendage are also very common. These presumably result from the whale rolling as a reaction to the initial entanglement, with constriction effected by the weight of attached gear. For example, a whale becoming entangled in a floating loop of groundline between lobster traps may well cause the line to wrap around the flipper; the considerable weight of the traps on either side will then cinch the line tightly around the appendage, in many cases embedding it into the tissue.

Approach, assessment and cutting the gear

Entangled whales should be approached slowly and carefully so as not to startle them. Moving down from the whale's head (where it can more easily see the boat when the latter initially gets close) may be a better strategy with some animals than approaching from behind, but this will vary with the whale. Use of a small but stable vessel (e.g. an inflatable boat) which is low to the water is helpful since it allows easier access to the animal. Inflatable boats are less likely to be damaged if a whale lashes out in a startle response, and the lack of a keel on these and some other vessels is useful in cases where a whale comes up under the boat. Inflatables are also easily towed behind a whale when attached to the gear, and they appear to minimise startle reactions relative to other types of boat.

Initial approach to the whale should not be directly behind until the extent of any trailing gear has been determined; the driver of the vessel should be continually vigilant to ensure that there is no possibility of a line becoming entangled in the propeller(s). Furthermore, if an outboard engine is being used, the driver should be constantly aware of what is happening and be ready to release and immediately pull up the engine out of the water at any moment; again, this is to prevent any line from becoming entangled in the propeller or shaft housing. Lightweight engines are preferable in this regard. Rescuers in Canada consider it essential that a haul-back line is available, attached to a nearby boat or anchor, which can be used to quickly move the rescue boat back away from the whale if it becomes aggressive or active.

An initial assessment of the entrapment is essential. Determining exactly how the animal is trapped will allow the release crew to plan a release strategy. This phase of a release effort was particularly important in Newfoundland as fishermen cooperated with the release programme because a skilled release of the entrapped whale would save their fishing gear. To do this, precisely placed cutting had to be based on good information. Hence, a good survey around the whale with a mask and snorkel while leaning over the side of the boat is an important first step. It is very useful to have a second person monitoring and even sometimes holding onto the individual engaged in the assessment or cutting, especially if these actions require the latter to lean out of the boat.

Randomly cutting gear from a whale is a bad idea. Removing some net or a few lines without attempting to first determine the full nature of the entanglement may make it more difficult to free the whale completely and may do little to remove those parts of the gear with the potential to kill the animal in the long run. For example, if a whale is dragging a number of heavy traps behind it, cutting the trap line will make it much easier for the whale to swim away, but may leave the animal with line that tightly constricts an appendage (notably the flippers or tail). In this case, the whale may die from infection if the line is not removed - but it will now be much more difficult to disentangle because it has been freed of much of its burden and so can easily 'escape'. Consequently, it is important that rescuers attempt to determine the full nature of the entanglement and plan a strategy before any gear is removed. Aerial photographs, when available, are also a very useful (albeit limited) means of assessing entanglements.

Equipment used in disentanglement is sometimes specially designed, but for the most part consists of items available to any fisherman. These include small sharp knives, a variety of gaffs, and small grappling hooks (thrown to grab onto the gear on a free-swimming whale; see Fig. 2). Knives used in cutting gear can be anything from regular commercially available knives to custom-designed blades (Fig. 3). Any knife used should be extremely sharp, allowing for efficient, rapid cutting; a sharpening device should be carried on board at all times. The Center for Coastal Studies notes that many of the looser lines on a whale can be effectively cut from a short distance away using a semi-circular knife blade welded onto the end of a long aluminum pole. Another variant of this design has the blade being detachable from the pole, and secured with a piece of line, the other end of which is made fast to the boat; in this manner, if a whale is moving, the friction generated by the animal's towing of the vessel should result in the blade cutting through the line.

Tighter wraps of line may not be able to be cut using a pole-mounted knife, and it may be necessary for the rescuers to get right up to the animal and cut the rope (or slip a semi-circular blade beneath it). This is frequently the situation in Newfoundland, where rescue personnel feel that having a whale within 'hand's reach' is usually necessary. In such cases, the rescuers will be touching the animal and in extremely close proximity to it; thus, extreme caution should be exercised at all times. Whales are less likely to startle if all movements and approaches are slow, noise (e.g. banging on the boat) is minimised, and any touching of the animal is done as gently as possible.

With immobile whales, it is important to use buoys on the gear, and especially to buoy off the haul-up rope before it is cut it from the whale; this is to ensure that the fisherman's gear is not lost after the animal has been freed. In some cases this procedure may mean that the gear can be retrieved for later analysis; knowledge of gear type on entangled whales can assist future management policy concerning this issue.

[Figs 2 and 3 here]

Stopping a free-swimming whale

The first issue that arises when dealing with a free-swimming entangled whale is how to stop the animal so that gear can be removed from its body. The Center for Coastal Studies employs a technique which is a modified version of what 19th century Yankee whalers referred to as 'kegging'. Kegging involved attaching barrels or other large buoyant objects to a harpoon line after the whale was struck; these served to not only allow the whalers to better follow the animal when it was below the surface, but also to tire the whale out.

In disentanglement attempts, a line is snapped onto some part of the entangling gear, and large plastic floats are then attached to the line to increase drag. These floats vary in diameter from 50cm to more than a meter, and are usually the heavy-duty type that are used (for example) to mark moorings or gear, or to attach to harpoon lines used in fisheries for swordfish, bluefin tuna and other large game fish. They are attached with quick-release snap hooks, and are prevented from sliding by the presence of knots placed at intervals in the line.

As the whale tires, the floats can be repositioned on the line closer to the animal, which has the effect of further decreasing its mobility. Depending on the size and species of whale involved, the number of floats which are required to slow or stop the whale will vary from a few to more than a dozen. Most humpback whales will eventually tire and 'give up' when sufficient buoyancy has been applied to the line; they will often then remain at the surface, allowing rescuers to approach and cut the gear free. As noted above, however, this relatively placid response should not be taken as inevitable in any whale, and extreme caution should always be exercised in close proximity to the animal. Adult right whales are sometimes capable of towing many floats (and also even moderate sized vessels with engines going full astern); see the caveat above on this species.

Education and community involvement

Whenever possible, it is important to involve local fishermen in efforts to disentangle whales. There are several reasons for this. Fishermen are the individuals most likely to encounter an entanglement and to be able to respond to it. They are also usually far more skilled in seamanship and the practicalities of dealing with gear and lines than any whale biologist. In addition, they can often serve as the safety boat which stands by the primary disentanglement operation. Finally, fishermen are much more likely to become involved in freeing whales if they are taught how to do this themselves, rather than having to rely on others (who frequently will not be able to get to the location concerned in a timely fashion). A long-term campaign to involve fishermen in disentanglements in Newfoundland waters has been very successful, and has resulted in the survival of many whales in that area.

Community involvement is also important in the reporting of entanglements. Fishermen and whalewatching vessels have been particularly good sources of such reports off the eastern coast of North America. Creating an expanded reporting network is highly desirable; the scarring study by Robbins and Mattila (2001) suggested that only about 3% of entanglements in the Gulf of Maine were reported, despite the existence of a reasonably well-developed entanglement network in this region.

Finally, some countries (such as the USA) have laws which prohibit individuals from working with marine mammals without a permit. Anyone who becomes involved in a disentanglement programme should be aware of these regulations beforehand.

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[FOOTNOTE]

[1] This right whale had thick rope deeply embedded in the rostrum, presumably as a result of rolling after contacting a ground line from offshore trap gear. The rope created a pathway for chronic infection and the animal's condition deteriorated over the summer. Sedation was then successfully applied repeatedly over several attempts, in increasing doses, with only minimal observed effect at the

highest dose. Unfortunately, the disentanglement efforts failed and there is no doubt that the whale is now dead. It should be noted that sedation of whales remains a largely undeveloped technique, and its use is not generally recommended at this time.

[FIGURE LEGENDS]

Fig. 1. Diagram of typical lobster pot gear (above) and gillnet (below). Whales typically become entangled in the ground lines between traps, the anchor lines, the endline (to the surface) or (in a gillnet) the net panels themselves. Graphics courtesy of the Center for Coastal Studies.

Fig. 2. Grappling tools and quick-release snap hooks. Photo: Center for Coastal Studies, http://www.coastalstudies.org.

Fig. 3. Knives and other cutting tools used in disentanglement. Photo: Center for Coastal Studies, http://www.coastalstudies.org.

Annex D Resource Limitations - Outline

Participants:

Moira Brown, Dana Hartley, John Kenney, Ed Lyman, Blair Mase, Bill McLellan, David Morin, Jamie Smith, Sean Todd, Barb Zoodsma

In regard to disentanglement, resource limitations is a broad topic with many concerns; however, this working group believes focus is possible by prioritizing the following:

Species

Distribution (animals and gear)

Reporting effort/ capability

By prioritizing limited resources based on the species involved, distribution of animals and gear, and reporting effort the working group essentially focused on entanglement hotspots (SE, MidAtl, CCB, GSC, BOF) and came up with the following outline, much of which was included under the workshop agenda:

I. Personnel

A. Increase number of level 4 responders at CCS and overall network

B. Increase number of level 2 and 3s (especially around new level 4 personnel) to establish viable teams and coverage.
* Bill McLennan expressed particular concern for the Hatteras region.

C. With increase in staff,
1. Stage personnel (CCS, others) at hotspots (i.e. BOF)
2. Increase CCS ability to respond to remote events
3. Increase training capability

D. Staff (at least at higher levels) should be:
1. Dedicated to effort
2. Fulltime
3. Regularly trained
4. Have general and specific skill sets (i.e. photo ID, whale beh.)
5. Compensated. Some examples included:
    a. Salary

b. Retainers

c. Contractual

d. By event

E. Continue use/ involvement of fishermen

II. Platforms (Increase overall numbers and capability)

A. Vessels

1. Make better use of available fishing vessels at key locations.

a. Chartering

b. Retainership

2. Revisit use of federal (USCG) / state (Marine patrols, DNRs) vessels.

3. Offshore capability

a. USCG – as above

b. CCS - acquisition of new rapid response, offshore vessel

B. Aerial

* Have shown their worth in the disentanglement effort both in terms of finding entangled whales and supporting disentanglement efforts.

1. Retainership of aerial platforms in key locations

2. Increase pool of available aircraft (Minimum requirements for aircraft and pilots such as those used in existing aerial surveys need to be met).

III. Equipment

* Expressed need for additional equipment, especially in Hatteras region, however staffing issues take priority.

IV. Insurance/ liability:

* Applies to all of the above.

A. Personnel (how will they be covered?)

1. Individual institutions?
2. Under MMPA?
3. Under permit holder?

B. Vessels

1. Inhouse policies vs. those stipulated by insurance companies
2. Coast Guard inspected to ease restrictions

Annex E **Right whale approaches to <500 yards**

July 29, 1998

Chistopher Mantzaris
Assistant Regional Administrator
For Protected Resources
National Marine Fisheries Service
1 Blackburn Drive
Gloucester, MA 01930

Dear Chris,

This letter is a formal request to improve the NMFS data gathering capabilities of the right whale alerts currently issued through the Early Warning System Program. Given our recent experience (described below), it is essential that the data gathering capabilities be expanded beyond the government conducted or contracted programs. As you know, right whales are uncommon in the southern Gulf of Maine and Massachusetts waters during the summer and fall; however, every year there are occasional reports of right whales that appear to be transiting state waters. Two of these chance sightings in the last two summers were whales entangled in gear that resulted in successful disentanglements by the Center for Coastal Studies under contract to NMFS. In both these cases the whales were carrying gear for considerable time and distance with no evidence of the entanglement occurring in state waters.

The Commonwealth believes all off-season (summer and fall months) right whale sightings should be thoroughly documented, and their presence monitored to the degree possible. The documentation should include 1) photographs to determine if it is entangled, and if possible 2) to identify the individual through the New England Aquarium right whale catalog to determine if it ever was entangled or injured for other reasons (e.g. ship strike). Furthermore, any mother/calf pairs should be monitored given their vulnerability and biological importance.

DMF's Conservation Plan included two components: an in-season, intensive at-sea and aerial surveillance program, as well as a contingency-based plan to deploy CCS under contract to investigate right whale sightings in state waters and adjacent waters, if warranted. DMF is prepared to take considerable actions if whales take up residence during summer in vulnerable locations of high vessel traffic and fixed gear densities. We envision the need for on-site enforcement patrol activities and possible fixed gear restrictions. Such an event has not occurred since 1986 and does not appear to be likely this season.

We believe that the state surveillance program and our ability to monitor right whale presence would be greatly improved if NMFS would better utilize the whale watch vessels ability to report sightings, and on a limited basis authorize these vessels to approach and photograph whales "for the record" of the right whale catalog at the New England Aquarium. Whale watch vessels have historically provided most off-season records of right whales, but these opportunistic, "out-of-habitat" sightings have declined because of the federal 500-yard rule. Now we can neither depend on these opportunistic sightings to revel whale distribution, nor rely on them to detect entanglements.

We urge you to find a means to restore those lost opportunities to gather critically important data – without disregarding the intent of the 500-yard rule. We recommend that whale watch vessels be given real-time permission by NMFS and/or Coast Guard to approach a whale to document its status, and then be required to move away from the whale.

It is clear that any government program that attempts to launch missions aboard planes or vessels to document or confirm out-of-season sightings (and obtain useful photos) would often be unsuccessful because whales often wander from their original sighting location, and may not be found in the hours and days that it takes to launch a response. Such a program would be expensive, compared to the cost of a program enlisting cooperation of industry that includes many professionals who are long-standing whale advocates.

Last week we had a classic example of the problem caused by the 500-yard rule. There were two right whale sighting events from whale watch boats: a so-called mother / calf pair off Cape Ann on Wednesday and a report of a single animal off Provincetown on Saturday. These two incomplete reports were not supported by any photographs. Without photo-documentation to confirm their identities, these may have been the same animals seen and phot0-documented by CCS off Dennis on Friday, that included the one disentangled, believed to be #2212, seen entangled in the Bay of Fundy last summer. Thanks (in part) to the 500-yard rule we will never know if there wee 5 different right whales or repeat sightings of just two whales.

We urge you to hasten the development of this federal system to grant vessels temporary authority to approach right whales on an as-needed basis to fulfill our goals of monitoring these endangered whales. We urge you to hasten the development of this federal system to grant vessels temporary authority to approach right whales on an as-need basis to fulfill our goals of monitoring these endangered whales. We believe a formal outreach program would improve the program's success where whale watch vessel operators and naturalists would be trained regarding photographic techniques and program protocols.

This action would be prudent and responsible and would undoubtedly contribute to the long-term efforts to save these whales from extinction with minimal risk, cost, or burden to existing government programs. We urge you to take this action as soon as possible to enhance both the state and federal conservation programs.

Sincerely,

Philip G. Coates, Director

Danial J. McKiernan

Coordinator, DMF's Right Whale Surveillance and Monitoring Program

cc:

Secretary Trudy Coxe

Commissioner John Phillips

Dr. Tom French, Division of Fisheries and Wildlife

Assistant Attorney General Sal Giorlandino

Peter Borrelli, Center for Coastal Studies

Doug Beach and Pat Gerrior, NMFS

Annex F **Report of previous disentanglement technology workshop:**

The work report can be found on-line at:
http://www.whoi.edu/science/B/people/mmoore/pdf/Dec14_2001_DisentanglementWorkshopReport.pdf

Large Whale Disentanglement Technology Workshop

Authors:

Michael Moore, Desray Reeb, Carolyn Miller and Dan Smith

Biology Department, Woods Hole Oceanographic Institution, Woods Hole MA 02543

A REPORT OF A WORKSHOP HELD IN WOODS HOLE ON DECEMBER 14^{TH} 2001

THE SECOND IN A SERIES OF WORKSHOPS ON LARGE WHALE MANAGEMENT AT SEA.
Report for the first workshop is available at www.whoi.edu/science/B/people/mmoore

Funded by:

Northeast Consortium

Sponsored by:

Held at:

Carriage House, Quissett Campus,

Woods Hole Oceanographic Institution,

Woods Hole, MA 02543

Friday December 14th 2001

Executive Summary/ Action list

This workshop set out to conceive and plan the necessary technology to improve disentanglement of large whales at sea. The overwhelming message from the presentations and discussions included in this report is of the enormity of the problem and risk facing management of severe entanglements. The need for entanglement avoidance screams out from these pages. The workshop profited from people with a broad diversity of engineering and biological backgrounds around the table. We thank them all for their time and energy.

Three focal areas emerged, each of which could be partially served by an attached multipurpose device. It was christened "***Robocyamid***", after the cyamid lice that adorn the callosities, genital slits and any wounds of all right whales.

Assessment

- Need better aerial images with real time assessment.
- Underwater imaging - a towed body, a boat mount or on a whale-mounted robot.
- AUV's (autonomous underwater vehicles) too slow and expensive for this application. Better to use a boat-based pole to attach device to whale or attached gear. A rope-ascending device may be able to image and maybe cut on arrival at obstructions.
- Onboard data collection to assess sedation: pitch, roll and fluke rate is available in the current Johnson/Nowacek dtag (digital recording tag on suction sups). Need heart rate and video. Could be part of Robocyamid concept.

Restraint

- Need better fluke harness - ? suction cup device to attach to back, allowing lines to fall either side, and then join, to form a fluke loop. On the water CCS workshop in early 2002 in Provincetown MA to test extant technology. Needs a whale tail model that flips from horizontal to vertical, and then testing on a free humpback.
- Net gun system developed by Woodward, Univ. of Maine, could be a promising method for attaching fluke harness
- On board serial drug delivery device – remotely triggered – could be part of Robocyamid package.

Cutter deployment

- Better cantilevered pole cutters.
- Attached cutting device – could be part of Robocyamid package.

In summary there are four areas on the to do list:

1. Better aerial and underwater assessment.
2. Better fluke restraint.
3. A Robocyamid package with assessment, sedation and cutting functions.

4. A rope-ascending device to image and maybe cut flipper and rostrum wraps.

It was also agreed that a contingency fund should exist to allow charter of an offshore platform for multi-day attempts without return to port.

Steering Committee: Michael Moore (Chair), Dan Smith, Richard Arthur, Mark Johnson, Doug Nowacek.

Address for Correspondence: Michael Moore, MS #33 WHOI, Woods Hole MA 02543. E-mail: mmoore@whoi.edu tel: 508 289 3228 fax: 508 457 2134

Attendees:

Richard Arthur	Falmouth	rarthur@cape.com
Andy Billings	WHOI	abillings@whoi.edu
Bob Bowman	CCS	bbowman@acadia.net
Moe Brown	CCS	mbrown@coastalstudies.org
Andrea Brunson	Kurt Salmon	akbrun@kurtsalmon.com
David Brunson	U Wisconsin	brunsond@svm.vetmed.wisc.edu
Marc Costa	CCS	mdcosta@cape.com
Kara Dwyer	NMFS	kara.dwyer@noaa.gov
Al Duester	WHOI	aduester@whoi.edu
Ken Ekstrom	MIT	kekstrom@MIT.EDU
Paul Girard	Buzzards Bay	pirate3200@aol.com
Andy Girard	WHOI	agirard@whoi.edu
Frank Grasso	Marine Biological Laboratory	fgrasso@brooklyn.cuny.edu
Teri Hammar	WHOI	thammar@whoi.edu
Dana Hartley	NMFS	Dana.Hartley@noaa.gov
Mark Johnson	WHOI	marky@bodhi.whoi.edu
Todd Keitel	Datex-Ohmeda	todd.keitel@us.datex-ohmeda.com
Amy Knowlton	NEAq	aknowlton@neaq.org
Bill Lange	WHOI	wlange@whoi.edu
Stormy Mayo	CCS	stormym33@pobox.com
Carolyn Miller	WHOI	cmiller@whoi.edu
Michael Moore	WHOI	mmoore@whoi.edu
Doug Nowacek	WHOI	dnowacek@whoi.edu
Jim Partan	WHOI	jpartan@whoi.edu
Walter Paul	WHOI	wpaul@whoi.edu
Desray Reeb	WHOI	dreeb@whoi.edu
Chris Roman	WHOI	croman@whoi.edu
Hanu Singh	WHOI	hsingh@whoi.edu

Dan Smith	WHOI	dwsmith@whoi.edu
Alex Shorter	WHOI	kshorter@whoi.edu
Dave Wiley	Stellwagen Bank Sanctuary	dwiley@cape.com
Becky Woodward	U Me Orono	woodward_becky@yahoo.com
Dana Baldi	Falmouth	marineconsultants@yahoo.com

CCS: Center for Coastal Studies

WHOI: Woods Hole Oceanographic Institution

NEAq: New England Aquarium

Thanks to the Northeast Consortium for financial support.

Agenda

0900 – 0930	Michael Moore – Welcome, agenda, right whale anatomy and photos of a recent entanglement necropsy
0930 – 1000	Stormy Mayo/ Bob Bowman - Review of some case histories, an overview of current gear and needs, and issues that might be addressed by an autonomous or semi-autonomous disentanglement device
1030 –1130	Mark Johnson/ Walter Paul. - Experience gained from suction cup devices on the backs of large whales. Rope cutting issues. Options for communication between device and vessel, and power supply issues.
1130 – 1200	David Brunson University of Wisconsin - Review of sedation efforts and potential remote deployment
1200 – 1300	Lunch - Becky Woodward – video of whale tail lasso
1300 - 1420	Three working groups 1) Assessment of entanglements – Chris Roman and Bill Lange 2) Restraint – Bob Bowman and David Brunson 3) Cutter deployment – Stormy Mayo and Todd Keitel
1420 – 1520	Bill Lange/ Bob Bowman/ Todd Keitel - Working Group Reports
1520 - 1540	Doug Nowacek - Other data collection options
1540 – 1600	Richard Arthur/ Michael Moore - Wrap up and future plans

BACKGROUND

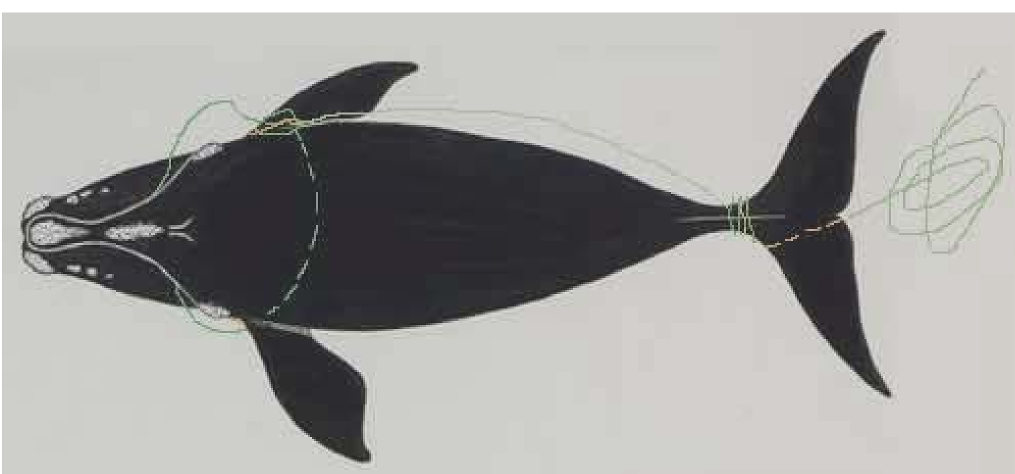
On February 7th 2000 a workshop was held in Woods Hole to discuss the potential for medical intervention in large whales at sea in need of disentanglement. Out of this workshop grew an effort by attendees to develop a sedation system to facilitate refractory disentanglement attempts. The most visible product was the attempts to sedate and disentangle right whale #1102, commonly known as 'Churchill', in the summer of 2001. During these events it became apparent that there was a need for better technology to assess, restrain and release entangled large whales. This current workshop was the result of that need. (Note that 4 digit numbers in this report, such as #1102, refer to right whale ID numbers in the right whale catalog maintained by the New England Aquarium).

The attendees all agreed that it was essential to view this workshop in the prior knowledge that the only genuine solution to the entanglement problem is prevention of entanglement, or at least avoidance of severe entanglements, not disentanglement, but that given the ongoing level of entanglements, and the precarious balance of the northern right whale between species survival and extinction, the workshop had merit in the hopefully short term.

1. Right Whale Anatomy – Moore

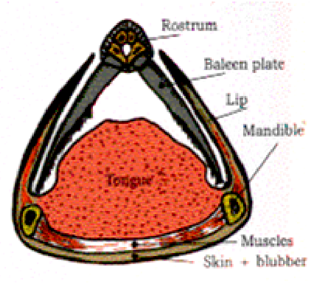
Moore described general right whale surface anatomy and showed slides of entangled right whales, pointing out high risk entanglement sites on the body of right whales: baleen and rostrum, flipper bases, and tail stock. He illustrated the structure of the right whale mouth and blubber coat. He briefly described the cantilevered pole system used for sedation (Mayo et al.), tag deployment (Johnson and Nowacek et al.) and acoustic body condition assessment (Miller and Moore). He then discussed the options to consider in the development of hand-held tools, rope climbers, and possibly AUVs.

The following sketch is of an entangled right whale (#1238) examined dead in the Magdalene Islands, Gulf of St Lawrence November 4th 2001. It illustrates the overall problem with line through the mouth, around flippers and around tail.



Scott Landry – Center for Coastal Studies.

The following sketch illustrates the relevant head anatomy.



Cross section of the head of a right whale.

Sketch, with permission from Pierre-Henry Fontaine, Whales of the North Atlantic 1998, Multimondes, St Foi, QC

The cantilevered pole system laying an acoustic sounder on a right whale

Doug Nowacek - WHOI

2. The Disentanglement Status Quo – Stormy Mayo

Mayo discussed the disentanglement work done at the Center for Coastal Studies, introducing Bob Bowman, Moira Brown and Mark Costa as other members of the rescue team. Assessment is a critical part of rescue efforts, considering not only the present condition of the animal but also the likelihood that the animal may become disentangled over time. Scott Kraus' recent suggestion of building a machine which can assess the condition and state of entanglement of the whales is something which should be seriously considered.

Dave Brunson, Teri Hammar, Teri Rowles and Michael Moore did work on the sedation of Churchill (#1102) about which Stormy was skeptical but the progress was impressive. #1102 was first spotted from the air, East of Cape Cod, 50-60 miles off Nauset Beach. Ropes were seen coming out of his mouth, and a deep cut was noted over the rostrum, which later was found to have a line embedded. His body condition was not emaciated. There was a collaborative effort to disentangle this animal. 9 June 2001 was the first attempt at disentanglement with Bob Bowman's grapple hooks. The best situation is having a trailing line available: cutting this line is not suggested as it leaves nothing to grapple. Two trailing lines were on Churchill. The left side line was the control line and was used throughout the rescue effort. Such a control line may be useful for a grappling/moving/walking robot.

Terry Hammar tested various delivery mechanisms on a carcass that washed up in the summer of 2001. Time is an important consideration and a robot that can go into "sleep mode" may be a good idea – folding arms etc. Telemetry is a great way of tracking these animals and very helpful in the rescue efforts. A single injection system was attempted on #1102, usually with 3 people in the inflatable. Doses are important to consider, Dave Brunson will continue on this topic. Biopsies were taken from #1102, allowing various indicators of health to be examined. The CCS team was able to "wrack back" on the animal to successfully slow it down. Multiple doses with a syringe pressurized with butane, tail harnesses and yokes were also deployed. Attempts at tail harnessing were unsuccessful. By August the animal was emaciated. In spite of these efforts on Sept 16 2001, in 15,000 ft of water, 1102 probably died and sank.

Historical whaling literature states the difficulty of dealing with right whales. Chemical restraint worked surprisingly well and may be a good way to proceed in the future. One of the biggest problems is dealing with the whale itself which usually uses the flukes and causes a very dangerous situation for rescuers – hence the importance of chemical restraint. Characteristics of drugs used so far seem very good.

Mayo then showed a video clip from a camera mounted on the helmet of an operator in a small boat behind a whale – illustrating the 6-8 ft amplitude of the fluke movement. The whale always wants to hit the line with its tail. When the line moved underneath the flukes, 1102 starting slashing at it, which indicates intense sensitivity. Right whales are powerful animals and dangerous to rescuers. #1971, a successful disentanglement was very violent with its flukes after it towed a 41 ft gill netter and a drogue for 6 hours during disentanglement. It would be a great advantage to have a good view of the head, like that provided by the pole cam, to determine where the entanglement is occurring. Possible tools: grapples are great for controlling lines and the cantilevered pole has great potential. The Coast Guard has been very helpful and supportive; NOAA too.

Two problem areas – flipper wraps can be fatal as the rope cuts into the bone. Hard to deal with because they occur about 6' under the water and visibility is bad. Hidden/buried line problem needs a solution – when lines cut into the rostrum and along the body, and disappears, how do you get to them? These lines represent serious contributors to morbidity and mortality. Once again, assessment would help to reveal other unseen lines. It is always best to deal with lines when entanglement initially occurs rather than waiting. The solution ultimately is not disentanglement, but non-entanglement. Although this effort (and workshop) is valuable it is only a stop-gap at CCS, it would be best not to have to do this type of work at all.

Questions

Duester: how deep do they dive?

Brown: 600-700 ft

Duester: how much personal space do they have – i.e. how close can you get with a zodiac?

Mayo: depends on the condition and individual.

Moore: pole work, 40ft pole worked best, 20ft exclusion zone in his opinion.

Brown: definitely depends on individual behavior.

Hartley: is it hard to approach animals in social groups e.g. humpbacks?

Brown: no way of approaching animals in the middle of socially active groups (SAGS). Wiley: if animal's let you within 20-30ft before diving a handheld pole may be better than the cantilevered pole as animal is not in a "fluke slap" position.

Mayo: when an animal is recently entangled it is extremely difficult to approach.

Ekstrom: would it help to "blindfold" the animals? Suction cups?

Mayo: is it possible? They watch us.

Moore: Beamish did this once on a tethered humpback in Newfoundland.

Bowman: applying the cups would be almost as hard as any disentanglement.

Mayo: humpback whales are comparatively easy to work with. They are co-operative with much smaller flukes and are easier to disentangle. They could provide a test-bed for some of the techniques to be used on right whales.

Bowman: ethical issues.

Johnson: is it single lines or lines with net that are causing the problems.

Bowman: recently less nets as less nets are out there, more entanglements by horizontal lines – polypropylene, in between trap lines. 3/8th to 1 inch line, all synthetic. Some gill nets have been found on entangled whales.

Singh: how many cuts would be needed to cut through?

Mayo: assessment is most important, but 3 cuts are generally what is needed. #2030 – would have needed many more, therefore it depends on the type of entanglement in each individual.

Bowman: Calvin, the entanglement was initially determined to be minimal: it was monitored for two months with a telemetry buoy attached to the entangling gear. The animal eventually freed itself, but the nature of the exact entanglement is still unknown.

Singh: device should stay on whale until it finds the rope to cut. Need to find a rope cutting strategy. The difference between getting a vehicle on the whale and being 100ft away from the animal is a million dollar difference in technology cost!

Roman: is all observation made from the surface?

Mayo: yes it is at present, but the animals that we want to get at are the moving and active animals with sub-surface entanglements.

3. Engineering Issues and Options – Mark Johnson

Issues:

1) what are the rope cutting options?

2) How should diagnostic, medical and camera packages be delivered and attached?

3) Options for communications: moving, cutting, information?

Proposed a remotely operated rope cutter. Johnson and Nowacek have used Moore's 40 ft cantilevered pole concept to deliver suction cup tags on right and sperm whales – a 10lb package could be deployed. Delivering and attaching devices to whales aren't too much of a problem, unless skin condition is poor. Suggested a platform on 4 suction cups delivered on the back and repeat deployment until it intersects with a rope. Questioned a remotely controlled cutter with a running blade and a camera attached. This would not be useful for rostrum entanglements and knots. The robot may not necessarily have to move. Simplicity and practicality would be paramount. Johnson then suggested the concept illustrated on the next page.

Questions

Singh: why limited to stationary cutter?

Johnson: does not want to add more technology than is needed.

Bowman: not good for flipper and rostrum entanglements.

Roman: retention time of suction cups?

Johnson: releases as air and water leaks into the cup, may seal it with a suction/vacuum. Don’t want to overdo the pressure – 2 psi are okay on d-tag deployments, but at 5 psi the animal begins to react and does not like anything near the rostrum.

Brown: worst reactions when biopsying from the mid-line on right whales and humpbacks too. They won’t tolerate suction cups less than a meter behind the blowhole.

Singh: can you cycle suction cups on and off?

Keitel: Yes, pneumatically. Can you use squid-like solenoids & pressurized suction cups?

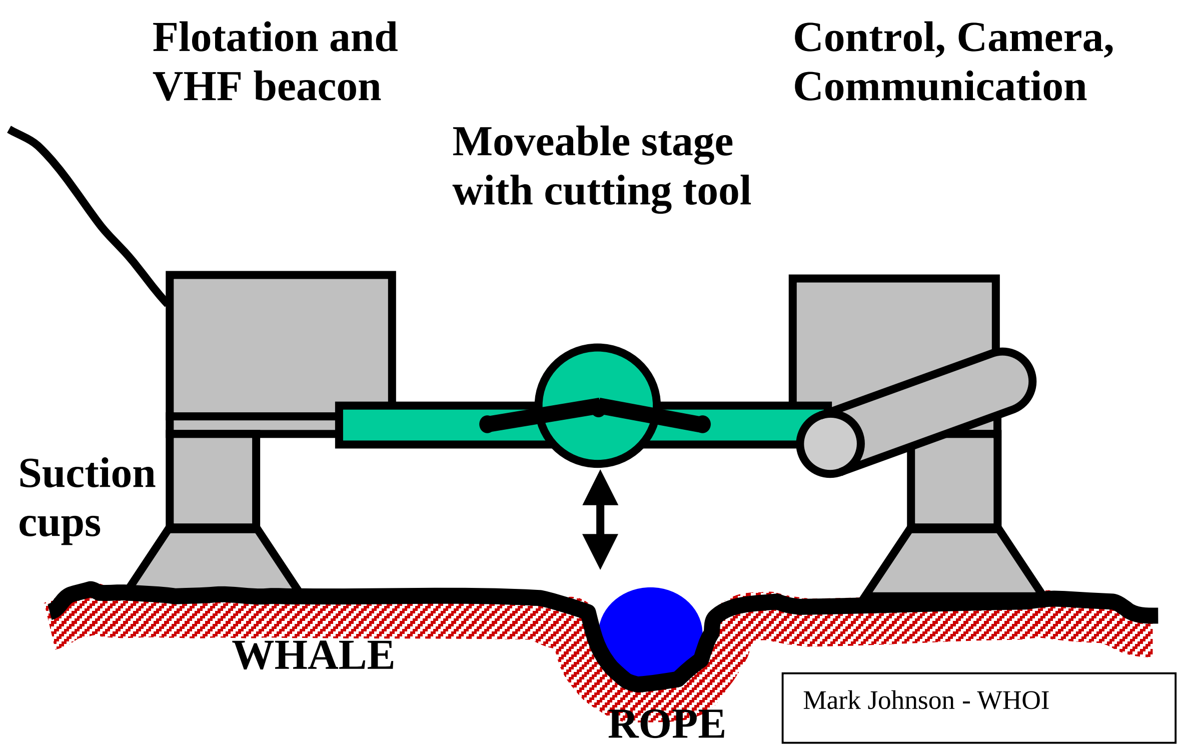
Johnson: Yes.

Keitel: Are there natural stimuli e.g. cyamids that would make the whale less responsive? Johnson: Yes, together with a sedative.

Grasso: octopus type suckers are realizable with existing technologies: they do not require excessive reversible adhesion.

Keitel: keep system as simple as possible: keeping the brain on the boat would be most successful, keep the smarts in the loop. Acoustic coms not practical and antennae are not either, magnetic communications may be an option.

A Remotely-Operated Rope Cutter



Johnson: video over these systems is not possible. A fiberoptic line is not a good idea. A surface float (balloon) attached to something may cause drag on the suction cups.

Roman: how fast do right whales move?

Mayo: right whales move at up to 4-7 knots.

Roman: This is a problem with the AUV community, REMUS is a small submarine, one of the fastest, at with 3-5 knots. First problem is speed. AUV executes its own plan, with very complex content.

Singh: using an AUV is not an option for this, they're expensive, not really as advanced as they need to be. A grappling Crawler with a little camera might do better imaging work. If vehicle is controlled by someone who knows right whale anatomy, they can put the mosaic together and determine very quickly whether the robot is above or below the whale. Relatively easy to do. Some problems, how do you tie the pictures together? Suction, making a mosaic, that is something easily done in a lab setting, independent of biology. Problem with introducing technology across fields, better to keep it with the people who know it. Get the cutter or whatever to a spot where it needs to be, general vicinity is easy – but cutting rope requires dexterity – real-time feed back with images which can make a huge difference. Dollar costs exceeds the average biology budget, this needs to be considered.

Grasso: walker, tracking chemicals in marine environment, maybe have a chemical sensor which can identify wounds that are not detectable otherwise, by seeking chemicals in the boundary layer around the body. Maybe cyamids give off certain chemicals – this could be a diagnostic triage.

Hartley; NMFS tried to diagnose entanglements using thermal imaging, but didn't work. and thermal imaging, but didn't work. However thermal imaging development is progressing quickly. Ann Pabst at the Univ. N. Carolina Wilmington would be a good contact for anyone following up on this issue.

Grasso: chemical sensing may be practical. Can be tuned to particular amino acids and bioactive compounds and will work primarily under water. Can tune it to species specificity.

Bowman: hopefully not working on injured animals, prefer to work on non-injured but initially entangled whales.

Hartley: can it detect bruising?

Grasso: if there are known compounds, it can be worked out.

Moore: cyamids are a potential flag for where the injuries may be occurring – the orange species only spreads from the genital slit in unhealthy or wounded whales.

Bowman: subsurface cyamids, is there an anaerobic environment for these creatures?

Moore: probably not.

Johnson: two problem areas – flipper and rostrum wraps. Rostrum, animal is very sensitive and it's also the worst possible platform to attach a robot to.

Bowman: a good cantilevered pole would work best for the rostrum, but the flipper wraps are underwater with a bundle of wraps, 4-5 inches of rope, equivalent to cable: this is a big problem.

Mayo: usually a shield of loose stuff, have to be very dexterous to actually get to the tight inside wraps. This kind of flipper wrap is the one we most want to develop on.

Wiley: suggested injecting something into the rope to dissolve it as it cannot realistically be cut.

Unknown: Why do these wraps cause problems? The line, rough polypropylene is put under tons of pressure and it cinches the rope down into the bone. Young animals grow into the rope and it cuts off circulation. Not conceivable to cut this rope – an injection would be great.

Bowman: some kind of physical restraint would be helpful

Mayo: thought about using a dry dock with stranded animals, even so it is difficult to cut these ropes off, chemical disassembly would be best.

Bowman: maybe we can determine whether something is actually hopeless or not.

Moore: According to news reports (http://www.capecodonline.com/cctimes/archives/2001/dec/11/whalezxstale11.htm) CCS rescuers probably will not intervene in the future if an entangled whale appears to be mortally injured. Thus this assessment is vitally important.

Johnson: polypropylene is a very inert plastic

Brunson, D: some of these animals are hopeless: amputations would be futile with flipper wraps. These appendages would basically be rendered useless, so maybe we should focus on less extreme wraps that would be easier to remove.

Johnson: do these wraps have control lines?

Mayo/Bowman: sometimes this is the case.

Johnson: need a camera for assessment and possibly an injection to destroy the line. Girard, A.: AUV attached to line detects animal slowing down and it surges past and sends pictures back.

Singh: an ascender makes more sense, always driving forward, ascender detects when it has no more room to move and starts snapping pictures.

Lange: two problems, assessment and rope removal. Technology exists to take footage. Stormy: terrible problems getting in front of the whales – they don't like to have things in front of them.

Lange: outrigger? Camera on whale gives such a small frame of view, something to consider.

Mayo: we can get up level with the head, within 20-30 ft of it, can do it often, not always. Hartley: always using small vessels?

Mayo: yes?

Singh: think about a remote-controlled helicopter/plane off a small boat, which is cheap and accessible. This would cover the global visibility.

Mayo: difficulty is at the water line, CCS feels good about above surface work with pole cam. Confident in above water assessment.

Hartley: need to look not only at where they are entangling the whale, but also along the entire length of the line. If we had removed a knot at the end of one of 1102's lines, things might have gone differently.

Duester: number of boats?

Mayo: successful in keeping the animal on the surface and then use 3 boats by confusing the animal. If we can get the boat over the nose of the animal, the whale slows down, in that way we can have influence. Need maneuverability: that is why we use inflatables. We want to work on animals which continually want to dive, as other, more co-operative animals in bad condition are probably not recoverable anyway.

Johnson: carrying a camera on suction cups could be good, but near rostrum, is not on. Getting a camera to a flipper area, a rope-crawling device. If the animal is thrashing what is the water visibility like anyway?

Walter Paul – Rope

His experience deals with rope fiber manufacturing and development. Basic need when cutting rope: apply force, have something underneath and then a knife to cut through. 135-155 deg C is the melting point of polypropylene rope.

Lead core rope has lead inside in small pieces – 1 inch long. The rope can be cut in between lead sections. Problem – have to get under the rope as it is on the whale – maybe use 2 fine prongs (whale reaction?) also need an anvil to act as the supporting surface when the knife is activated. To activate the knife you have to decouple the action between the boat and the whale. Higher tension on rope, easier it severs.

Questions

Bowman – we don't use knives with mechanical action.

Paul: Need cutter, float, compliance and activation link. Must be sure to cut right through the rope. Described a cutter with a prong, anvil and piston with an accumulator/pump which is controlled via a pressure hose or cable that is activated from the boat. Mounted on a handle. Requires bench-testing. Handle has to support push, get prongs under rope through blubber, all this without sending the whale into a frenzy and has to allow pull on trigger rope. Speed is essential.

Mayo: never had a problem cutting rope, the problem is actually getting the knives to the right position.

Johnson: the nub of the problem is this point and we should focus on it.

Duester: have you tried a bone saw?

Bowman: No. What about chemical dissolution of rope?

Paul: need to have heat under water and laser would be good if this could happen. Problem with efficiency of lasers.

Brunson, D: need to be precise with laser use.

Ekstrom: focused ultrasound?

Brunson: ultrasound device to measure presence of rope? Did Churchill have rope across his rostrum or was it an old wound?

Ekstrom: used to burn out tumors.

Keitel: need to be tethered.

Moore: Problem for diagnostic ultrasound was cable length: longest available was 12 ft. Our system is only depth sounder, no image. Suggested combining a spinning blade with a video on the tip of the cantilever pole.

Johnson: cannot use pole underwater.

Keitel: preset blade speed and depth.

Wiley: there is a movement away from polypropylene ropes, are there any other materials - poly alcohol dissolves with time and salt water.

Paul: polyprop is cheap and it floats – the floating is the big problem.

Bowman: come up with a new composition?

Paul: current trends in rope development are unlikely to result in a product that dissolves more easily.

Moore: recent *Eubalaena* award rope disintegration proposal – not practical for the fishing industry.

4. Sedation of Large Whales – David Brunson

Seeking conscious sedation (in contrast to anesthesia: unconsciousness and loss of reflexes) and analgesia.

Sedation: quieting, calming, +/- analgesia. Primary concerns: safety of the drugs both for the whale and for the rescue team, and secondly, the effectiveness of the drugs. Initial obstacles – what drugs? What dose, how to administer, what effect will the drugs have, onset, duration, degree of central nervous system depression? Wanted to deploy drugs first before the whale is excited or harassed. Therefore the drugs have to take effect before any work can be done on the animal. Although sedation is a good tool, it may not provide all day opportunity, but it is repeatable. Midazolam and meperidine have been used in seals, sea lions, killer whales and other marine mammals and produce mild sedation affects. Midazolam: a benzodiazepine (like Valium) at a low dose of 0.025mg/kg for 40,000 kg whale requires 1,000mg. Commercial concentration is 5 mg/ml i.e. 200mls would be needed, so formulated a special concentration 90mg/ml requiring 11ml per dose. Meperidine (Demerol) is an opioid analgesic: dose 0.25 mg/kg i.e. 10,000mg for a 40,000 kg whale. Commercial concentration is 100 mg/ml i.e. 100 ml so formulated a special concentration of 550 mg/ml or 18 ml. Thus a dose of 1 gm medazolam and 10g of meperidine was given to Churchill with special formulation resulting in 29 mls. Midazolam is water soluble and is like valium. Gave this dose 4 times in a 2 hour period with light sedation effects, therefore the dose could probably be doubled in the future. He was confident that the drugs are working and safe at this concentration.. Three different sedation series were administered to Churchill and they did no detectable damage.

The team had to develop a delivery system: a large capacity auto-injecting syringe, special needles, and a cantilever pole system. The syringe had a 40 ml capacity and a 12 inch needle. The drug chamber in front of a standard syringe sealing plug, the pressure chamber behind, with a one way valve to retain pressure. Compressed atmospheric air was used initially, but force was lost as the plunger moved. Liquid butane replaced this and worked very well and is simple to load and use in the field. The butane charge lasted for one day in a bench test. Shape of the syringe can change but the drug has to be delivered at a level of approx 12 inches below skin surface. The cantilevered pole system of delivery was successful. Churchill gave minimal reactions to these injections. Syringes stayed in initially but did fall out eventually.

Measuring the effects of the drugs:

Response to external stimulation – flight distance; pain – test with some type of stimulus.

Heart rate

Respiration rate

Muscle tone/movement

Churchill's behaviour changed after the drugs were administered: surfacing was less forceful, and exhalations began before the blowhole was clear of the water. This was taken as direct evidence that the drugs were taking effect. As time went on his further change in behavior also indicated the drugs' effect wearing off. Respiration rate wasn't a clear indicator.

So the approximate dosage is now known. The dose used was the same as used for captive killer whales, so metabolic scaling doesn't seem to apply here, however environment and stress levels may have been a factor in increasing the required dose. The onset of effects was 20-30 minutes, the duration <2 hours. The level of CNS depression was mild.

Questions

Ekstrom: can an ECG be used with telemetry?

Brunson, D: yes.

Knowlton: what about local anesthesia?

Brunson, D: Local anesthesia may be one of the best tools to decrease the reaction of the animal to any rescue operation procedures.

Moore: really need to know the distribution of the neurosensory receptors on the body of these animals: hopes to do that histologically.

Unknown: can we use spinal or regional anaesthesia – need to inject on the nerve that serves the specific area.

Brunson: we are using a systemic approach.

Bowman: only part of the animal that needs to be restrained is the tail.

Moore: the motor muscles are located above the tail and the nerves are located higher on the spinal cord. Mid-line block could in theory stop the impulses to the muscles and therefore slow down the movement of the flukes. Not a practical approach.

Ekstrom: proposed a non-invasive, different approach to sedation using modulated energy. Acoustics and light. Suggested using a low frequency transducer to project a specific wavelength to match its body length: “tuned acoustic energy”. Bathe a whale in 100 cycles/sec of sound and cause full body/internal resonance which may affect the fluke and flipper rate such that the whale will heave to and be sedated. 100 cycles/sec is a typical fundamental calling frequency they use, indicating internal source resonance.

Johnson: Would it deafen them?

Ekstrom: No, use very low amplitudes.

Break for lunch

Becky Woodward - Lassoing right whale flukes.

30-40 ft range, single cartridge 4 barrel net gun, to shoot net over right whale flukes as they enter their terminal dive. 24x18'rectangle lasso. Can buy net guns to mount on the deck of a boat. Can construct lasso out of floating material if desired and different shapes of lassos can be made.

After lunch the workshop reconvened into three subgroups as defined by the morning discussion.

Subgroups and chairs

Assessment - Chris Roman and Bill Lange

Restraint - Bob Bowman

Cutter Deployment - Stormy Mayo

Assessment subgroup

Chairman: Chris Roman and Bill Lange

Nowacek

Knowlton

Grasso

Girard, A

Girard, P

Baldi

Partan

Smith

Singh

Dwyer

Duester

Moore (partial)

Assessment Subgroup

Lange described a priority to improve aerial photography to help make initial assessment of the animal. He suggested the need for a system to provide real-time analysis of images to relay information to coordinators on water/landhelp to focus their attention on specific areas of the whale. A second issue concerned areas of the whale under the water, in particular, the flippers and belly. There is a need for a system to provide wide shots of whale to avoid the need to create a mosaic. The third issue was monitoring of the animal on a real-time basis, specifically heart-rate in terms of sedation response. The final issue was to define terminology better – such as 'mortal wound'.

The discussion began with some general comments and questions about right whales including reactions to boats/other animals, natural history, etc.

1. Aerial photography

Lange suggests the use of high-definition video mounted in/on the survey plane

to provide high quality digital images (30 frames/second) with the ability to zoom in/out to specific areas of the body. The system would also allow observers to view the images in real-time to relay information to the necessary team members. The equipment to test the system is available - already tested briefly in Iceland on killer whales.

2. Underwater imagery

Lange suggested the use of a towed body- system available in the WHOI warehouse that will be repaired and loaned to Stormy for testing (use two boats, one trying to avoid the other to simulate the whale's reaction). The system could be mounted on a rigid inflatable off to the side of the boat. The camera tow body would have controllable fins to provide better visualization. There could be a pan and tilt zoom function internal to the housing.

Lange suggested traveling around the animal: towing camera to achieve images underneath and along all aspects. Maybe can avoid head on approach to obtain necessary images. Could vary the length of the towed body to allow greater flexibility in distance to the whale.

Nowacek: heart rate data derivation is in the process of development, not easily obtainable at the moment.

Hartley: heart rate data important for sedation info.

Bowman: life expectancy of tag?

Lange: a few hours to a few weeks. More extensive optical surveys are going to require more land-based/laboratory interpretation. Data collection needs to be concise and focused to avoid substantial processing.

Bowman: what is the time span to deploy better imaging?

Lange: warehouse has towed camera body parts, need to be put together and tested. Baldi and Lange want to work on the visual quality, and will work with Brown and Cole (NMFS) to deploy.

Moore: We need to better define a mortal entanglement?

Knowlton: Heather Pettis looked at whether you can assess the fatness of a whale photographically. She found 10 severely emaciated animals that haven't been seen since (n=8) or were subsequently seen dead (n=2). (Churchill is included in the 10). Of these 10 animals, six were entangled and one was ship-struck. White flippers also indicate a poor prognosis.

Moore: need to have side view photos of the front half of whales as part of initial assessment. D-tag should have data available real time to be of use during a disentanglement.

Johnson: that is possible and a test model may be available.

Moore: pitch and roll data from the d-tag is relevant now and should be deployed but further development is certainly recommended.

Singh: suggested the use of a suction cup camera attached to the whale by a suction cup- the camera itself would be on a "fishing line". Once attached the line would let loose (amount of line out would be controlled by observer) and the camera would drop underneath the whale. Would have to look into hydrodynamics of the camera, specifically when the whale was swimming, and development of special fins for the camera which could be remotely operated.

Restraint subgroup

Chairman: Bob Bowman

Brunson, D

Brunson, A

Woodward

Brown

Wiley

Miller

Bob Bowman reported back on physical and chemical restraint. He spoke about existing models. Two extant systems need the animal to have an existing control line on it. Other models involve a lasso on a cantilevered pole system. Discussed Becky Woodward's system – maybe requiring stronger material and different lines etc. He described a planned practical workshop in Provincetown in Spring 2002 with a working model of a right whale fluke. Will help prepare operators for training and point out weaknesses. Bob Bowman and Marc Costa will come up with a longer pole.

Johnson: suggested there may be a benefit of a drug delivery system attached to the four suction cup system suggested earlier by him. Thus, multiple doses of the drug and if needed, the antidote, could be administered remotely. This would be a huge improvement to the current delivery method. The dose would be on a radio link which needs to be worked on. At the moment we should try to work with the existing cantilevered pole system. Sedation drops the fluke and the harnesses need to be designed considering this fact.

Mayo:Churchill's head was up and this may have caused the "fluke drop". Suggested running a remotely-inflated tail collar down the control line, to keep the tail up and reduce the amplitude of the flukes, and therefore reduce the weight required to restrain the whale. The primary objective is to stop the whale from creating dangerous situations with its fluke.

Cutter deployment subgroup

Chairman: Mayo

Hammar

Costa

Paul

Arthur

Keitel

Reeb

Cutter/deployment summary – Todd Keitel

Two problems: How to cut the rope and how to deliver the cutting device. Two types of ropes: 1) loose and accessible to tools, and 2) tightly embedded ropes. Tool doesn't have to do everything, but taking a few parameters into consideration, we thought that the device could carry almost any blade and would probably be able to work for almost all the entanglements. Reciprocating blade works well in some situations, circular blade has dimension limitations. Standard blade would probably work best as long as needed degrees of freedom and visibility are met.

Position and orientation of delivery system onto the whale. Many options discussed but the cantilevered pole is probably the best. Optimal placement is probably not going to be achieved using suction cups. Described a design with a circle or retractable hooks. Push up and they stick in, push down and they release. Video feed back would be in place, a second deployment of a buoy anchor will act as a tether between boat and whale walker. Fail safe is imperative, springs to engage hooks are power-charged and loss of power would result in the hooks releasing.

Mayo: hooks into whales may result in bad reactions and that is a serious concern and needs to be checked and tested for acclimation. Can have different lengths of hooks and differing pressures would engage different hooks for walking, clamping etc…

Hartley: could each step forward inject a dose of a topical analgesic (Lidocaine)?

Keitel: This was discussed in the subgroup. Telemetry is possible but it has power limitations, but by using the tethered system, the batteries can be in the buoy. The buoy may also be able to stay in the boat.

Moore: cost?

Keitel: high power, low accuracy and therefore favorable cost-wise, most parts are off the shelf things.

Mayo: integrate with assessment side of things, pack more "gadgets" on it. DSP processor is required and could be remotely controlled (by Stormy on his couch!).

Moore: this concept sounds like a 'Robocyamid', but (added at editing stage) I suspect that basing the device on suction cups rather than hooks is advisable for reasons of pain and permit-ability.

Monitoring Technology – Doug Nowacek

What do we want to know during disentanglement efforts? Between disentanglement efforts, after successful or unsuccessful attempts?

How do we assess the health of the animal visually: we should include Pettis' work at NEAq. Body wounds, blubber thickness etc may help assess whether entanglements are mortal or not. Biopsy to use various assay techniques. Respiration, electromyogram (EMG), ECG rates are known, but between disentanglement efforts are so far unmeasured. Need to have a high data density archival tag: fluke stroke rate, velocity and heart rate? Satellite-linked time depth recorder (TDR) would provide real time dive behavior and if the animal is noted in one area for a sufficient time, that allows opportunities for disentanglement efforts. Johnson can comment on changing memory set up of tag to allow long duration application.

Bowman: possibly add this to the buoy that is already being deployed by CCS. Can add 10 more pounds to the buoy.

Monitoring the whale after disentanglement whether gear is taken off or not. What can we learn from this animal?

Hartley: collecting blood and wound biopsies. Tail restraint and a lift bag under the tail would be a good set up.

Bowman: time restrictions make this improbable. He thinks next season may mirror the entanglements of this season.

Nowacek: to have an overnight team would be ideal.

Moore: having money to charter the right vessel to stay on station for more than a single period of daylight?

Hartley: NMFS have spoken about this option.

Wrap up

Arthur – Assessment is important and using current tools/technology is always the first choice. Tools already in your toolbox. Funding limitations need to be considered and therefore further system contemplation is required.

Moore – suggestions as to where to from here? To have a method to physically restrain a whale is necessary for all disentanglement and rescue operations. Assessment is equally important. Don't think we can currently fund, fabricate and present the walker Keitel and the subgroup proposed. A remotely controlled sedation system would be a great advantage and may be the best immediate advance. He then asked what is the most urgent need for the "workshop on the water"?

Bowman: right whale tail model to test tail harnesses and development of better tail harnesses.

Duester: fuel tank bladder concept could be modified to allow an inflatable tail collar. Would affixing the bladder assist in restraining a whale?

Mayo: not a practical option, size and attachment-wise.

Brunson: attachment to the correct positions is critical and one of the hardest things to accomplish.

Mayo: reasonably healthy animal, can we get enough sedative effect to allow us to get to where we need to go? Physical and chemical systems are intimately linked. Better chemical delivery system and new physical restraint system. This is the primary priority according to CCS.

Smith: Singh mentioned a fishing spool to run out. Smith asked whether it would be possible to attach a package to the whale's back and deploy two separate lines around the peduncle which would attach to each other?

Mayo: interesting idea, not mentioned before.

Brunson: engineers need to help with the harness. Engineers could help with developing electric screws, spring, pump could be developed to engage the plunger in the drug delivery device, but the engineering of the tail harness is most important.

Woodward (added in report edit stage): need tail harness design criteria (what

elements are essential: quick release, stops to prevent cinching too tightly, etc) and critical dimensions of the fluke and peduncle.

Bowman: need input on existing CCS tools. Need to solicit other designs from outside people and test the designs in the harbor.

Knowlton: would it be possible to test Woodward's gun on a non-entangled humpback whale in Cape Cod Bay this winter?

Hartley: permits are an issue and need to be applied for asap.

Moore: thanked all participants. The sedation work done by Dave Brunson, WHOI, NMFS and CCS has roused tremendous amounts of interest in the veterinary profession as well as from the public. More awareness in the Mid-west as a result of this work. A lot has been accomplished since the meeting two years ago.

Conclusion: disentanglement is not the solution, we are only treating the symptom, it's the cause that needs attention and solutions.

Mayo/Bowman: concerned that the focus is not where it should be.

Brunson: bring the gear development people into these meetings so that the focus is always maintained i.e. gear entanglements need to be prevented, not solved.

Wiley: there is a NMFS gear development meeting 13-15 February 2002 in RI, more people from this meeting should try to attend.

Meeting adjourned 1600.

Annex G Sedation: Brunson et al. 2002:

TECHNIQUE FOR DRUG DELIVERY AND SEDATION OF A FREE-RANGING NORTH ATLANTIC RIGHT WHALE (Balenea glacialis).

David B. Brunson, DVM, MS[1,*], DACVA, Teri K. Rowles, DVM, PhD[2], Fances Gulland, Vet. MB, MRCVS, PhD[3], Michael Walsh DVM[4], J. Lawrence Dunn VMD[5], Terence Hammer[6], Michael Moore Vet. MB, PhD[6].

[1]School of Veterinary Medicine, University of Wisconsin, Madison, WI 53706; [2]Office of Protected Resources, National Marine Fisheries Service, Silver Spring, MD; [3]The Marine Mammal Center, Sausalito, CA; [4]Sea World of Florida, Orlando, FL, Department of Research and Veterinary Medicine, [5]Mystic Aquarium, Mystic, CT; [6]Biology Dept. Redfield 2-44, MS 33 Woods Hole Oceanographic Institution, Woods Hole, MA, 02543-1049

North Atlantic Right whales are a highly endangered species. Current estimates list the population at approximately 300 individuals. In addition, the calving interval has lengthened in recent years raising concern for the survival of this species. Approximately 60% of the animals have scars indicating either entanglements with ropes and/or nets or injuries from boat strikes. This species is highly vulnerable because they feed, migrate and reproduce in the coastal ocean waters along the eastern edge of the United States.

In most cases, entangled whales either break free on their own or are cut free by marine mammal rescue teams. Several cases have been documented where the entanglement could not be removed. The large size (20,000 to 45,000 kgs) and strong willed temperament preclude the physical handling of this species. Because of an experience with a fatally entangled female NA Right Whale in 1999, a group of biologists and veterinarians met to explore the potential for sedation of a free-swimming whale for disentanglement efforts.

On June 8, 2002 an adult male NA Right Whale (#1102) was reported by a NOAA-SAS survey flight to be entangled northwest of Cultivator Shoal. An assessment team remove part of the entangle ¾ inch polypropylene rope and determined that a linear wound across the maxilla appeared to be infected. The whale apparently had a single line that entered one side of the mouth, cinched around the rostrum and exited the other side of the mouth. This line was cinched very tight and was imbedded in necrotic tissue in the head. The whale was in very bad condition. The inability to remove all of the rope and the conditions of the wound indicated the entanglement was life threatening. A satellite telemetry buoy was attached to the end of the entangle rope to enable tracking and relocating the whale.

Available sedatives, analgesics and immobilization drugs were reviewed for the following characteristics: clinical use in related marine mammals, availability of a specific antagonist, predicted potency and deliverable concentration. Midazolam and Meperidine were selected as the drugs that best fit these criteria.

Clinical experiences with these 2 drugs had demonstrated efficacy in a Killer Whale at a dosage of 0.025mg/kg Midazolam and 0.25 mg/kg Meperidine. Furthermore, this combination has been used routinely for sedation/immobilization of seals, sealions and walruses. A benzodiazepine anatagonist (Fluamzenil) was available. The solubility characteristics of Midazolam suggested reformulation of the drug to approximately 4 times the commercially available 5.0 mg/ml concentration would be possible. However, when lyophilized Midazolam was redissolved in equal parts sterile water and ethyl alcohol, a final concentration of 90 mg/ml was obtained.

Commercially formulated Meperidine (50 mg/ml) was lyophilized and redissolved in sterile water to a final concentration of 550 mg/ml. The opioid antagonist Naltrexone was obtained for reversal of Meperidine. Based on relative potency data of Meperidine and Carfentanil the reversal dosage was estimated to be 1 mg of Naltrexone for each 500 mgs of Meperidine.

On the first sedation attempt only Midazolam was administered to determine if sedation alone would be effective and safe for a free swimming whale. As a starting point dosage was estimated by metabolic scaling the On June 26th, 500mg Midazolam, 37 minutes later a second 500mg Midazolam dose was administered. No measurable sedation was observed form either dose.

The second attempt to sedate included both Midazolam and Meperidine. Since the metabolic scaled dosage produced no observable effects, the dosage of Midazolam used to sedate a SeaWorld killer whale was used (0.025 mg/kg). Based on the estimated body weight of 40,000 kgs the Midazolam dosage was estimated to be 1000 mgs (1 gm). Limited capacity of the syringe dart resulted in a Meperidine dosage of 7500 mgs (0.17 mg/kg). Two dosages were administered on July 14th. The signs of sedation included slower swimming and decreased speed of swimming.

The final sedation attempt on August 30th utilized an increased dosage of Meperidine. Additionally, the plan was to decrease the dosage intervals and increased number of dosages. A total of 4 doses of 1 gm Midazolam and 10 gms of Meperidine for a total of 40 gms Meperidine + 4 gms Midazolam were administered over a 2 hours and 43 minutes period.

Greater sedation was apparent without fully immobilizing the whale. Signs of sedation included a lower respiratory rate, slowed breeching and decreased swimming strength. Freeing Churchill from the rope required physical restraint as well as sedation. Attempts to place a harness around the tail of Churchill failed despite successful sedation. Ultimately we were not able to remove the rope.

A method for drug administration of sedatives to a free-swimming whale was developed and successfully deployed. A blow-dart style syringe with a 12 inch long needle was designed and assembled by the engineering staff at Woods Hole Oceanographic Institute.

The design of the current syringe used for pharmacological injections into large whales was adapted from designs used for large terrestrial mammals for remote drug delivery. All components for the main syringe are made of polycarbonate. This material was chose for its impact resistance and its ability to be solvent welded together, thereby minimizing the cost of machining. The barrel is a piece of standard size tubing that is simply cut to length. Both the nosepiece and the tailpiece are machined from solid stock to fit the inside dimension of the barrel, and the plunger is machined for an o-ring seal to the inside dimension of the barrel. A check valve in the tail of the syringe was an "off the shelf" product, which has a polycarbonate body for easy assembly into the syringe.

The needle was a piece of type 316 stainless steel tubing that measures approximately 4.7 mm od x 3.2 mm id (3/16 od. X 1/8 id.). The tip was welded closed, and then ground to a 15° bevel point. There is a 2.3 mm hole drilled through the tip approximately 21 mm from the point. The drug delivery outlet was sealed with tygon or surgical tubing until the needle penetrated the whale's skin. The stainless steel tube was welded to a ¼-20 socket head cap screw that has a 3.2 mm hole bored through the middle. This screw attached the needle to the syringe.

Churchill was followed for 100 days and 3 sedation procedures were performed. The dosage for light sedation using Midazolam and Meperidine was successfully determined for a large free-swimming whale. A method for drug delivery and special formulation of a high concentration formulation was developed and deployed successfully.

Annex H **CCS policy on safety:**

Safety

During large whale disentanglement efforts

Some guidelines developed by the Center for Coastal Studies

GENERAL RULES

i) Do not put the whale's rescue above human safety.

ii) Never initiate an action that has not been thoroughly thought through and discussed with participants

iii) Do not get in the water with an entangled whale.

iv) Encourage participants to speak up if they are not comfortable with either a particular action or the general situation. Respect their concerns by not asking them to participate in that action or event.

v) When in doubt, tag and regroup (e.g. attempt another day with more assistance and/or new tools and procedures)

vi) Do not be pressured into an action
- **(1) BY WEATHER**
- **(2) BY ONLOOKERS**
- **(3) BY THE NEED TO "JUST DO SOMETHING"**

SUPPORT VESSEL AND PLANE

vii) Establish communication protocols

viii) Communicate intentions to vessel (esp. before a potentially dangerous action)

ix) Review worst case scenario protocols

x) Use an appropriate support and rescue vessel

xi) Use Coast Guard, and/or other emergency-prepared support, whenever possible.

xii) Know the operating limitation of the support vessel. Anticipate and prepare for reaching those limits (e.g. clean up and tag, before those limits are reached)

APPROACHES TO WHALE

xiii) Never approach from directly behind (e.g. unseen gear trailing), unless using "tracking" line

xiv) Avoid danger zone (range of movement of the tail flukes)

xv) Use a "clean", and preferably soft, bottomed vessel (i.e. inflatable) for close work

xvi) Use an easily lift-able engine to avoid tangling in the gear on the whale

xvii) Minimize equipment (and personnel) in the inflatable (store non-immediate gear on support vessel)

PERSONNEL EQUIPMENT

xviii) Emergency (spiderco) knives handy at all times

xix) Gloves on when handling lines with load

xx) Helmets on if near the whale and/or using poles

xxi) Appropriate personal floatation at all times

xxii) Proper attire (warm, non-constricting, but not too baggy or with "snag points")

xxiii) Communications (waterproof vhf handheld)

PROCEDURE

xxiv) Know your tools, especially the ones immediately at hand

xxv) Be aware of the location of gear and <u>vigilantly keep it "clear"</u>

xxvi) Be aware of the location of the whale

xxvii) Be aware of other team members

xxviii) Keep all gear that is attached to the whale outside of the inflatable and free from the engine

xxix) Do not attach the line from the whale to the inflatable. Instead, "bend" it over the bow, ready for immediate release.

xxx) Stay out of "line-of-fire" of any load-bearing line that may break

xxxi) Do not loop line around hand, body or foot (by accident). This also means to stay inboard of any "bend" in the line that might need to be released quickly.

xxxii) Think through all possible outcomes to planned actions, and be prepared for any of them (best and worst)

xxxiii) Discuss any new ideas with other experienced personnel and illicit their advice and feedback before undertaking them

xxxiv) Keep poles above or outboard of personnel as much as possible (e.g. be cognizant of possible pole trajectories if the whale hits it).

xxxv) Focus on the job, but pay attention to the overall environment

WHALE BEHAVIOR AND BEHAVIOR AROUND WHALES

xxxvi) Always expect the possibility of unpredictable behaviour

xxxvii) Avoid any sudden boat maneuver’s (e.g. gear shifting or sudden velocity changes), which have a higher probability of startling the whale

xxxviii) If the whale begins to make numerous "unusual" noises or struggles violently, stand back and let it settle