# Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations: Report of the Serious Injury Workshop 1-2 April 1997, Silver Spring, Maryland

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## Executive Summary

### Background

One of the mandates of the Marine Mammal Protection Act (MMPA) is that the incidental mortality and serious injury of marine mammals incidentally taken in the course of commercial fishing operations be reduced to below Potential Biological Removal (PBR) levels. In addition, the long term goal of the MMPA is to reduce incidental mortality and serious injury to insignificant levels approaching a zero mortality and serious injury rate. Take Reduction Teams appointed by NMFS develop Take Reduction Plans for reducing the mortality and serious injury incidental to commercial fishing. The MMPA does not, however, provide a definition for serious injury. "Serious injury" was defined by the National Marine Fisheries Service (NMFS) in 50 CFR part 229.2 as an injury that is likely to lead to mortality. The objective of the Serious Injury Workshop was to explore a broad range of guidelines that could be used to determine which marine mammals entangled in fishing gear or injured incidental to fishing operations should be considered seriously injured as a result of the encounter.

The development of guidelines for which injuries should be considered serious is critical because NMFS is mandated to reduce the level of incidental serious injury and mortality incidental to commercial fishing operations below Potential Biological Removal (PBR) levels. Currently, NMFS manages many fisheries only based only on the level of mortality incurred in that fishery. NMFS needs to develop a consistent approach for determining what constitutes a serious injury to incorporate this into the management regime.

### Description of fisheries and changes to fishing practices to reduce interactions with marine mammals

Three fisheries that incur marine mammal injuries incidental to fishing operations based on documentation from observer or stranding programs were described in detail to provide workshop participants with a basic background on their nature and operation.

*Lobster pot fishery*: The New England lobster pot fishery represents one of the largest and most valuable fisheries in the northwest Atlantic. Gear configurations vary significantly between offshore waters and inshore waters. Groundlines that connect pots may or may not be suspended above the bottom of the sea floor, depending on the bottom topography and whether retrieving overlapping gear has caused loops in the groundlines. Inshore fishers pull and re-set their pots 2-3 times per week; offshore fishers pull and re-set their pots 1-2 times per week.

Marine mammals, particularly large whales, entangled in lobster pot gear appear to survive the initial entanglement but may trail gear after the entanglement occurs. Verified reports indicate that large whales can survive entanglement with lobster pot gear and that they may free themselves of the gear; the long-term effects of the entanglement or release from entanglement are unknown.

*Sink gillnet fishery*: There has been a large decrease in the level of effort in this fishery in New England in the past several years due to declining groundfish stocks; much of the effort has moved to waters in the mid-Atlantic. A series of sink gillnets are suspended above the seafloor on a floating rope, and are anchored to the bottom at each end of the series. The gear typically stands 12 ft high off the bottom and is fished in water 10-200 fathoms deep. Mesh size and soak times differ depending on the target species.

Delphinids and small pinnipeds that become entangled in sink gillnet are believed to remain entangled and die. Large whales and large pinnipeds are more likely to survive the initial entanglement because they either pass through the gillnet or because they may be able to reach the surface to breathe despite the weight of the gillnet gear. Animals that survive the initial entanglement may continue to trail gear for extended periods of time. Verified reports indicate that large marine mammals can survive initial entanglement with sink gillnet gear and that some large marine mammals may eventually free themselves of the gear; the long-term effects of the entanglement or release from entanglement are unknown.

Efforts to mitigate interactions with harbor porpoise have resulted in the mandatory use of pingers in a fishery with a high rate of harbor porpoise mortality (Kraus, et. al., 1997).

*Pelagic longline fishery*: This fishery is widely distributed in the Atlantic Ocean and occurs near Newfoundland, the Bahamas, and the Gulf of Mexico, and targets swordfish and tunas. The depth of the thermocline determines both the depth of the gear and the number of hooks placed on the mainline. Fishers use monofilament line and typically fish 28-35 miles of gear at a time.

Typically, entanglement occurs when marine mammals are hooked when attempting to take bait from the hook, although they are occasionally snagged. It is more likely that marine mammals and sea turtles will survive being hooked if the gear is fished near the surface, as the animals will be able to reach the surface to breathe. The rate of interaction between this fishery and marine mammals depends on where the gear is set, and the hook style, size, and type of bait. Analyses are under way to determine how the interaction rates differ by gear type.

**Survival of marine mammals entangled in gear**

The probability that a marine mammal will initially survive an entanglement in fishing gear depends on the species of marine mammal involved and the type of gear in which the animal becomes entangled. During the workshop, the results of entanglement of several types of marine mammals in gillnet, longline, and pot/trap gear was discussed.

*Gillnet*: Small marine mammals, such as harbor porpoise and bottlenose dolphins, that contact and become entangled in gillnets seldom survive. This statement is supported by a lack of observer or fisher observations of living delphinids that are released from gillnet gear, and from a low frequency of healed wounds consistent with interactions with gillnet gear on dead, stranded marine mammals. A few stranded small marine mammals do, however, exhibit healed lesions consistent with previous interactions with gillnet gear, so it is clear that not all small marine mammals die as a result of those interactions.

Gillnet interactions are often identified as the cause of death of stranded harbor porpoise in the mid-Atlantic. Because lesions and wounds indicative of gillnet interactions may be easily missed during a perfunctory necropsy, a detailed protocol has been designed to aid biologists in determining whether gillnet interactions was the cause of death. Signs considered diagnostic of interactions with gillnet are 1) a lack of indications of bottom scavenging of the carcass, 2) gillnet marks on leading edge of flukes, pectoral fins, or dorsal fin, 3) gillnet marks on body (may be mono- or multi-filament), 4) deep grooves in caudal peduncle, and 5) loss of appendage (Read and Murray, 1996). The most common lesion associated with a mortality caused by gillnet gear is the presence of narrow, linear lacerations in the epidermis caused by the gillnet pressing into the animal's body. Sometimes these lacerations can be used to estimate mesh size and whether the line was mono- or multi-filament.

Large marine mammals, such as humpback whales, right whales, and Steller sea lions may become entangled in gillnet but often survive the initial contact with the gear. The entanglement of larger marine mammals in gillnet gear may cause considerable damage to the gear. Marine mammals may also swim away with a portion of the gillnet wrapped around a pectoral fin, the tail stock, the neck, or the mouth.

*Longline*: The Atlantic pelagic longline fishery, which targets swordfish and tunas, primarily has interactions with pilot whales and Risso's dolphins. Although this fishery has a low rate of observed incidental mortality of marine mammals, it has a potentially high rate of incidental injury of marine mammals. Whether a hooked or entangled animal is considered seriously injured will affect the rate of serious injury and mortality incurred by this fishery. Specifically, although there was only one mortality observed in 1994 and 1995, if all hooked or entangled animals were assumed to have died, the average kill levels for 1994/1995 would be approximately 225 animals. If some portion of the animals hooked or entangled are considered seriously injured, the average kill levels would be lower. Nearly all observed marine mammal interactions with this fishery occur north of Cape Hatteras. The pattern of interactions is non-random. Therefore, allocating observer coverage proportional to the rate of interactions in an area would improve the precision of the mortality estimate.

Pilot whales and Risso's dolphins may become entangled in the mainline or gangions, and may be hooked in the body or in the mouth. Animals are often released alive and trailing some type of longline gear either from their mouth (often hook only, or hook and gangion) or from their caudal peduncle (gangion and/or mainline).

It was noted that few pilot whales or other marine mammals strand with evidence of interaction with a longline. A recommendation was made that the Atlantic stranding data be reviewed to determine whether animals have stranded with evidence of hooking.

*Injuries of large whales due to entanglement* : Large whales become entangled in large and small-mesh gillnets, pot gear, and unidentifiable line of different types. Documented cases indicated that entangled animals may carry gear for long periods of time and over long distances, may free themselves from the gear, may be freed by the disentanglement network, or may die as a direct result of the entanglement. Indirect impacts are also possible: entanglement may compromise the animal by causing cuts or impeding mobility or feeding, which may make the animal more susceptible to disease. The majority of large cetaceans that become entangled are juveniles. Workshop participants acknowledged that not all entanglements will result in mortality and indicated that the proportion of entangled animals that survive the entanglement is unknown. The New England Aquarium has a study underway that will provide survival estimates for right whales known to carry (hereafter referred to as "trail") fishing line or gear.

Participants stressed that a thorough necropsy is necessary to determine the cause of death of large cetaceans and the degree to which an entanglement may have contributed to the mortality[1].

*Injuries of pinnipeds*: Human-related injuries to pinnipeds occur as a result of entanglement in net or line, internal and external imbedding of hooks, shooting, or other trauma. Only 10% of the animals treated for gun shot wounds at the Marine Mammal Center in California survive to be returned to the wild. The number and fate of animals shot and not found is not known. Typically, it is very difficult to determine the extent of the pathology based solely on an external examination of the animal. Minor injuries that result from entanglements or hookings may or may not cause major infections that can severely compromise the health of the animal. Injuries resulting from shark attacks or vessel strikes can typically be distinguished from injuries resulting from interactions with commercial fisheries.

**Physiological effects of stress**

*Hormonal/physiological response*: Marine mammals may die from physiological responses to stressful events such as live strandings, chase, capture, or interaction with fishing gear. The physiological changes that stress may trigger include hyponatremia in pinnipeds (an inability to retain sodium, which causes the animal to release water), and hormone imbalance that may ultimately cause death or increased susceptibility to disease. The severity of the stress response depends on the species, age, and general health/condition of the marine mammal and the type and duration of the stressors. Most circulating hormones and other stress indicators degrade and break down within one hour of death, making it difficult to diagnose stress effects unless the death had been very recent.

Hormonal stress responses may be reversed by medical intervention in captive situations, but this is not likely in the wild. Generalizations cannot presently be made about how many marine mammals subjected to a specific stressor would likely die. In general, marine mammals that inhabit offshore waters (e.g. spinner or common dolphins) appear to be more susceptible to stress-related mortality than marine mammals that inhabit nearshore habitat or occupy a more complex ecological niche (e.g., bottlenose dolphins).

*Muscular response to stress*: Exposure to chronic stress may cause physical damage to certain tissues. Tissue necrosis, bubbles in muscle tissue, and separation of the muscle fibers are indicative of stress injuries to the myocardium. This type of damage is caused by extended

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1 The need for thorough necropsies to determine cause of death was stressed for all marine mammals in general.

exposure of tissue to adrenaline (exposure that lasts longer than minutes or days). Necropsies have identified lesions in the myocardium of cetaceans known to be encircled in fishing gear and recovered dead; for these animals, stress was the likely cause of death. It is unknown what proportion of stressed animals die some time after the stressor occurs.

**Collecting data on injuries**

The importance of observer data to determining whether an injury was serious, especially data that describe an interaction, was stressed throughout the workshop. The level of detail provided by observers who document injuries of marine mammals incidental to commercial fishing is often adequate for assessing whether an injury should be considered a serious injury, but in some cases the level of detail should be increased. Workshop participants identified several actions that would improve the data that observers provide on incidental injuries, such as 1) improve the training for recording interactions with marine mammals, 2) include marine mammal scientists in the debriefing process, and 3) encourage observers to provide more detail in their comments on an interaction.

Agreement was not reached on what process NMFS should use to determine which injuries should be considered serious. Ideas discussed were 1) provide training to editors of observer data so they can determine which injuries are likely to be serious, 2) have a person or a group of NMFS employees determine which injuries are likely to be serious, or 3) develop a panel of outside expertise that would determine which injuries are likely to be serious.

Participants discussed requesting that observers or fishers take photographs of injured animals to document the extent of the injury; however, this may be impractical due to poor image quality, and could detract from primary observer responsibilities. In addition, workshop participants indicated that the observer coverage should be increased in those fisheries where many marine mammals are injured but not killed.

**Options for determining what constitutes a serious injury**

In general, it was recognized that guidelines for what constitutes a serious injury could include: 1) all animals should be considered seriously injured if they are observed injured in any way or are observed trailing gear, 2) some portion of animals trailing gear or injured in any way should be considered seriously injured, or 3) no animals that are observed injured or trailing gear that are not moribund should be considered seriously injured. The workshop participants generally accepted 2) as the realistic "middle ground" because of observations of living or dead marine mammals with healed injuries and observations of marine mammals that disentangle themselves from fishing lines and/or nets.

The workshop participants separated into two subgroups and developed possible guidelines for what constitutes a serious injury.

*Large whale subgroup*: This group addressed the entanglements of large whales in fishing line and nets that resulted in an animal becoming entangled in some or all of the fishing gear. The group identified many ways an entanglement could impact an animal, including impeding its locomotion, its ability to feed, its reproduction, or causing systemic injury. Subgroup participants indicated that any entanglement which resulted in an animal trailing gear, such that it's mobility or ability to feed was impeded should be considered a serious injury. However, specific criteria that indicated how to determine whether an entanglement impeded locomotion or ability to feed were not identified.

*Small cetacean subgroup*: This group addressed the interactions between small cetaceans and the longline fishery. The subgroup participants indicated animals that ingest hooks, were released trailing gear, or were released and swam away abnormally should be considered seriously injured. The subgroup participants indicated animals that were hooked externally or were released and swam away normally should not be considered injured. The participants stated that any incident that cannot be addressed by the above criteria should be evaluated on a case-by-case basis. Specific criteria indicating the amount of gear a cetacean would have to trail before it was considered a serious injury was discussed but a consensus was not reached.

**Other issues discussed at the Serious Injury Workshop**

*Disentangled marine mammals*: The workshop participants discussed whether an animal that has been disentangled by a commercial fisher or by a formal disentanglement effort should be used to classify a commercial fishery. This was identified as a concern because there is no incentive for fishers to report an entangled animal to the disentanglement network if disentangled animals will be automatically used to classify and regulate a fishery. It was suggested that animals documented as disentangled would be classified as uninjured. However, there was not consensus on this issue.

*Legal considerations*: Because information on marine mammal serious injury and mortality is used to manage commercial fisheries, it is important that adequate documentation on the level of serious injury and mortality be provided. The strongest types of evidence of marine mammal interactions with commercial fisheries include data published in peer reviewed journals or situations where information is collected in a systematic way using an established protocol (e.g., observer programs, necropsy reports). Anecdotal or opportunistic reports of marine mammal serious injury or mortality are less useful, but may be used to support management decisions. If possible, anecdotal or opportunistic reports should be accompanied by a statement from the individual who made the report, and a written statement from a NMFS individual who can assess the objectivity of the individual who made the report.

*Injury of pinnipeds*: A brief discussion of injuries reported for pinnipeds indicated that an animal hooked in the mouth (internally) or trailing gear should be considered seriously injured. Some participants felt that an animal hooked in its body would likely not be seriously injured.

**Research needs identified by workshop participants**

- Determine survival rates of animals entangled/injured in different types of fishing gear.
- Develop/improve methods for collecting blood and biopsy samples from entangled, stranded, or free-ranging animals to enable better determination of the effects of stress.
- Develop methods for radio or satellite tagging entangled animals. Ensure that equipment is available for tagging entangled animals.
- Survey the existing stranding networks for evidence of hook and line interactions.

**The next step**

The results of this workshop will be used when NMFS develops proposed guidelines for what constitutes a serious injury. Proposed guidelines will be published in the Federal Register for public comment; final guidelines will be published after public comments are reviewed and addressed.

## Workshop Proceedings

### 1.0 Introduction.

A workshop for the purpose of exploring a broad range of guidelines for what may constitute a serious injury to a marine mammal caused incidental to the operations of a commercial fishery was held in Silver Spring, MD on 1-2 April 1997. A list of workshop participants is provided in Appendix B. Robyn Angliss chaired the workshop, and Douglas DeMaster was the rapporteur.

Workshop participants were informed that a workshop report would be prepared to provide: 1) a record of the presentations and discussions, 2) a list of possible approaches to defining serious injury, and 3) a list of guidelines that could be used to determine whether an injury should be considered a serious injury. The findings and recommendations in this report would subsequently be used as the basis for proposed guidelines for what determines serious injury to marine mammals.

The underlying problem regarding the definition of serious injury is that the National Marine Fisheries Service (NMFS) is mandated to manage interactions between marine mammals and commercial fisheries based on the level of serious injury and mortality that occurs incidental to commercial fishing. At this time, NMFS does not have a consistent approach for determining what constitutes an injury that will likely lead to mortality (i.e., a serious injury). Angliss further noted that the number of animals either seriously injured or killed incidental to commercial fisheries was required under the Marine Mammal Protection Act (MMPA) to determine whether a stock of marine mammals should be classified as strategic, to classify fisheries into one of three categories in the List of Fisheries, and to determine whether Take Reduction Teams must be established.

NMFS formalized a definition for injury in the final regulations implementing section 118 of the MMPA (50 CFR 229.2; Box 1). It was noted that the definition for injury was developed to be all-inclusive to assist fishers in understanding which interactions must to be reported to NMFS.

> <u>Box 1: Definition of Injury</u>
>
> An injury is defined in 50 CFR 229.2 as. . .
>
> *". . .a wound or other physical harm. Signs of injury include, but are not limited to, visible blood flow, loss of or damage to an appendage or jaw, inability to use one or more appendages, asymmetry in the shape of the body or body position, noticeable swelling or hemorrhage, laceration, puncture, or rupture of eyeball, listless appearance or inability to defend itself, inability to swim or dive upon release from fishing gear, or signs of equilibrium imbalance. Any animal that ingests fishing gear, or any animal that is released with fishing gear entangling, trailing, or perforating any part of the body will be considered injured regardless of the absence of any wound or other evidence of an injury."*

The definition of serious injury had been intentionally left vague in 50 CFR 229.2 (Box 2) because NMFS recognized that serious injury could be defined in a multitude of ways (eg., species-specific, gear-specific, etc) and that outside expertise should be consulted prior to providing strict guidelines for what constitutes a serious injury to a marine mammal.

> <u>Box 2: Definition of Serious Injury</u>
>
> Serious injury is defined as. . . .
>
> *". . .any injury that is likely to result in mortality."*

Angliss reminded the workshop participants that, because the workshop is not exempt from the Federal Advisory Committee Act (FACA), opinions must be provided at the individual level, and not as a group.

## 2.0 Description and causes of injuries incurred by marine mammals

### 2.1 Evidence of entanglement of small cetaceans

Charles Potter presented a review of injuries to small cetaceans that were stranded and recovered along the east coast of the U.S. He reported that while signs of interactions with humans (e.g., line marks, bruises, penetrating wounds, lacerations, or missing appendages) were obvious at times, this was not always the case. For example, there have been numerous reports of harbor porpoise carcasses brought to researchers by fishers or by observers that were known to have drowned in fishing gear but were free of any signs of human interactions. Further complicating the determination of cause of death were the effects of benthic scavengers on carcasses, as well as the general putrification of tissues within a few days of death. Finally, inter- (e.g., shark) and intra-specific interactions also cause wounds that are superficially similar to marks caused by interactions with fishing gear. Because of these problems in distinguishing lesions and other marks caused by fishery interactions from other causes, a protocol for scoring lesions and marks has been developed (see Read and Murray, 1996) and was recommended for use by Potter. He noted that, in general, all external scars and lesions were photodocumented prior to conducting a full necropsy.

The following signs considered diagnostic of interactions with fishing gear were noted:

1) indications of bottom scavenging are not observed in animals suspended above the bottom in fishing gear,

2) characteristic marks on flukes (leading edge) caused by certain types of gill nets,

3) above average parasitic loads in animals in poor condition,

4) deep grooves in caudal peduncle, which are characteristic of entanglement in line or gillnet, and

5) loss of appendage (e.g., flukes) are typical of animal that has been cut out of a gill net by a fisher.

Scars caused by propeller marks are usually found on the dorsal surface of the animal if the animal was hit while alive, whereas scars caused by sharks look very similar but are often found on ventral or posterior surfaces.

Potter concluded that, in general, the most common lesions associated with capture in fishing gear were narrow, linear lacerations in the epidermis. These lacerations typically were found in the head, dorsal fin (leading edge), flipper, or fluke regions. Further, given the number of healed lesions consistent with entanglement in gear on harbor porpoise and other small cetaceans, it is clear that some fraction of animals that encounter fishery gear survive the interaction.

A number of participants had questions regarding the presentation:

**Q**: Are there different frequencies of some injury types among different species?

**Answer:** Yes- pilot whales show evidence of past trauma (e.g., broken mandibles). Also Risso's dolphins often are observed with numerous healed scars.

**Comment:** Harbor porpoise are the hummingbird of cetaceans and they are very easily killed through shock response with apparently little trauma. Potter added that spinner dolphins also seem to die with little evidence of trauma; whereas spotted dolphins typically survived a similarly stressful situation, but nonetheless show signs of trauma.

**Comment:** Pilot whales frequently have evidence of trauma, especially in southern U.S. waters. Many stranded pilot whales have many scars and have mandibles which have been broken and healed.

**Q:** Are some species more likely to die as a result of entanglement in fishing gear than others?

**Answer:** Yes- species like harbor porpoise, once entangled in a gill net, almost always die as a result of the interaction.

**Comment:** Most of the observed marks on bottlenose dolphins that are collected along the Texas coastline are well healed, and not fresh. Many of these marks appear to be caused by intraspecific trauma (e.g., fighting).

**Comment:** There seems to be some pattern in how well small cetaceans handle the stress of human-caused injury. Coastal species, such as coastal bottlenose dolphins, which are accustomed to foraging around debris in shallow water, appear to be less intimidated by artificial barriers, such as fishing nets. Pelagic species that have no experience with barriers tend to experience more stress and are more apt to die with little evidence of the interaction.

**Q:** When are harbor porpoise most likely to get entangled in a gill net?

**Answer:** Harbor porpoise become entangled while the net is fishing and while the harbor porpoise are feeding. Entangling while nets are being pulled seemed rare.

**Q:** Is scavenging damage more common in some areas than others?

**Answer:** Yes - Generally, bottom scavenging damage is uncommon in animals collected from the mid-Atlantic, but relatively common from animals collected from the Gulf of Maine.

**Q:** Can you tell mesh size from the pattern of marks on a carcass?

**Answer:** Yes, in those cases where the animal is a code 1 animal or code 2 carcass, where code 1= "currently alive", 2 = "death was very recent", 3 = "organs still discernable- death within several days", and 4 = "putrification- death more than a few days ago". For a code 1 or 2 animal, the marks created by the knots in the net can often be detected. In addition, sometimes the type of net can be distinguished on the carcass. For instance, the weave of a multifilament gillnet could sometimes be seen on the carcass of a stranded common dolphin.

**Q:** What about damage to nets? Can you tell what species caused a particular type of damage?

**Answer:** The nets are very fragile. Therefore, some species like the white sided dolphin or a medium size tuna would create holes in the net rather than becoming entangled like a harbor porpoise would.

**Comment:** White sided dolphins are squid feeders that normally don't feed off or near the bottom. Therefore, it would be unlikely for this species to be caught in a sink gill net.

**Comment:** Steller sea lions would also tend to rip through most gill nets set for salmon in Alaska.

**Comment:** In the New England area, fishers use fine twine in most of the gillnet fisheries, while in the mid-Atlantic gill net fisheries they use a twine that is twice as heavy. Therefore, workshop participants should keep in mind that generalizing about line size is almost impossible, given the unique nature of many of these fisheries.

## 2.2 Evidence of entanglement of large cetaceans

Scott Kraus summarized evidence of large whale entanglement obtained by examination of scars. He noted that the task of ascertaining whether a particular scar was due to a fishery interaction and the associated survival rate was easier for a species/stock like the North Atlantic right whale, where most of the population was uniquely identified and where the entire animal was photographed as part of the photo-identification study. In contrast, conducting a study of scars on a species/stock like the North Atlantic humpback whale would be more problematic because only a fraction of the population was uniquely identified and only the flukes were photographed for the purpose of photo-identification. When only the flukes are focused on and photographed, observers may easily miss gear entangling the animal around other parts of its body. Kraus also noted that in large whales there were three general areas of entanglement in net or other gear: 1) gape of the mouth, 2) around the flippers, and 3) around the tail stock (although this area was often difficult to view, as most balenopterid whales do not fluke frequently).

Kraus reported several observations of individuals entangled in gear, subsequently shedding the gear, and surviving the entanglement with evidence of the interaction in the form of a healed scar (e.g, often white scar tissue on a black background). In other animals, lesions caused by line or net material were areas of concentrations of orange colored cyamids, which typically did not occur in healthy tissue in these areas. Still in other animals, entanglement in line or net material caused lesions that did not appear to heal, where active necrosis around the impacted area was obvious. A number of these animals were subsequently found dead on the beach. Kraus commented that some fraction of entangled animals were also observed to be infected with a type of fungus that was typically white and associated with the anterior end of the animal (i.e., the head). Some of the animals that have developed this fungal infection have not been resighted in recent years.

Kraus made the point that without a proper necropsy, it was very difficult to determine the cause of death and the extent to which entangling gear may have contributed to it. For example, one animal observed entangled in a gill net in 1990 was seen in 1995 with an apparent fungal infection on its head. This animal was subsequently found dead on a beach in the southeastern U.S. The lesion caused by the entanglement was not healed and the tissue surrounding the impacted area was necrotic. However, during the necropsy it was determined that the cause of death was due to a collision with a vessel. The extent to which the entanglement contributed to the vessel strike could not be determined. In conclusion, Kraus commented that entanglement, while not good for the health of an animal, does not necessarily always lead to death. Necropsies of animals were required, when possible, to determine the cause of death. Necropsies were often compromised by the putrid condition of the stranded right whales (condition 4), but were nonetheless necessary.

A number of participants had questions or comments regarding the presentation:

**Q:** Was it common to observe stranded animals with damage to the tail caused by machetes or large knives?

> **Answer:** It is very difficult to cause extensive damage to the tail stock of a large whale with such an instrument. With right whales at least, fishermen are better off cutting the line rather than trying to cut off the flukes (which is relatively common in the situation where a small cetacean becomes entangled in active fishing gear).

**Q:** Is it difficult to tell damage caused by vessel strikes or predation (e.g., killer whale) from damage caused by net or line entanglement?

> **Answer:** In some cases damage caused by ship strikes can appear similar to damage caused by entanglement, although the former is almost never observed on the ventral surface of animal. Damage from ship strikes usually occurs as a series of large parallel cuts along the dorsal surface of the animal. Damage caused by killer whales is typically at the ends of the flippers or flukes and is often associated with visible rake marks.

**Q:** Is gear entanglement associated with higher levels of mortality or associated changes in behavior?

> **Answer:** The New England Aquarium (NEA) is in the process of analyzing all of the photographs in the right whale catalog for scar data (i.e., approximately 150,000 photographs of which about half have been scored). Upon completion of the analysis, survival patterns will be analyzed to look for correlations with entanglement, presence or absence of fungus, evidence of past or recent vessel strikes, the number of offspring, etc.

**Q:** Is it possible to generalize about large whale entanglements?

> **Answer:** Based on preliminary analyses of right whale data, the following seems to be true in general:
>
> 1) more than 60% of the individually recognizable animals show evidence of past or current entanglement in line or net material,
>
> 2) most of these entanglements occur when the animals are juveniles (e.g., between ages 2 and 5),
>
> 3) entanglement, while not always the immediate cause of death, may substantially increase the likelihood of mortality (e.g., 50% of entangled animals are infected on

their head with a white fungus and some of these animals have not been resighted recently while only a small percentage of non-entangled animals have been reported to have this type of infection), although predicting the survivability of individual animals that are entangled is unreliable (note: some animals have been observed to carry gear for over 5 years with no apparent ill effects),

4) it is not possible to reliably predict whether an animal will free itself of gear in which it is entangled (note: given the high rate of scarring among apparently healthy animals, a high proportion of animals must be able to lose or extricate themselves from the gear), and

5) an animal is likely at risk if it is a young/growing animal and the entangling gear is tightly wrapped.

**Q:** For species/stocks such as humpback whales, is it possible to get good photos of the tail stock to determine whether the animal has scarring consistent with gear entanglement?

**Answer:** Yes, but it requires the photographer to start taking photographs prior to full "fluke up". People accustomed to photographing humpback whales in the full "fluke up" position would have to be retrained to begin photographing earlier in the dive.

## 3.0 Entanglement and release from entanglement: Hormonal/physiological response to stress

Joe Geraci presented the summary of the immediate or short-term consequences of entanglement and release from entanglement. He noted that marine mammals have evolved to handle a wide variety of stressors, including a saline environment, predation, food shortages, etc. He further noted that cetaceans have developed a very unique healing process, which requires salt water to kill several cell layers to block penetration of additional salt water. After this process is completed, healing from within is initiated. Once the balance shifts to regeneration, healing is quick. However, only healthy animals have an optimal healing response.

Geraci noted that the physiological response of the body to stress, such as stress from entanglement, is to increase the secretion of glucocorticoids (e.g., cortisol) from the cortex of the adrenal gland and epinepherine from the medulla of the adrenal gland. In the short term, this response is beneficial to the animal because it breaks down blubber and muscle to provide glucose; however, if the stress condition persists, the acute response over time compromises the health of the animal. For example, cortisol suppresses the inflammatory response of the body (i.e., where cells that come in to surround a wound), thus retarding healing. It was further noted that after capture, cortisol increases rapidly and then falls off within days. A further complication is that lymphocytes are suppressed during the general stress response. Thus, sustained stress response makes marine mammals less able to fight infection or disease.

Another hormone, aldosterone, whose function is to cause the body to retain sodium, increases in concentration in response to stress in order to allow the animal to retain more water. However, if the stressor is chronic rather than acute, certain marine mammals (e.g., pinnipeds), will stop producing aldosterone, which causes sodium to flush out of the body. This imbalance (referred to as hyponatremia), if severe, can lead to metabolic death. Hyponatremia has been reported in wild caught animals (e.g., ringed seals), and has been induced in captive animals.

Geraci commented that cetaceans also have a well defined stress response, but it is physiologically different from the stress response of pinnipeds. In these animals, chronic exposure to stress causes an imbalance of numerous hormones and enzymes which can lead to some or all of the following: 1) increased sodium concentration in blood, 2) reduced eosinophil concentration in the blood, 3) hypoperfusion of the liver, 4) disseminated intravascular coagulation, 5) tissue necrosis, and 6) hypoxia. Geraci postulated that within 2-4 days of being traumatized in a net or by some other means these metabolic anomalies will manifest. In severe cases, death could be the result, even though superficially an animal might appear quite healthy.

Stranding is also a stressful event for a cetacean. The following physiological responses to stranding were reported by Geraci[2]:

1) Cortisol: rises within 5-20 hours following stranding. In healthy animals, cortisol levels would typically be at or below 3 ug/dl (levels above 5 ug/dl are considered suspect). Following a stranding, cortisol levels have been documented at greater than 8 ug/dl. It is not unlikely that an animal will survive with cortisol levels this high. Cortisol levels this high have not been duplicated with captive animals in experimental situations;

2) Aldosterone: rises from normal levels of 100 - 300 pg/ml to 100 - 600 pg/ml 10 hours post-stranding; aldosterone levels this high have not been duplicated with captive animals in experimental situations;

3) SGOT enzyme: rises from 100-200 to well above 200 IU/L 8 hours post-stranding. Such elevations are often associated with muscle and liver damage;

4) LDH muscle enzyme: normally found at levels of 200-300 iu/L, this enzyme will rise above 500 iu/L after stranding;

5) Potassium: concentrations can rise from 4-5 meq/L to 8.0-8.5 meq/L. Potassium levels above 5 meq/L are typically fatal. The source of the potassium is muscle tissue (i.e., as the muscle tissue breaks, potassium is released into the general circulation); in captive

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[2] Abbreviations are as follows:
SGOT enzyme is equivalent to aspartate aminotransferase
"LDH" is lactate dehydrogenase
"CPK" is creatine phosphokinease

situations, veterinarians may be able to correct for high potassium, but this cannot be done in the wild; free-ranging marine mammals do not have a mechanism for lowering the level of potassium in their blood;

6) CPK enzyme: normally found at levels under 200 iu/L, these levels increase to 400 to 800 iu/L within 10 hours following a stranding;

7) serum iron: declines within hours after stranding. Sustained cortisol will keep serum iron levels low. (Note: Geraci commented that as cortisol tests are not practical nor necessarily meaningful, a protocol could be developed that used a much cheaper test for iron, differential white cell counts, etc, to reflect elevated cortisol levels);

8) sodium levels in the blood increase in some cetaceans following a stranding event. Levels that are fatal (i.e., over 160 mmoles/L) have been observed. Normal levels are between 150-160 mmoles/L. The likely cause of the increase in blood sodium levels is the drinking of sea waters by cetaceans (note: pinnipeds do not behave this way, as stress causes blood sodium levels to fall);

Geraci noted that when cetaceans go through circulatory collapse, there is no blood circulation to the muscle. This causes hypoxia and destruction of muscle cells and release of enzymes and metabolites. Hypoxia may cause the body to cramp into an S shape and may cause scarring of muscle tissue.

Several of the participants had questions related to the presentation.

**Q:** Is the stress response reversible?

**Answer:** In captivity, the general stress response can be reversible. In the wild, a severe response is probably not reversible.

**Q:** Are strandings symptomatic of specific problems in cetaceans?

**Answer:** - Yes and no. In different areas, general factors responsible for stranding will change. For example, in some areas illness may be associated with a high frequency of stranding events. In other areas, stranding events may be correlated with a combination of a shoreward distribution of animals and the onset of severe weather.

**Q:** Could the stranded marine mammals studied for signs of stress response also be diseased? How often would healthy animals suffer the same stress response and die?

**Answer:** Disease is sometimes suspected as the cause for marine mammal strandings. Whether or not the animal will die once stranded can be dependent on the species involved. Healthy animals taken by the public display industry seldom die during capture; however, hardier species, such as bottlenose dolphins, are selected for captivity over species such as harbor porpoise.

**Q:** What percentage of animals in the display industry die?

**Answer:** Recent reports (e.g., DeMaster and Drevenak 1988, Small and DeMaster 1995) indicate that annual survival rates for captive cetaceans are typically on the order of 0.93 to 0.95. Of the cetacean species typically held in captivity, bottlenose dolphins seem to be the most robust.

**Q:** Can species-specific generalizations be made about how many marine mammals would die of stress given a particular stressor?

**Answer:** Not really. In a general sense, animals such as bottlenose dolphins tend to be more robust; animals such as harbor porpoise tend to be rather dainty.

**Q:** Studies on stress using fish indicate that their blood chemistry values recover after 2 days (defined by lactic acid). Is this also the case for cetaceans?

**Answer:** This does not seem to apply to cetaceans.

**Comment:** The response to stress seems to be very species specific with species like bottlenose dolphin being considerably more robust than species like harbor porpoise.

**Comment:** Also, species like white sided dolphin, short- and long-finned pilot whale, and grampus seem considerably more resistant to stress than harbor porpoise.

**Comment:** Bottlenose dolphin in Sarasota Bay have been captured and released with very few problems for over 30 years. There may be ecological factors that predispose particular species to handle stress well. For example, large coastal species (like bottlenose dolphin) seem to be both wary and adaptable relative to smaller coastal species (like harbor porpoise) or pelagic species.

**Q:** Most of the blood chemistry data from stranded animals is collected hours after the stranding event was observed. Was the animal likely to be stressed prior to actually becoming "beached"?

**Answer:** Yes, it is likely that the animal was stressed prior to stranding. In some cases fear or psychogenic stress may conceivably be the factor leading to a stranding event.

**Comment:** Psychogenic effects complicates predicting the response of an animal to stress or a stranding event. There are likely species specific differences related to ecological niche. For example, right whales and bottlenose dolphin are likely to be very robust to psychogenic stress. Harbor porpoise, which are prey for a variety of large predators, may not be. Further, social species that are isolated by a capture, entanglement, or stranding event may be more susceptible to psychogenic effects than less social species.

**Q:** Given that some unknown fraction of stressed animals will die as a result of stress, would it be possible to tell from a blood sample which animals were most likely to die?

**Answer:** Yes- if you took a blood sample and looked at 4-5 analytes you could build a profile of which animals were more or less likely to recover.

**Q:** How long after death are blood values meaningful? That is, is blood from a carcass several days old of use for blood chemistry evaluation?

**Answer:** No. Very few blood parameters are reliable after an hour or so following death.

## 4.0 Legal considerations

Karl Gleaves led this discussion and addressed the basic question of what information needs to be collected to support certain administrative/management actions. In general, NMFS administrative/regulatory decisions rely on documents that are recognized as being legally sufficient. For example, documents that reflect good science (e.g., a peer reviewed article published in a recognized journal) are considered adequate to support a particular agency position. Documents that reflect case studies, where the data were collected in a systematic fashion (e.g., a good necropsy report carried out by a reputable expert who followed an established and accepted protocol) are often considered adequate. Opportunistic or anecdotal reports are generally not considered suitable to support a legal position. Nonetheless, Gleaves recommended that a standardized way of collecting opportunistic information should be developed so the information can be used for management. For instance, whenever possible, efforts should be made to prepare written statements from individuals who witnessed a particular event and the NMFS individual who documents the opportunistic information should attempt to assess the objectiveness of that person. He added that a common weakness in reports related to marine mammal-fishery interactions was the inability of the person making the report to accurately determine or even describe the specific fishery that was involved.

Several of the participants had questions related to the presentation.

**Q:** In most legal actions in which NMFS gets involved, is a preponderance of evidence necessary to support a particular position?

**Answer:** No. Under the MMPA, where there is uncertainty regarding a marine mammal-fishery interaction, the agency should err on the side of the marine mammal. However, the agency can neither be arbitrary nor capricious in any of its rulings.

**Q:** Will some results of NMFS actions discourage opportunistic reports of marine mammal-fishery interactions?

**Answer:** Yes. For example, an approach rule was established for right whales to specifically define what constitutes a "close approach". This regulation prohibits approaches, so fishers may not be able to see and report entanglements. In addition, because opportunistic information was used to support recent management recommendations by the Atlantic Large Whale Take Reduction Team, it is clear to the public that there may be severe consequences if opportunistic information is provided.

**Comment:** One disadvantage of such efforts will be to create disincentives for fishers to report interactions with large whales. At present, such reports are not required (i.e., they are voluntary). Once required, the degree to which fishers continue to report such interactions may decline. Further, reduced numbers of reports of interactions will likely reduce the number of reports of entangled animals, which will severely compromise efforts to locate and disentangle them.

**Comment:** In general, discouraging opportunistic reports might reduce the overall number of reports; however, some fisheries in competition with other fisheries would be more willing to report interactions under a more formal system.

**Q:** Why is it that on the east coast fishers are liable for interacting with some marine mammals listed under the Endangered Species Act (ESA) while on the west coast this is not the case?

**Answer:** Both the MMPA and ESA prohibit incidental taking of listed species/stocks, unless exempted (which requires a determination that a particular level of take will have a negligible impact on the species/stock). Such determinations have been made for several of the listed stocks on the west coast. In those cases, individual fishers are not personally liable for an interaction with those species.

## 5.0 Entanglement and release from entanglement: Muscular response to stress

Dan Cowan presented information on chronic effects of entanglement and other stressors on cetaceans. He noted that most of his experience was with bottlenose dolphins in the Gulf of Mexico. As noted by other participants, bottlenose dolphins are very adaptable and seem to be relatively able to cope with anthropogenically-induced stress. He added that the objective of the necropsy program for salvaged marine mammals is to determine the cause of death, when possible, to catalog specimens for anatomical collections, to provide specimens for toxicological studies, and to provide specimens for disease studies.

He noted that after 50 or more necropsies of bottlenose dolphins he now has some idea of what constitutes "normal" organs and tissues. For instance, he has records of the range of typical weights of bottlenose dolphin organs. In addition, he has described which microscopic features can be used to differentiate between a healthy and a diseased organ. Further, he noted that there was a wide range of circumstances, where without the benefit of a systematic necropsy, the cause of death would remain either unknown or be determined incorrectly.

Cowan made two points regarding the general effects of stress on marine mammals. First, stress responses are reflexes that cannot be controlled by the animal being stressed. Second, the extent of a stress response depends on the animal's perception of the world.

Cowan noted that for bottlenose dolphins there was strong histological evidence that exposure to chronic stress results in physical damage to certain tissues. For example, he has found evidence of damage to the myocardium referred to as "eschemic" injuries. Evidence of such injuries in the myocardium include a change in color of the damaged tissue indicating necrosis of the myocardium, the formation of bubbles in the muscle tissue, ruptured blood vessels, and separation of muscle fibers within the tissue. Cowan postulated that such damage is caused by long-term exposure of tissue to high levels of adrenaline. He noted that both pigs and humans show similar lesions if chronically stressed, and indicated that older bottlenose dolphins have healed scars on the myocardium likely caused by prior stress events.

Where sufficient adrenaline is released, a vaso-spastic response can develop that can seriously damage the heart muscle, which will, over time, compromise the animal's survivability. In some cases, contraction band necrosis can be seen as a series of stripes that form perpendicular to the length of the muscle cells. Enzymes released from muscle cells damaged during a stress response are present for some time in the blood stream, but typically in low amounts.

An early sign of eschemic injury is heart muscle fibers that appear wavy. This appearance is cause by fibers that stretch, then are damaged during the stress response and subsequently cannot contract. This was seen in a bottlenose dolphin carcass retrieved from a gillnet.

Cowan concluded by noting that stress has been reported to be a factor leading to mortality in several species of cetacea caught in nets. For example, in the eastern tropical Pacific purse seine fishery for yellowfin tuna, several spinner dolphins were necropsied after being found dead at the bottom of the purse seine net. Necropsy results indicated that these animals did not drown, but died due to profound lesions in the myocardium. In some situations, mortality occurred immediately after the stress was observed; however, mortality sometimes occurred one to two weeks after the event. As noted previously, the actual cause or causes of death are often times not obvious from an external examination. A full necropsy is required to make reliable determinations as to the cause of death, and even then may be inconclusive.

Finally, Cowan noted that the volume of the adrenal medulla in bottlenose dolphins is very large relative to other similarly sized mammals. It may be that this adaptation to the marine life style predisposes these animals to some form of chronic stress syndrome. Additional research is needed on other cetacean species to determine the extent to which the adrenals are enlarged in cetaceans relative to other mammals.

Several questions were raised following this presentation.

**Q:** How long after death can you pick up anatomical evidence of a chronic or acute stress response?

> **Answer:** After 18 hours there is still histological evidence of heart damage. Unfortunately, a standard sampling protocol for histological analysis has not been developed and implemented among the various stranding response organizations. Therefore, considerable information on the cause of a mortality has been lost. Ideally, core sections should be taken through several sections of the heart.
>
> A new clinical test for humans has been developed to detect heart damage (e.g., a test for enzymes that are associated with heart damage). Similar tests could likely be developed for cetaceans, if blood samples were available was from relatively fresh carcasses.

**Q:** Would it be possible to develop a protocol for histological studies of hearts from large whales, such as a humpback whale.

> **Answer:** Yes, if the tissue obtained was fresh enough.
>
> **Comment:** Most right whale carcasses are in a semi-putrefied or putrefied condition (code 3 or 4) when beached. It would be very difficult to get an adequate sample of tissues from fresh carcasses of right whales in the NE.
>
> **Comment:** A few stranded humpback and fin whales are fresh enough for histologic determination.

**Q:** What fraction of animals sampled have heart lesions similar to those described?

> **Answer:** 100%, but the number and magnitude of the lesions vary greatly among animals.

## 6.0 Entanglement and injury of pinnipeds

Francis Gulland led the discussion of this topic. She cautioned that most of her experience was with west coast pinnipeds (e.g., California sea lion, harbor seal, Steller sea lion, northern elephant seal, northern fur seal). Further, on the west coast, given the number of pinniped stranding events per year, only reports of live stranded pinnipeds generally result in a response. Even with this limitation, she noted that typically over 500 animals per year were treated at the Marine Mammal Center, in central California, where she works. Of these, three types of injuries related to human interactions were most common: 1) gunshot wounds, 2) wounds caused by hooks or nets, and 3) wounds related to unspecified trauma (most likely gun shot wounds, but where physical evidence was lacking). These three types of injuries were identified in 7%, 4%, and 0.4% of the animals examined between January 1994 and January 1996, respectively. As expected, the cause of injury for a large fraction of the observed wounds or lesions could be not determined.

In the absense of fishery-specific wounds, evidence for interactions with specific fisheries is often related to the timing of the opening or closing of a certain fishery and a change in the pattern of strandings of injured pinnipeds. For example, in Monterey Bay and Half Moon Bay, gunshot wounds in California sea lions increase at the start of the herring season and diminish dramatically at the end of the season. Typically, only about 10% of animals that are shot survive to be released into the wild.

Gulland noted that it was very difficult to accurately determine the full extent of any pathology an animal might exhibit from external examinations alone. For example, lesions from netting or packing bands are often infected and associated with necrotic tissue. If such an injury is in the neck region and if the infection surpasses the ability of the lymph system to control it, the lungs will often become infected, often leading to mortality. In addition, microbes that enter the blood stream can cause secondary infections in the heart (e.g,. heart valves), brain, or other vital organs. Another example of trauma difficult to ascertain without a full necropsy is that caused by embedded fish hooks. In some cases, hooks are only detected on an x-ray. Where hooks (or nails) migrate from the stomach to the lungs, pleuritis may develop over a period of weeks. Where hooks embed in the jaw, abscesses may develop over weeks or months and cause tooth loss or the inability to feed.

Gulland commented that most gun shot wounds in live stranded pinnipeds were in the head or thorax region. Shots to the head region are often associated with eye damage (e.g., opacity in the lens) or infections in the nasal cavity or palate. Where such injuries lead to major infections, the nasal tract may serve as a conduit to the brain, which could result in meningitis.

Shots to the thorax (where the shooter was presumably aiming at the heart) are often associated with broken ribs and subsequent infections, thoracic necrosis, paralysis in the posterior portion of the body, urinary retention, etc. Such injuries often take 3 - 4 months to become fully manifest and are often fatal.

Gulland also noted that injuries caused by sharks and vessel propellers are also observed and are typically distinguishable from injuries associated with fishery interactions. For example, shark bites are almost always found on the rear flippers of pinnipeds. Many of these injuries are insufficient to be the immediate cause of death, but if they become infected, could lead to death over weeks or months. Gulland added that other causes of death include, but were not limited to: 1) malnutrition (typically observed in yearlings), and 2) diseases, including leptospirosis, lung worm, carcinomas (observed in 20% of adults). Finally, she noted that intraspecific wounding was relatively uncommon in the California sea lions treated at the Marine Mammal Center.

Several questions were asked following this presentation.

**Q:** How many animals survive with hooks embedded in them?

> **Answer:** It is unusual to find healthy animals with hooks in them. Ingested nails and hooks may perforate the stomach wall and cause infection. This sort of injury should be considered serious (by the NMFS definition).

**Q:** Are the majority of injured sea lions male? Could some injuries be intraspecific?

> **Answer:** Yes, about 80% of the injured animals are male. It is unlikely that the injuries are intraspecific because they occur throughout the year, not just during mating season, and because the injuries are seen in young animals under 3 years of age.

## 7.0 Fishing gear technology

### 7.1 Lobster pot fishery

Terry Stockwell led this discussion. He noted that from Maine to North Carolina, there were over 25,000 licensed fishers for lobster, of which about 80% fish within 20 miles of shore (75% within 3 miles). Approximately 4,000 federal permits are issued for lobster. This fishery involves setting over 4 million traps per year; in 1995, approximately 67 million pounds of lobster worth $220 million were caught. Therefore, the lobster fishery is one of the largest and one of the most valuable fisheries in the NE Atlantic.

Stockwell commented that a variety of gear is used in this fishery (e.g., single trap with 1 buoy (inshore), pair of traps with 1 buoy (inshore), two buoys attached to 2- 4 traps (inshore) or 2 buoys attached to a string of 15 or more traps (offshore)). Further, the fishers who fish the inshore area use lighter gear (5/16-3/8 inch line) than do fishers who fish offshore.

Typically, fishers who set pots near shore have one or two pots for each vertical line to the surface. When there is more than one pot set, pots are connected via groundlines. Fishers who fish offshore often have many pots connected to each other and typically have a buoy marking each end of the string of pots. Ideally, the ground line is stretched tight on the bottom, which would minimize the probability of entangling a cetacean. However, where the bottom topography is irregular or where there are gear problems (e.g., if two pots are deployed too close together), the bottom lines would be loose and float above the sea floor. DeAlteris commented that he has had experience diving on the ground lines in this fishery and generally the line is stretched taut along the bottom. Where a trap lands on end, the ground line is off the bottom by several feet (i.e., the height of the trap). S. Young commented that in areas where one fisher retrieves gear overlapped by the gear of another fisher, gear would be pulled up and loops would form in the ground line of the gear that is redeposited on the bottom. Such loops were sometimes in excess of 6 ft.

In the offshore area, fishers typically use over 300 ft of ground line between pots; in the inshore fishery 100 - 200 ft of line is used between pots. The cost of the traps associated with the inshore lobster fishery is approximately $50; the cost of traps in the offshore is a little higher. In general, the inshore fishers pull and re-set their pots 2-3 times per week, while the offshore fishers pull and re-set their pots 1-2 times per week.

Efforts to mitigate right whale or other large whale entanglements are ongoing. In the lobster fishery management plan for the State of Massachusetts, the following elements have been incorporated to eliminate or minimize entanglements: 1) closure of critical habitat at certain times, 2) prohibition of use of float ropes, 3) reduction in the number of vertical lines used, 4) use of break away lines attached to buoys, 5) use of break away lines near the surface, 6) use of lighter (more easily broken) lines in general, and 7) implementation of a warp marking program (by region or fishery user group). In Maine, a disentanglement network for identifying and disentangling entangled right whales is being established.

### 7.2 Sink gillnet fishery

Stockwell also led the discussion regarding the sink gill net fishery. He described this fishery as a fishery where the number of fishers has been in decline for several years. For example, in Maine there are now less than 20 active gillnetters, while several years ago there were more than 200 active gillnetters. A series of sink gillnets are attached to floating rope and attached to an anchor. The gear typically stands 12 ft high off the bottom and is fished in water 10 to 200 fathoms deep. This is a multispecies fishery, which targets dogfish, flatfish, monkfish, and some species of bait fish. Typically, the mesh size used to target monkfish is 12 inches, while the mesh size used to target dogfish is 7 inches. Mesh size for other species varies by area and season, but minimum mesh size requirements are in place in many areas. An individual fisher often fishes between 40 and 200 nets at a time. Successful efforts to mitigate interactions with harbor porpoise have involved the use of pingers. Future efforts to mitigate interactions with large whales will include incorporating a weak link on the floating portion of bridle (the bridle connects adjacent sink gillnets), and securely anchoring the nets.

Regarding harbor porpoise interactions in this fishery, Stockwell noted that almost all of the interactions resulted in mortalities and that injuries, where the porpoise was released alive, were rarely observed or reported.

### 7.3 Pelagic longline fishery

John Hoey led the discussion regarding this fishery. This is a widely distributed fishery in space and time, where fishers fish in water depths anywhere from 10-15 fathoms to 2000-3000 fathoms and between 5° - 45° N. In the last several years, the longline fishery has targeted offshore tuna and swordfish (mostly outside of 75 fathoms). In recent years, this fishery has carried natural resource monitors (i.e., observers). From 1991 to 1995, 2600 observations of line retrievals took place. A total of 83 interactions with marine mammals were reported from 72 sets. Marine mammal interactions mostly involved pilot whales. Interactions were typically clustered in space and time. Most of the interactions were believed to be predation events, where a fisher would lose 30-40 % of the catch on a daily set . Several hooking events were reported where the line would be cut as close to the hook as possible and the animal would be released (trailing the remainder of the line and the hook). While one mortality of a pilot whale and two mortalities of Risso's dolphins have been observed, most animals are released alive but may be injured to different degrees or have varying amounts of gear still attached. A focus of recent research on longline interactions with marine mammals is to look at gear combinations to see how different gear takes marine mammals.

In the late 1970s, the U.S. longline fishery switched to monofilament gear, using squid for bait supplemented with light sticks. While the specific gear used varies by area and by fisher, the main line used in this fishery is typically 600 lb to 900 lb test monofilament line, which is used because of minimal drag on the line during retrieval. s are lines that attach a hook, bait, and light stick to the mainline at regular intervals. Hoey added that because fishers want to minimize entanglement of consecutive s, the spacing of s along the mainline is slightly more than twice the length of a single . Fishing depth is regulated either by using longer dropper lines, longer lines, reduced tension on the mainline, or by increasing the number of hooks between floats, when the thermocline is deeper than usual. Fishers often fish 28-35 miles of surface gear. The target depth is at the thermocline in most longline fisheries. Therefore, if the thermocline is deep, fishers will typically fish 300 hooks on a 35 mile main line; while if the thermocline is shallow, they will fish 600 to 700 hooks on the main line. Where the gear is rigged shallow (e.g., on the Grand Banks), with s that are longer than or equal to the depth of the mainline, entangled marine mammals and sea turtles can get to the surface to breathe. When gear is rigged deeper (e.g., Gulf of Mexico?), marine mammals and sea turtles will have greater difficulty reaching the surface, especially when there are a large number of hooks between floats with other species caught on nearby hooks. Additionally, mainline and gangion construction material could have an influence in that lines with greater drag and resistance in the water will be more difficult to drag to the surface[3].

Hoey also commented that in different areas and at different times of the year, fishers use different style and size hooks and different types of bait. Because the hooking rate of marine mammals likely varies with hook size and style, and type of bait, more information is needed on factors that affect hooking rates. In addition, some hooks have different coatings or treatments to prevent corrosion, while older styles are less resistant to corrosion. During a sea turtle/longline workshop, a Captain suggested that use of the older style hooks, which corrode within a few weeks, might present less of a threat to marine mammals. Preliminary efforts are underway at the Southwest Fisheries Science Center to design a process whereby hooks are treated every night to prevent corrosion and hooks that are lost (and therefore untreated) will corrode rapidly. Finally, Hoey noted that certain fishers use live bait when tuna fishing, which results in higher rates of billfish interactions. Bait differences may contribute to regional differences in marine mammal interactions as well.

Hoey concluded that based on observer reports, most of the interactions between this fishery and marine mammals are not lethal, and animals are typically released alive. A proportion of these animals are released trailing gear (i.e., a hook with part of the gangion)[4].

Several questions were raised following this presentation.

**Q:** How long do the treated hooks last?

> **Answer:** Three to four months.

**Q:** Is it better for a marine mammal to be hooked by a hook that rusts quickly or a hook that is clean?

> **Answer:** A clean hook would be worse because it would stay in a marine mammal's mouth longer. A hook that rusts might be preferable because it would rust out of the animal's mouth.

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[3] Most gangions used north of Cape Hattaras are less than 50 ft in length. Thus, the total weight of the hook, a longline snap, and 50 ft of 400 pound test line would weigh less than 1 pound.

[4] A piece of mainline material was circulated to workshop participants to illustrate it's potential for entangling an animal once tension is released on the line by cutting both ends of the mainline.

**Comment:** The industry needs approved guidelines from NMFS regarding how to release entangled and/or hooked marine mammals. The Blue Water Fisherman's Association provided draft suggestions from Captains on operating guidelines for releasing marine mammals during the initial meeting of the Atlantic Offshore Take Reduction Team meeting[5].

**Comment:** Sink gillnetter and other commercial fisheries in the NE have taken it upon themselves to develop new fishing techniques to reduce interactions with marine mammals. Why doesn't the longline fishery do something similar?

**Comment:** The agency is looking at preliminary guidelines for releasing turtles.

## 8.0 Information needs for managing marine mammal-fishery interactions relative to serious injuries.

### 8.1 Observer program: A national overview

Mike Tork led the discussion of this topic. He noted that there was an urgent need for the development of a consistent approach to the way injuries were used in the PBR-based management system currently used by NMFS for managing interactions between marine mammals and commercial fisheries. He added that in different NMFS regions, data on injury and serious injury are used differently in estimating stock-specific rates of annual removal levels. Further, because a consistent policy is lacking, training regarding identification and evaluation of what constitutes a serious injury varies by Region. He recommended that the agency develop a protocol that would be used to direct observers in all Category I and II fisheries as to how information on injuries and serious injury should be collected and reported. This protocol would include: 1) requirements as to what type of information is important in describing interactions that result in injuries to marine mammals, 2) completing the necessary forms, 3) training to determine when it is not possible to collect the information necessary to classify an injury as serious or not, 4) training in the use of photography to document certain types of injury, 5) training in the collection of specimen material (e.g., blood samples) needed to document certain types of injury, and 6) training in the identification and collection of fishery-specific or species-specific information needed to classify injuries.

Tork then summarized observer data from 1994-1996 collected in fisheries from the NE and SE Regions. The following fisheries were found to have no reports of injuries to marine mammals: bottom trawl (no injuries, but 14 mortalities reported), coastal bottom trawl, sink gillnet (no injuries, numerous mortalities), and the scallop dredge fishery. The following fisheries were found to have reports of injuries to marine mammals: pelagic longline, pelagic swordfish

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[5] These draft guidelines were part of the draft Atlantic Offshore Cetacean Take Reduction Plan and will be addressed by NMFS when the Plan is made available to the public.

driftnet, and pair-trawl fishery. Tork noted that the primary fishery where injuries were reported was the longline fishery.

Several questions were asked following this presentation.

**Q:** Regarding the interactions between marine mammals and the Atlantic tuna purse seine fishery, did the fishers set on the marine mammals?

**Answer:** No, the fishers set on small groups of tuna. Eight marine mammals were observed encircled and all swam out of the net before it was pursed.

**Q:** Is it even possible to determine the probability that an animal released trailing longline gear will die as a result of that gear?

**Comment:** To conduct a controlled experiment to address this question is not reasonable. However, while assigning a probability of mortality to a particular type of entanglement is very difficult, it is possible to put limits on the number of hooked animals that could possibly die. If such estimates are applied to the PBR process and make no difference in the agency's management response, it can be assumed that the definition of what constitutes a serious injury is not a serious problem for this particular fishery.

**Comment:** For longline fisheries, all animals should be considered seriously injured that are cut free and trail gear, where the gear is internally hooked (e.g., in the mouth, throat, or lips); while animals externally hooked (e.g., in the flukes or flippers) should be considered injured. Which of these injuries are serious will depend on the definition of serious injuries. In addition, studies should be done on those species where photo-identification methods can be used to determine survivability relative to whether an animal is hooked internally, hooked externally, or not hooked.

**Comment:** There are really two extremes that could be selected in the absence of information: 1) all animals that are injured will die in the year they are injured or 2) injured animals have the same mortality schedule as comparable animals (i.e., age and sex) that are not injured. In the management of Pacific halibut, specific condition codes are assigned to all discards. A qualitative index should be similarly developed for marine mammals that are injured incidental to the operations of commercial fisheries. One such approach to such an undertaking would be to put animals in a pen after hooking and compare the survival of such animals with healthy animals held in captivity.

**Q:** Should observers at sea be required to make the determination as to whether an injury is serious?

> **Answer (many of the participants agreed with the following):** Even with well trained, experienced observers, this decision should be made by the data editors, using predetermined criteria to evaluate the information provided by the observer. In this way, the observer is less likely to be pressured by vessel personnel to classify an injury a certain way. Further, this avoids the situation where an observer may be dissatisfied with the actions of the skipper or his/her crew and the situation where an observer is relatively inexperienced.
>
> **Comment:** At present, sufficient information does not exist to address the question of survivability. Perhaps a separate workshop should be convened to address the issue of experimental design for studies to determine the impact of entanglement on the subsequent survival of a number of species of marine mammals. Further, perhaps new technology (e.g., motion sensing tags) could be adapted to address this question.
>
> **Comment:** For Atlantic fisheries, something on the order of 20 marine mammals (all species combined) are entangled and released per year from the longline fishery. Even if every animal were tagged, estimates of survival would be imprecise to the point where they were not informative.

### 8.2 Longline observer perspective

Mike Pol briefly discussed the collection of data by observers in the longline fishery. He recommended that observers be better trained regarding what information should be collected on interactions that result in injuries prior to efforts being spent on research to estimate survival rates of hooked individuals.

**Q:** Is there any information from the longline fishery on loss rates and how much gear might be "ghost fishing"?

> **Answer:** There is now a code for lost gear. Therefore, for the past couple of years it would be possible to estimate loss rates for this fishery.
>
> **Comment:** In this fishery, fishers don't want to lose gear to container ships or large whales because of the cost of replacing it. Fishers will often radio tag one end of the gear to facilitate its location if lost. In addition, fishers typically fish in code groups, where one fisher in the same code group would pick up any lost gear of another fisher in his/her same code group.

**Comment:** The rate of gear loss in the lobster pot fishery could, however, be substantial.

### 8.3 Longline data analysis

Craig Brown led the discussion of this topic. Brown noted that the longline fishing area in the Atlantic and Gulf of Mexico was divided into 11 statistical areas. The target level for observer coverage in 1994 and 1995 was 5%. However, due to a reduction in available resources, the sampling fractions for 1996 and 1997 are estimated to be around 3% based upon current and expected sampling levels and recent average total effort. Swordfish logbooks from 1994 and 1995 were used to determine the total amount of fishing effort per year. The observed marine mammal mortalities were extrapolated to total mortality based on a General Linear Model. In using this approach it was assumed that the distribution of catches followed a delta log-normal distribution. It was further assumed that the mortality rate on non-observed vessels was equal to that on observed vessels. Brown reported that the distribution of fishing effort based on logbooks and observer reports were in close agreement. Factors used to predict catch included year, quarter (season), area, and effort. The probability of a non zero catch was estimated separately from the distribution for the mean catch for trips where catch was nonzero.

Only one marine mammal was observed killed in 1994 and 1995. If all captured (i.e., hooked or entangled) marine mammals were assumed to have been killed due to the interaction, approximate kill levels in 1994 in the Atlantic and Gulf of Mexico would have been 168 and 36, respectively. In 1995, the same mortality levels would have been 286 and 0, respectively. Brown commented that given the small number of observed mortalities and injuries, there is substantial loss in precision when mortality rates are estimated by species. Because of the low observer coverage and low numbers of mortalities and injuries involved, the confidence interval on any total take estimate is large. Nearly all marine mammal takes occurred north of Cape Hatteras.

The following questions were asked regarding this presentation.

**Q:** Is there really a problem with marine mammal mortalities and serious injuries in this fishery?

> **Answer:** At this time, the PBR for pilot whales in the western North Atlantic is 28. The estimated annual removal level was 109 animals, of which 11 were from the longline fishery. Therefore, the removal rate of 11 animals per year in the longline fishery is significant.

> **Comment:** The real problem with the management of pilot whales is the inability of researchers to estimate minimum abundance without substantial negative bias.

> **Comment:** The estimated annual removal level of marine mammals that interact with the western North Atlantic longline fishery did not include animals that were

seriously injured, but only animals that were reported to have been killed incidental to the operation of the fishery.

**Comment:** The Atlantic SRG made a recommendation that NMFS include injuries in the estimation of annual removal levels; this recommendation was not adopted by NMFS. Given that the PBR is exceeded based on only observed mortalities, it is likely that mortalities of pilot whales incidental to commercial fishing is significant.

**Q:** If the pattern of interactions is non-random, would there be an advantage in allocating observer coverage proportional to average interaction rates for a given strata?

**Answer:** Yes- allocating observer effort in such a manner would likely improve the precision of the mortality estimate, assuming that the pattern of mortality is relatively constant from year to year, although the improvement would be modest for these species. However, such an approach could make it difficult to detect changes in the fishery and mortality patterns, and could affect other objectives of the observer program.

**Q:** Is it possible that a pilot whale hooked on a longline could be as stressed as a harbor porpoise entangled in a gill net? Could stress related physiological changes in these animals lead to mortalities even though an animal was released alive?

**Answer:** It is possible. He concurred with S. Young that an animal hooked (internally) in the mouth or throat is in grave danger. Further, a hook trailing a lot of line is also likely to compromise survivability. Geraci suggested that three categories of predicted survivability be established: 1) unlikely to survive, 2) unknown, and 3) likely to survive.

**Comment:** If the data are further stratified, as recommended by Geraci, the precision of the estimate, given the small number of interactions per year, will get worse.

**Comment:** Cowan agreed with Geraci that if an animal is hooked in the mouth or throat, the animal is likely to die. On the other hand, if an animal is hooked in the blubber or a fin, it is more likely to survive than die.

**Q:** Do different vessels fish differently for different target species (e.g., are sets made at different times of day)? Also, what about seabird interactions?

**Answer:** Yes - tuna sets are typically made during day, while sets for swordfish are made at night. Also fishers fish at different depths for different target species. Finally, interactions with seabirds were not included in the analysis[6].

**Q:** Is the amount of longline fishing effort relatively constant over time?

**Answer:** Yes, at least for 1994 and 1995.

**Q:** What is the multiplier used to estimate total kill in the longline fishery?

**Answer:** A multiplier was not used to calculate total mortality. Rather, a general linear model was used to determine the probability of non-zero kill sets and the mean kill per set, given that at least one animal was killed in the set.

**Q:** Is only mortality considered under PBR management (i.e., is the sexual composition of the take considered)?

**Answer:** Both mortality and serious injury are supposed to be considered in determining the level of take relative to the calculated PBR level. To date, the age and sex composition of the take have not been considered in making the determinations. It is important to recognize that the formula for calculating PBR levels is conservative so that human-caused mortality and serious injury likely would be sustainable if it is kept below the calculated PBR, even if the take is biased toward reproductive-aged females.

### 8.4 Data from the lobster pot/trap fishery

Kim Thounhurst led the discussion on this topic. She noted that most of the reported large whale entanglements are not from the observer programs, but rather are anecdotal reports. Such reports often have questionable information regarding species identification, fisheries identification, etc. Based on data from 1991 - 1995, the lobster fishery removed 23% of the humpback whale PBR, 100% of the right whale PBR, and 8% of the minke whale PBR.

Thounhurst commented that the Atlantic SRG had recommended that any animals observed trailing gear should be considered seriously injured. This recommendation was not adopted by NMFS in last year's status review. The Northeast Region, in the final List of Fisheries for 1997, recommended the following criteria be used in determining whether an entanglement of lobster gear constitutes a serious injury for a large whale: 1) if movement is impeded, 2) if feeding is impeded (e.g., baleen is fouled), or 3) if the entangling line is observed to cut through

[6] Interactions between the longline fishery and seabirds have been observed but were not included in the analysis by Scott and Brown.

the skin. Secondary considerations were if the entangled animal is a juvenile and it is entangled (even loosely), as the entanglement will become restrictive as the animal grows in size, and if the entanglement impedes nursing.

Discussion ensued regarding whether all animals trailing gear should be considered seriously injured and whether the numbers of animals seriously injured should be adjusted if the animal was either disentangled or observed at a later time without the entangling gear. Geraci commented that as it was operationally impossible to estimate the amount of trailing gear on an entangled animal and very difficult to ascertain the degree to which locomotion, feeding, or nursing was impeded, all entanglements of large whales should be considered serious injuries. Pol responded to Geraci' s comment by noting that cameras or videocameras could be used to assist in the classification as to whether a particular incident of entanglement constituted a serious injury, but that use of this equipment would be tremendously difficult given the current responsibilities of observers. Hofman noted that if Geraci's recommendation were adopted there would be a strong disincentive for fishers to report entangled whales to the right whale sighting network, whereas if the number of animals seriously injured was to be adjusted if animals were disentangled it would likely provide an incentive to fishers to report animals.

The following questions were asked regarding this presentation.

**Q:** Would it be possible to use photographs to help classify entanglements?

> **Comment:** Cameras should work, but observers are often very busy. Therefore, they might not have the time to take photographs of the necessary quality.
>
> **Comment:** Such observations are rare, but the observers are very busy. It would be better for the captain to be responsible for photography. Also, the fishermen assume that if an entanglement results in an animal being separated from its pod, it will die. Should NMFS make a similar assumption?
>
> **Comment:** If cameras were used to photograph large whale entanglements, it isn't clear whether the evaluation would be on a case by case basis or whether the photograph would be used to answer questions related to specific criteria.
>
> **Comment:** In the SW Region observer program, animals are photographed in the water when they are too large to bring onboard. The pictures tend to be of poor quality. The SW Region has data editors that consider all available information when classifying an apparent injury as serious or not.

**Comment:** A photograph should be taken whenever possible. Given the pandemonium on the deck, the potential for fatigue and inadequate training, a photograph of an entangled animal is worth the effort.

**Comment:** It isn't fair to either consider all entangled large whales as mortalities or all such animals as survivors. It is important that objective criteria to evaluate the likelihood of survival be developed as soon as possible. Further, observer training should be improved. For example, all observers should be able to discriminate between krill swarms at the surface or krill remains in fecal deposits at the surface from blood.

## 9.0 Recommendations of the large whale subgroup

Subgroup chair: Mansfield
Subgroup participants: Brix, Thounhurst, Cowan, Gulland, Hofman, Kraus, Potter, Stockwell, N. Young

The following options were identified in classifying injuries as to whether they should be considered serious: 1) All (or none) of the entangled animals should be considered seriously injured, 2) a case by case evaluation should be made as to whether the animal is likely to survive, given its entanglement, 3) assign average probability of mortality based on analysis of survivability of entangled and healthy animals, and 4) assign a probability of mortality on a case-by-case basis.

In evaluating the degree to which the survival of a large whale may be compromised by entanglement, it was recognized that different types of entanglement can affect a large whale in different ways. The subgroup identified the following ways an entanglement could affect an animal:

Entanglement effects-

1. locomotion
    - 1.1. prevent movement
        - 1.1.1. anchored in place
        - 1.1.2 immobilized in gear
    - 1.2. impaired-
        - 1.2.1. sufficient gear to restrict motion
        - 1.2.2. gear in gape of the mouth
        - 1.2.3. gear wrapped around flukes/flippers
2. feeding
    - 2.1. prevent- mouth bound by gear
    - 2.2. impaired- lines thru gape of mouth

3. reproduction- covered under 1 and 4

4. systemic injury
   4.1. gear wraps causing wounds around rostrum, flippers, flukes, blowhole, lower mandible.
   4.2. thrashing trauma
   4.3. disease or parasitic condition
   4.4. injuries to eye
   4.5. stress

Systemic injury may also be caused by blunt trauma or contact with a propeller.

There was general agreement that entanglement that impeded locomotion or feeding, and that entanglement of young whales in ways that could cause trauma and mortality as the animal grows should be considered a serious injury . Unfortunately, there was insufficient time to develop specific criteria for identifying when locomotion or feeding is impaired in a large whale due to entanglement. Some members of the subgroup believed that entanglement of any sort should be considered serious, in the absence of criteria for categorizing a specific entanglement as having impeded an animal's locomotion or ability to feed. Others commented that entanglement with a relatively small amount of material or material that was only loosely entangling would not necessarily result in mortality. This group noted information reported by Kraus that animals do survive entanglement and are subsequently observed free of any entangling gear.

The following research needs were identified by the subgroup. Addressing these research needs would provide information required for evaluating the degree to which entanglement removes large whales from their respective populations:

1. Analyze existing data on humpback and right whale survival and reproductive fitness by examining entanglement type and scarring data. It was estimated by Kraus that the analysis of the available humpback data would take 2 years to complete, and the right whale analysis would take 6 months to finish.

2. Develop necropsy methods that would provide information on fishery specific mortality that can be added to the database on salvaged animals as well as to existing databases on individually recognizable animals.

3. Examine stranding data from other large whales (minke, fin, and sperm whale) for evidence of scars likely related to past or existing entanglements.

4. Develop methods for collecting blood from entangled and stranded animals. In addition, develop methods for collecting blood from free ranging animals (i.e., development of remote methods).

5. Develop methods for radio tagging or satellite tagging entangled animals. Equipment should be made available so that all entangled animals can be tagged. Also, consider application of new technology (e.g., acoustic sensors) in the protocol for tagging entangled animals.

6. Request blood samples from large whales taken by aboriginal or research whaling (bowhead, gray, humpback, fin, minke) to serve as a comparison to blood samples from stranded or entangled animals. The objective of this action would be to profile the blood characteristics of a "stressed" animal.

7. Determine if the abundance and life history data are sufficient to estimate the change in survival associated with being entangled. If they are sufficient, a model should be created that would relate abundance, trends in abundance, reproductive interval, survival, percent of population scarred, and change in survival associated with being entangled.

## 10.0 Recommendations of the small cetacean subgroup

Subgroup chair: Cornish
Subgroup participants: Brown, DeAlteris, DeMaster, Geraci, Hoey, Pol, Price, Tork, S. Young

There was general agreement that each interaction between a dolphin or porpoise and a fishery, where there remained uncertainty as to the severity of an injury, should be evaluated on a case-by-case basis. The following guidelines for evaluating such interactions were developed:

1. Animals that have ingested hooks should be considered seriously injured.
2. Animals that are hooked externally (e.g., in the skin or blubber), except when the hook is near the eyes or the head, should not be considered seriously injured.
3. Animals that were swimming abnormally or were entangled in fishing net and trailing gear when released should be considered seriously injured.
4. Animals that were swimming normally or were entangled in line or net, but have subsequently become disentangled, should not be considered seriously injured[7].

If the extent of injury is identified as "unknown" for a particular interaction, these "unknown" cases should be pro-rated based on the proportions of observations where animals were judged seriously injured and not seriously injured to estimate what proportion of the "unknown" cases are likely serious. Concern was expressed by some participants that, because there are almost no data on mortality following release, pro-rating "unknown" cases to estimate the number of serious injuries for pilot whales could be biased.

All other categories of injury should be considered on a case by case basis. Given concern over the effects of stress, the behavioral response of animals (e.g., abnormal swimming behavior)

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[7] Items 3 and 4 in this list are general in nature and do not discriminate between entanglement in net or longline gear.

should be considered in evaluating whether an injury should be classified as serious. Also, entanglements that result in an animal being separated from its pod should be considered serious injuries. The subgroup was not able to come up with specific recommendations regarding the amount of entangling gear necessary to be considered a serious injury for a small cetacean. In regard to injuries in the longline fishery, it was mentioned that the specific portion of the gear involved and the weight and drag characteristics of the gear are important factors to consider.

The subgroup identified the following actions as immediate needs to resolve the issue of what constitutes a serious injury to a small cetacean.

1. Improve marine mammal training of observers (especially where the potential for serious injury problems appears to be significant- i.e., the longline fishery /SE Region).

2. Include marine mammal scientists in the observer debriefing process.

3. Increase observer coverage rates in fisheries where the potential for serious injury problems appears to be significant (i.e., longline fisheries).

4. Develop a reporting system for observers that encourages more elaborate comments by observers on injuries, such as hooking, and whether an entangled animal was completely disentangled prior to being released.

5. Provide guidelines for use by data editors/peer review committee for determining whether an injury should be classified as serious.

The subgroup also identified the following research activities as necessary to provide the information needed to address this issue of serious injury.

1. Initiate a program to tag all entangled animals that are released alive (e.g., satellite tags for short term survivability and internal/external tags for long term marking). Concern was expressed that any such study must be designed to ensure that the number of recoveries from such a program will likely result in statistically meaningful results.

2. Collect biopsy dart samples from all entangled animals and use to supplement materials for determining stock structure.

3. Survey the existing stranding networks for incidence of hook and line interactions.

Participants discussed whether or not an observer on a commercial fishing vessel should have the authority and should be instructed to euthanize marine mammals that are considered moribund. Several members commented that such animals should be euthanized, as the opportunity to collect fresh tissue samples from marine mammals was extremely rare. The information derived from such collections would help the agency better understand the direct and indirect effects of commercial fishing on marine mammal populations. Other members noted that it was extremely unlikely that suitable criteria could be developed to distinguish a moribund animal from an injured animal that had a reasonable chance of recovery. Further, it was noted that the facilities for bringing such animals on board for a proper necropsy generally did not exist on many of the commercial fishery vessels. It was recommended that this issue be reconsidered at a later date.

## 11.0 Discussion about subgroup results

After the subgroup report was given in plenary, a number of comments were made. Hofman noted that line attached to a hook that was hooked through the skin of a small cetacean would actually facilitate the hook pulling out on its own. Therefore, the mere presence of trailing gear is insufficient to classify an injury as serious. Geraci commented that the critical determination regarding trailing gear has to do with the extent to which the gear would impede locomotion or feeding (See section IX). There was also concern expressed that trailing gear could snag on other gear, on boat propellers, or wrap around other body parts. Therefore, generic guidelines regarding the extent to which trailing gear or being hooked externally constituted a serious injury were likely to be less desirable than the case-specific determinations. However, the above guidelines were nonetheless useful in making case-specific determinations. Ideally guidelines developed for classifying serious injuries in small cetaceans would be similar in nature and structure to the guidelines developed for large whales. Geraci noted that the guidelines provided by both subgroups could be combined into a single set of guidelines for what constitutes serious injury.

## 12.0 Injury in pinnipeds

Due to time constraints, the discussion about serious injury in pinnipeds was very brief. DeMaster briefly discussed the following injuries that have been reported for pinnipeds and which could possibly be considered serious injuries:

1. Hooked -- in mouth (likely a serious injury)
   -- in body (likely not a serious injury)
2. Entanglement with gear trailing (likely a serious injury)
3. Entanglement without gear trailing (address on a case-by-case basis)
4. Auditory damage via acoustic harassment devices (unknown at this time)

## 13.0 Draft release guidelines

Vicki Cornish briefly discussed draft release guidelines which had recently been developed by the longline fishery to present to the Atlantic Offshore Cetacean Take Reduction Team. These guidelines would be used by commercial fishers to maximize the survival of the most commonly entangled marine mammals (e.g., small cetaceans) in longline gear. The applicability of these guidelines to other fisheries needs to be determined.

1. Use two long gaffs to grab the mainline on opposite sides of the entangled animal.
2. Gently bring animal alongside the vessel.
3. Relax tension on the line.
4. Work the tangle off the animal; remove all of the line in which the animal is entangled, if possible.
5. Photograph and measure the animal, if possible.
6. Move out of the area (as there are likely to be other marine mammals in the immediate vicinity).

## 14.0 Closing comments

Angliss thanked everyone for their time and efforts. She noted that the information and recommendations made by the participants of this workshop would form the basis of the draft NMFS position developed on the use of serious injury data in managing marine mammal-fishery interactions.

Draft minutes would be prepared by mid-April and that a draft workshop report would be circulated to all participants for comments by the end of April. Receipt of comments should be completed by 15 May 1997. A final workshop report should be available to all participants by the summer of 1997. Proposed guidelines for what constitutes a serious injury will be published in the Federal Register for public comment; final guidelines will be published after public comments are reviewed, addressed, and incorporated.

## 15.0 References


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Small, R. J., and DeMaster, D.P. 1995. Survival of five species of captive marine mammals. Mar. Mamm. Sci.. 11(2): 109-226.

## Acknowledgements

The workshop report was greatly improved by thoughtful review and comments provided by the workshop participants. Vicki Cornish and Bridget Mansfield chaired the working sessions on serious injury to small cetaceans and large cetaceans, respectively. Peaches Hodge provided logistical support for the invited participants.

## Appendix A: Agenda

**SERIOUS INJURY WORKSHOP**
**Agenda, 3/31/97**

**APRIL 1, 1997**

| | |
|---|---|
| 9:00 | Introductions, statutory/regulatory background, statement of problem (:30) (Angliss) |
| 9:30 | Description & causes of injuries incurred by marine mammals |
| | Evidence of entanglement in small cetaceans captured in commercial fisheries - (Potter) (:30) |
| | Physical evidence of entanglement in large cetaceans; frequency of occurrence and survival - (Kraus) (:30) |
| *10:30* | *Break* |
| 10:45 | Immediate consequences of entanglement and entanglement and release; effects of stress - presentation and discussion - (Geraci) (1:00) |
| 12:00 | Legal entanglements (Gleaves) (:10) |
| *12:15* | *Lunch* |
| 1:30 | Chronic consequences of entanglement and entanglement and release - presentation and discussion - (Cowan) (1:00) |
| 2:30 | Entanglement and injury of pinnipeds (Gulland) (:30) |
| 3:00 | Fishery gear/technology (Hoey/Stockwell) (:30) |
| | Lobster pot fishery: current practices & modifications to reduce serious injury & mortality (Stockwell) (:15) |
| | Longline fishery: current practices & modifications to reduce serious injury (Hoey) (:15) |
| *3:30* | *Break* |

3:45 Data used to manage marine mammal interactions w/commercial fisheries - overview (Angliss) (:10)

Observer program data collection - national overview (Tork) (:10)

Longline observer perspective - How are data collected? (Pol) (:10)

Longline analysis (Brown) (:15)

Lobster pot/trap data (Thounhurst) (:15)

**SERIOUS INJURY WORKSHOP**
**Agenda, 3/31/97**

**APRIL 2, 1997**

| | |
|---|---|
| 8:00 | Summary of previous discussion; review current definition of injury; describe process (DeMaster/Angliss) (:15) |
| 8:15 | Presentation and discussion of interim definition of serious injury (Thounhurst) (:15) |
| 8:30 | Discussion of options for definition of serious injury |
| | General approach (define serious injury relative to fisheries, marine mammals, or generic?) |
| *10:30* | *Break* |
| | Specific approach (once options for general approach are provided) |
| *12:00* | *Lunch* |
| 1:15 | Long-term approach |
| | National consistency between data collected and data required |
| | Research? |
| 2:30 | Development of release guidelines (Cornish) (:15) |
| 2:45 | Where do we go now? |
| | Description of process |
| | Assignments (if necessary) |
| 3:00 | Adjourn |

## Appendix B: Key background documents provided prior to and during the workshop


Kraus, S.D. 1990. Rates and potential causes of mortality in North Atlantic right whales (*Eubalaena glacialis*) Mar. Mamm. Sci.. 6(4):278-291.

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Sections 5.0 and 5.1 from Wade, P. R. and Angliss, R. P. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS workshop, April 3-5, 1996, Seattle, WA. NOAA Technical Memorandum NMFS-OPR-12.

## Appendix C: Serious Injury Workshop Participants


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