WORKSHOP SUMMARY

NOAA/NMFS
SERIOUS INJURY TECHNICAL WORKSHOP
(OPEN SESSION)

SEATTLE, WA
SEPTEMBER 10-12, 2007

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EXECUTIVE SUMMARY

On September 10-13, 2007, NOAA's National Marine Fisheries Service (NMFS) convened the Serious Injury Technical Workshop in Seattle, Washington. The goals of the workshop were to evaluate the effectiveness of NMFS' efforts over the past ten years to distinguish serious from non-serious injury of marine mammals, to review relevant information obtained since 1997, and to discuss needed changes to existing serious injury determination guidance.

The Serious Injury Technical Workshop consisted of two sessions: an open session (Days 1-3), and a closed federal session (Day 4). The primary purpose of the open session was to inform Day-4 federal discussions on whether and how to revise NMFS' guidance for making serious injury determinations. This document presents a workshop summary for the open session only.

Over 65 invited participants attended the open session, representing NMFS, other federal agencies, regional Scientific Review Groups, state resource management agencies, stranding response organizations, universities and research institutes, and conservation organizations. Participants were invited based on their expertise in marine mammal biology, pathobiology, and veterinary medicine.

The open session included a mix of plenary presentations and discussions and breakout session discussions. Key outcomes include the following:

1) Participants presented, discussed, and evaluated the procedures for determining serious injury present in each of NMFS' respective regions. Participants also addressed how current data and data collection constraints have affected serious injury determinations.

2) Participants reviewed new information on serious injuries obtained over the past decade, including types and frequencies of observed injuries and evidence of survival of marine mammals sustaining such injuries. Discussions were organized around four groups of marine mammals: large cetaceans, small cetaceans, pinnipeds, and manatees.

3) Participants presented and discussed recent information on the pathobiology of injuries to marine mammals. This included discussion on efforts to predict lethality from vessel and fishing gear trauma.

4) During breakout sessions participants discussed a suite of key issues pertaining to marine mammal serious injury determinations, including:
   - Suggestions for refining the current procedures for making serious injury determinations
   - Data needs for making serious injury determinations
   - How to address scientific uncertainty in making serious injury determinations
   - Longitudinal/survival rates from a modeling perspective
   - Categorization and pathobiological consequences of a variety of injuries, including gear-related, sharp, blunt force, and penetrating injuries
   - Applicability of existing categorization and classification of injuries to different taxonomic groups (e.g., large cetaceans, small cetaceans, pinnipeds, and manatees)

During the open session, workshop participants shared their views and provided individual advice on the topics under discussion.

GLOSSARY

AKFSC	Alaska Fisheries Science Center
AKR	Alaska Regional Office
MMHSRP	Marine Mammal Health and Stranding Response Program
MMPA	Marine Mammal Protection Act
NEFSC	Northeast Fisheries Science Center
NER	Northeast Regional Office
NMFS	NOAA's National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	NOAA's National Ocean Service
PBR	Potential Biological Removal
PIFSC	Pacific Islands Fisheries Science Center
PIR	Pacific Islands Regional Office
SAR	Stock Assessment Report
SEFSC	Southeast Fisheries Science Center
SER	Southeast Regional Office
SRG	Scientific Review Group
SWFSC	Southwest Fisheries Science Center
SWR	Southwest Regional Office

1.0 Introduction

1.1 Background

Under the Marine Mammal Protection Act (MMPA), the National Marine Fisheries Service (NMFS) must distinguish human-caused serious injuries from non-serious injuries to marine mammals. MMPA section 117 directs NMFS and the U.S. Fish and Wildlife Service to prepare stock assessment reports (SAR) for all stocks of marine mammals that occur in waters under the jurisdiction of the United States. Among the types of information that must be included in each of these reports, the agencies must enumerate human-caused mortalities and serious injuries by source. The MMPA also states that a stock of marine mammals is to be labeled as a strategic stock if, among other things, human-caused mortality and serious injuries exceed the stock's Potential Biological Removal (PBR) level.

MMPA section 118 is the regime to govern the taking of marine mammals incidental to commercial fishing operations. MMPA section 118(c) directs NMFS to categorize fisheries based upon whether a fishery has frequent (Category I), occasional (Category II), or remote (Category III) likelihood of incidental mortality and serious injury of marine mammals. Additionally, MMPA section 118(b) requires commercial fisheries to reduce mortality and serious injury of marine mammals to insignificant levels approaching a zero mortality and serious injury rate. Section 118(f) of the MMPA states that NMFS "shall" develop a plan for strategic stocks interacting with Category I or II fisheries, and "may" develop a plan for any marine mammal stocks interacting with Category I fisheries, to reduce incidental mortality and serious injury levels to specified goals.

As noted above, "serious injury" has scientific and regulatory meaning under the MMPA; however, the MMPA and its legislative history do not provide guidance on how severe an injury must be to be considered "serious". To implement MMPA sections 117 and 118, NMFS defined "serious injury" in regulations (50 CFR 229.2) as "any injury that will likely result in mortality." To promote national consistency in the interpretation of the regulatory definition, NMFS convened a workshop in April 1997 to discuss available information related to the impact of injuries to marine mammals incidental to commercial fishing operations.[1] These discussions were designed to result in a framework upon which NMFS could develop a consistent approach for determining which injuries should be considered serious injuries.

NMFS staff have used the information from the 1997 workshop in evaluating injury reports submitted by commercial fishers, fishery observers, and stranding network participants to determine which injuries could be considered serious injuries. Since 1997, additional information has been collected, and this new information may allow NMFS to re-evaluate whether a given injury would likely result in mortality. In addition, annual updates to the stock assessment reports required under MMPA section 117 indicate that injuries to marine mammals from vessel collisions are relatively common. Accordingly, the guidance for distinguishing between serious and non-serious injuries of marine mammals should be extended to include injuries sustained from vessel collisions (i.e., blunt and sharp force trauma) as well as those sustained from

[1] Angliss, R.P., and D.P. DeMaster (1998). 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. NOAA Technical Memorandum NMFS-OPR-13

interactions with fisheries (i.e., entanglement and hooking). Although there are other sources of human-caused injuries, those related to fishing and vessel collisions have resulted in the most scrutiny of NMFS' distinguishing serious and non-serious injuries. Thus, the workshop focused on injuries typical of encounters with vessels and fishing gear.

1.2 Workshop goals, objectives, and organization

On September 10-13, 2007, NMFS convened the Serious Injury Technical Workshop in Seattle, Washington. The purpose of the workshop was to evaluate the effectiveness of NMFS efforts since the 1997 workshop to distinguish between serious and non-serious injury. The stated objectives of this workshop were to:

1) Review recommendations from the 1997 workshop and information obtained since 1997, including types and frequencies of observed injuries and evidence of survival of marine mammals sustaining such injuries.

2) Discuss the use of, and needed changes to, existing guidance in making serious injury determinations. In particular:
   - Identify when information is insufficient to determine the severity of the injury.
   - Identify data needs for making serious injury determinations.
   - Review existing data sources for making serious injury determinations, raise awareness in these data collection programs to kinds of information needed for serious injury determinations, and identify constraints.

3) Discuss potential actions following the workshop.

The Serious Injury Technical Workshop consisted of two sessions: an open session (Days 1-3), and a closed federal session (Day 4). This document presents a workshop summary for Days 1-3 only.

Days 1-3 of the workshop were open to invited federal and non-federal participants as well as public observers. Invited participants include NOAA and peer agency staff, representatives of the three regional Scientific Review Groups (SRG), and representatives of academia, industry, and environmental non-government groups with expertise in marine mammal serious injury issues. The format for the first three days included a mix of plenary presentations and discussions and breakout session activities. The primary purpose of Days 1-3 was to inform the federal-only discussion on Day 4.

Note: *Day 4* was a closed session in which only Federal Government officials participated. The primary purpose of the federal closed session was to draw on Day 1-3 presentations and discussions to consider potential changes to the existing guidelines for making serious injury determinations and associated administrative approaches. The workshop summary for Day 4 is a separate, internal document.

The main topics addressed during Days 1-3 included the following (the agenda for Days 1-3 is found in Appendix A):

- Evaluation of current data and determination systems (in plenary and breakout sessions)
- Overview of new information on survival of injured marine mammals (large cetaceans, small cetaceans, pinnipeds, and manatees)
- Pathobiology of injuries
- Breakout activities to address key questions on the topic of marine mammal serious injury determinations

The workshop was not chartered under the Federal Advisory Committed Act; nor was it noticed in the *Federal Register*. For these reasons, discussions during Days 1-3 of the workshop focused on the exchange of facts and information. The aim was not to seek consensus advice on future Federal Government policies or actions. Further, the objective was not to develop consensus advice from participants as a group. Any information, ideas, recommendations, or advice provided to NMFS reflected the views of individual workshop participants.

1.3 Participants, roles, and ground rules

Over 65 invited participants attended the technical workshop. They were invited based upon their expertise in marine mammal biology, pathobiology, and veterinary medicine. Most participants came from NMFS, including staff from regional offices and science centers as well as the Headquarters' Office of Protected Resources. Also represented were other sister federal agencies, state resource management agencies, stranding response organizations, universities and research institutes, and conservation organizations. One member of the public, representing a consulting firm, attended and participated in discussions.

CONCUR, Inc—an environmental mediation firm specializing in marine and water resources issues—facilitated the workshop and prepared the first draft of this meeting summary, which was reviewed by the NMFS convenors.

A full list of participants is shown in Appendix B.

The primary role of invited participants was to provide expert input for NMFS' consideration. In this role, participants were asked to share pertinent information, ask clarifying questions, and express professional views in both plenary and breakout sessions. Observers were allowed to view and track the deliberations on Days 1-3 but not to participate in the discussions.

Workshop participants adopted a set of ground rules for the workshop. The ground rules were intended to foster and reinforce constructive interaction and deliberation among the workshop participants. They emphasized clear communication, respect for divergent views, creative thinking and collaborative problem solving. The ground rules for the workshop are listed in Appendix C.

Workshop preparations were guided by a steering committee consisting of agency staff, including: Melissa Andersen, Tom Eagle, Kristy Long, Teri Rowles, Janet Whaley, Robyn Angliss, Bridget Mansfield, Tim Cole, Diane Borggaard, Brent Norberg, Lynne Barre, Lisa Van Atta, and Karin Forney.

2.0 Description and Evaluation of Current Data and Serious Injury Determination Systems

The workshop began with an overview of current data and serious injury determination systems. First, several presentations were made on the types of data collected, challenges in data collection, and development of data forms. This was followed by an overview from the different regions on existing serious injury determination systems.

Each presentation is summarized below. References cited are shown in Appendix D.

2.1 Description of current data sources

Participants presented an overview of current data from U.S. observer programs and marine mammal health and stranding response programs.

Collection of Marine Mammal Data by U.S. Observer Programs (Amy Van Atten, NMFS NER Observer Program)

Under Federal law, NMFS has the authority to place observers on board vessels engaged in commercial fishing operations that incidentally take marine mammals. Data collected by NMFS observer programs are used to assess the level of serious injury and mortality of marine mammals, develop marine mammal stock assessments, and to identify bycatch reduction measures to ensure the recovery and conservation of these species. Ten observer programs are currently conducted, which monitor over 42 fisheries nationwide for catch of target fish, incidental take of marine mammals, bycatch of other protected resources and fish, and discards of fish.

Not all fisheries interact with marine mammals and not all programs focus on protected resources (for example, the North Pacific groundfish observer program monitors for total catch of finfish). Fisheries currently monitored under the authority of the MMPA include: Kodiak set-gillnet (Category III), California/Oregon pelagic drift gillnet (Category I), California pelagic longline (Category I), Southern California set gillnet (Category II), Mid-Atlantic gillnet (Category II), New England and Mid-Atlantic small mesh trawl (Category I), New England groundfish trawl and gillnet fisheries (Category II), Mid-Atlantic *Illex* squid trawl (Category I), Atlantic, Gulf of Mexico, Caribbean pelagic longline (Category I), Southeast shark gillnet (Category II), and the North Carolina coastal gillnet (Category I).

Regional observer programs are responsible for the development of observer data collection forms, including forms for collecting marine mammal incidental takes. Marine mammal data are typically collected using the following types of forms:

- Incidental Take Form- for documentation of species, type of marine mammal take, and deterrents used.
- Biological Information Form- for documentation of species, length, weight, sex, and tissue/teeth samples for fisheries permitted under 50 CFR 229.7.
- Sightings Form- for documentation of species, number of animals, and behavior for animals near or around fishing gear.

- Photos and comments are also recorded to provide further information on marine mammal incidental takes.

Each observer program's training manual contains detailed information on data collection forms and procedures. There is no national standardized format for these manuals. In addition to the information collected on marine mammals, observers also collect a variety of data on other species such as gear type, fishing location, estimated weight of retained and discarded catch, species composition of discarded catch, reasons for discard, weight, length, sex, dissections from tagged fish, socioeconomic data, biological samples, and seabird and sea turtle interactions. Data collection on protected species is the top priority for all regional observer programs.

When considering changes to current marine mammal data collection procedures, it is important to remember there are a number of inherent tradeoffs. For example, observer programs must balance the collection of more data, the need to provide high quality data for all species of interest, improvements in data management and processing, and cost. Observer programs strive to provide the best data possible to aid in the conservation and protection of marine mammals and other species, and are willing to work with protected resources experts to identify possible improvements in observer data collection.

Marine Mammal Health and Stranding Response Program: Data Collection (Teri Rowles and Janet Whaley, NMFS Office of Protected Resources)

The Marine Mammal Health and Stranding Response Program (MMHSRP) was formalized in 1992 after the passage of the Marine Mammal Health and Stranding Response Act amending the Marine Mammal Protection Act. The MMHSRP goals are to: collect and disseminate information on the health and health trends of marine mammal populations in the wild; to correlate the health and health trends of marine mammal populations in the wild with biological, chemical, and physical environmental parameters; and to coordinate effective responses to marine mammal unusual mortality events. To that end the program has developed the following components: response networks, surveillance, research and development, banking, quality assurance, information management, outreach/education, and grant assistance.

<u>Data Collection</u>
Over the last 15 years, the program has collected the following health data:

- Visual observations
- Health assessments
- Physical examinations
- Analytical results such as pathology, toxicology, infectious disease, injuries
- Necropsies including cause of death
- Morphometrics and life history data

Data sources have included strandings, entanglements, out of habitat animals, by-caught animals, live capture release studies, subsistence hunts, translocations and free swimming animals. The overall program collects information and samples to evaluate the cause of stranding, cause of mortality, or cause of morbidity including infectious and non-infectious causes and human interactions. David Mattila will be talking about the large whale disentanglement network, which will not be covered in this talk.

The most common type of data collected comes from stranded animals. Over the last 15 years, there have been over 40,000 animals reported stranded in the U.S. These have included single strandings, mass strandings, and unusual mortality events. Level A data is collected from all stranded animals. These are the minimum data that should be collected from any live or dead stranding. The data collection forms and the data fields have changed over the last 15 years and are becoming more specific in the types and manner of information required. Level A data does include "Findings of Human Interaction," but this field does not represent the cause of the stranding nor the cause of death.

To truly determine what role human interactions play in mortality and morbidity, we must use a decision tree matrix, use standardized terminology, evaluate the animal in a consistent defined manner, and ensure that data is reported in a consistent manner by trained personnel. To identify if there are findings of Human Interaction, one consistently evaluates each animal with specific targets. To determine whether human interactions contributed to the stranding event, the observation data, event history, and experience of the observer are used. Finally, to truly answer the question did human interactions cause the death of the animal, full necropsies and analyses and interpretation of the complete case must be reviewed. In order to improve the quality of the evaluations of human interactions, consistent protocols must be used by trained personnel reporting the information in consistent format, and having access to the data to support the interpretations, observations, and findings. The program is currently adopting a standardized protocol and database for collecting this information and providing training to stranding network personnel.

<u>Summary</u>
The collection of data from live and dead strandings and from live animals observed entangled or injured in a consistent manner, standardized format, using common terminology and scoring, and integrated across disciplines is critically important for assessment of human interactions and human caused serious injuries.

2.2 Description of current serious injury determination systems

NMFS staff responsible for making serious injury determinations presented an overview of current serious injury determination systems from their respective regions. Presenters highlighted the nature of marine mammal interactions in their regions, the causes of injuries, the methods by which serious injury determinations are made, and key issues and challenges faced in making these determinations.

Baleen whale serious injury determinations in the Atlantic and Gulf of Mexico over the past 10 years (Tim Cole, NMFS NEFSC)

<u>Nature of interactions</u>
From 2001 – 2005, 133 large whale entanglement events occurred along the Gulf of Mexico, U.S. East coast and adjacent Canadian Maritimes (Nelson *et al.* 2007). Of these events, 11 were determined to be serious injuries. In many cases there is insufficient information to make a determination. Live whales have been observed with ship strike injuries, but despite ship strikes being implicated as a leading anthropogenic cause of death for right, humpback, fin and sei

whales, we have rarely assigned a serious injury to a ship strike event. Blunt trauma injuries show little or no external evidence (bodily or behaviorally), and are likely to be missed by our visual, external examination of living whales.

Cause of injuries
Traps/pots: When entangling gear could be attributed to a particular fishery, pot gear was involved in 10 of 14 right whale entanglements between 1993 and 2002 (Johnson *et al.* 2005). Eight of the 10 pot gear entanglements were attributed to lobster pot gear. One or two reports of humpback and/or minke whales anchored by trap gear are received by the Northeast Regional Office each year.

Sink gillnet: Johnson *et al.* (2005) identified sink gillnet gear in 11 of 22 events involving humpbacks and identifiable gear between 1997 and 2002. Gillnet gear was identified in 2 of 14 events involving right whales and identifiable gear.

Trawls: Since 1989, five pilot whales, 5 white-sided and 3 common dolphins were reported to have been released alive or of unknown condition within the Northeast Sea Sampling data.

Ship strikes: Ship strike injuries and deaths have been documented for several cetacean species, including right, humpback, blue, and fin whales. Relatively intensive survey effort for right whales each year discovers one or two individuals with lacerations from propellers of small (<65') vessels. We currently do not have a means of identifying living whales that have sustained blunt trauma.

Methods of determining serious injury
All cetaceans recorded as released alive or of unknown condition by the Northeast Sea Sampling program are counted as serious injuries. Large whale entanglement or ship strike events are evaluated using criteria outlined in Cole *et al.* 2005 (see also Cole *et al.* 2006 and Nelson *et al.* 2007).

Key issues and questions
- There is great disparity in report/data quality.
- Often, there is a lack of external evidence in cases of blunt trauma.
- Accounting for an animal's health prior to injury (already sick? pre- or postpartum?) is an important consideration.
- What behaviors, in conjunction with an entanglement, are likely to cause serious injury?
- Should the size of an injury be used as an indication of its seriousness?
- Should the presence of constricting line always trigger a serious injury determination?
- What are the effects of short, repeated, or chronic injuries?
- Can anecdotal reports provide a means for estimating actual rates of serious injury for a population/stock?

Small cetacean serious injury determinations in the Atlantic and Gulf of Mexico (Lance Garrison, NMFS SEFSC)

Nature of interactions
Several categories of injuries occur in the Southeast region. These include:

- Injuries to small cetaceans caused by hookings or entanglements with longline gear
- Injuries to small cetaceans from interactions with commercial gear, where animal is released alive
- Injuries to small cetaceans from interactions with recreational gear, where animal is either hooked externally or ingests gear, including cases of repeated hookings.
- Entanglements and vessel collisions with right whales, with particular attention to very young calves
- Injuries to small cetaceans from vessel collisions

Cause of Injuries

Longline gear: The Atlantic pelagic longline fishery operates from the Grand Banks off Canada to the Caribbean and the Gulf of Mexico. The majority of interactions with marine mammals occur in the Mid-Atlantic Bight, which extends from New York south to North Carolina. Fishermen report that pilot whales depredate their catch, and observer data indicates that there is a significant positive correlation between interactions with pilot whales and damage to swordfish catch (Draft PLTRP 2006). Similarly, observer data show a positive correlation between interactions with Risso's dolphins and damage to swordfish catch (*Ibid*). There are not enough encounters between longline gear and other marine mammals to determine whether depredation or just chance encounters with the gear are responsible for the interactions, but in general, most marine mammals that interact with longline gear are released alive with varying degrees of injury. Interactions take the form of hookings in the mouth and in other areas of the body, as well as entanglements in fishing line.

Entanglements most frequently occur in the mainline, and animals are generally cut free of the gear and not classified as seriously injured on release. Hookings are most often in the mouth and the hook not removed prior to release. Frequently, the gangion or leader line parts off before the animal can be brought near the boat and the animal is released both hooked in the mouth and trailing significant amounts of entangling gear. When an animal becomes hooked or entangled, the crews typically work rapidly to release the animal, as undue struggle has the potential to further harm the animal as well as the crew. Factors that influence whether the gear can be removed include the size of the animal, the location and severity of the hooking/entanglement, the condition of the seas, and the experience of the crew.

Traps/pots: Dolphins generally become entangled in line around the flukes, pectoral fins, or head. Animals may drown or be seriously injured by dragging crab trap/pot gear for extended periods of time. Dolphins are frequently released alive from these entanglements (8 *Tursiops* in South Carolina alone in the crab trap/pot fishery, with 5 since 2003; McFee et al. 2006). However, the extent of serious injury caused by entanglements have not been assessed.
The Atlantic crab trap/pot fishery is one that is included under the Bottlenose Dolphin Take Reduction Plan (BDTRP; 71 FR 24776; April 26, 2006).

Shrimp trawl: Lazy lines on shrimp trawls have caused mortality to bottlenose dolphins throughout the southeast. There are anecdotal accounts of entanglement in which the animal is released alive.

Recreational gear: The range of the coastal stocks of bottlenose dolphins frequently overlaps with recreational activities of people. Illegal feeding of dolphins by recreationists is prevalent in the southeast. In some areas, this activity is causing behavioral changes of the animals--such as conditioning to people and loss of wariness of people and vessels--which may be contributing to depredation on recreational and commercial gear. Dolphin depredation on bait/catch of recreational gear is increasing, and, in some cases, dolphins are being repeatedly hooked or entangled in gear. Observed and anecdotal reports of depredation show dolphins cleaning the hook of bait or catch or snapping the line.

NMFS staff have also observed females teaching begging and depredation behaviors to their calves and other animals. Injuries generally include lures/hooks lodged in the mouth or head region, partial or total ingestion of lures/hooks, and monofilament nests entangled around various parts of the body either in combination with hooks/lures or separately. This year, there have been increased dolphin strandings with recreational gear attached, ingested, or entangled, especially in Sarasota Bay and Indian River Lagoon, Florida. A review of Florida statewide stranding data from 2001-2006, shows 28 cases of tackle ingestion, 15 entanglements, and 5 cases of hooks or lures in the mouth. In some cases, mortality was a direct result of the interaction. The fates of animals that do not strand dead with recreational gear attached but sustain multiple hookings or entanglements are not known, nor is the potential impact of chronic injuries from these interactions. (Case study: female *Tursiops truncatus* with calf in Panama City, FL, that was hooked on two separate occasions within 6 months).

Ship strikes: The Southeast U.S. is the only known calving area for northern right whales. There are several major ports in the Southeast (Canaveral, Jacksonville, Brunswick, Fernandina Beach, Savannah, and Charleston) along the right whale migratory pathway to the Northeast U.S. Calves may be particularly vulnerable to ship strikes and entanglements in fishing gear. In 1991, a calf was documented in the Southeast with propeller gashes. In 2005, NMFS staff observed this same animal floating dead off Cumberland Island, the cause of death likely her healed propeller wounds splitting open as her girth expanded with advancing pregnancy.

Vessel collisions with small cetaceans does not happen as frequently as with whales. However, when it occurs, it often results in mortality from blunt trauma or severe propeller wounds. There are cases in which small cetaceans--notably bottlenose dolphins--survive boat strikes but sustain injuries and disfigurement to dorsal fins and other body parts. In Sarasota Bay, Wells and Scott (1997) documented four cases of vessel strikes on bottlenose dolphins in which all four animals survived the actual vessel strike.

One of the animals struck was a female less than 2 months old. Her wounds consisted of a large gash on the left side of the dorsal fin with trailing yellowish necrotic tissue, which ultimately caused the dorsal fin to curl to the right. She was seen swimming normally alongside her mother with the fresh wounds, but later died at age 4 from a lung infection. It is unknown to what extent her early injuries from the vessel collision may have had on her overall health. Likewise, the effect on long-term survival in similar cases is unknown. (Case studies: mortality of *Stenella coeruleoalba* in Destin, FL; propeller wounds to dorsal fin from *Tursiops truncatus* in the Indian River Lagoon, FL).

<u>Methods of determining serious injury</u>

Serious injury determinations are made based on the guidelines provided in Angliss and DeMaster (1998). For small cetaceans, it was concluded that animals that ingested hooks, were released with significant amounts of trailing fishing gear, were swimming abnormally, or suffered some obvious severe external trauma should be considered seriously injured. Animals that are hooked externally or are released and swim away normally are not considered seriously injured. For large whales, the guidelines indicate that entanglement of young whales in a way that could cause trauma and mortality as the whale grows should be considered a serious injury. However, no further distinction was made in assessing injuries of calves as compared to larger animals.

Serious injury determinations for cetaceans interacting with the longline fishery are made on a case-by-case basis after reviewing the observations, comments, and photographs of fishery observers. These determinations are made and reported annually in technical memoranda that provide estimates of bycatch in the pelagic longline fishery of both marine mammals and sea turtles (Fairfield-Walsh and Garrison 2006). In general, the Northeast Fisheries Science Center makes serious injury determinations for large whales. However, recently the Southeast Region made a cause-of-death determination for an entangled right whale calf in order to facilitate timely management action. This determination was based on necropsy findings, photographs, and other observations.

Currently, there is no process in place for making serious injury determinations for small cetaceans that have been reported due to vessel collisions or interactions with commercial or recreational gear. These injuries are generally not included in estimates of total human-caused serious injury and mortality in Stock Assessment Reports.

<u>Key issues/questions</u>
Longline gear: The observer may or may not be able to see the nature of the injuries if the animal is released far from the boat or in poor visibility. In addition, the report form that had been used did not prompt consistency in observer comments regarding the nature of the injury or the condition of the animal upon release. Issues include:

- Specific criteria indicating the amount of gear a cetacean would have to trail before it was considered a serious injury was discussed at the previous serious injury workshop, but consensus was not reached.
- The fishery is now required to use circle hooks. More information is needed to determine whether injuries caused by circle hooks are different than those caused by J hooks (specifically the degree to which hooks are ingested).
- There has been a lack of consistency and detail in reporting by observers regarding the nature of the injury as well as the condition of the animal upon release (due to factors discussed above).
- Fishermen may be more able (and motivated) to release animals with a minimum of harm if they receive proper training, but almost no effort in establishing a program has been made.
- Fishermen have also indicated that they would be more motivated to take on the risk of disentangling or dehooking an animal if the animal released without gear was then determined to be only injured (as opposed to seriously injured).

Trap/pot: The ultimate fate of animals released alive from an entanglement is unknown. Questions include:

- How can we assess internal injuries that may have resulted from an entanglement?

- Is the extent of entanglement injuries more serious depending on location of entanglement (e.g., head, pectoral fins, fluke)?
- Do injuries incurred during such entanglements cause the animals to be more susceptible to other stressors?
- Depending on the extent of the injuries, should entanglements in which dolphins are released alive be included in serious injury and mortality estimates under take reduction plans?

Recreational gear: Questions include:

- Must an injury be acute to be serious? What about injuries that have latent impacts on an animal's ability to forage, defend itself against predators, or reproduce?
- What is the fate of small cetaceans released with a hook/lure in their mouth or other body part? With an ingested hook? Could a hook in the mouth lead to death?
- If the hook/lure is shed naturally--i.e., corrodes, gets displaced, or tears out--are there potential longer-term implications of injuries where the hook/lure was lodged? From repeated hookings? From shedding of gear?
- Are calves more susceptible to serious injury than adults from these interactions?

Ship strikes: At the 1997 Serious Injury Workshop, the large whale subgroup noted that serious injury should be assigned to cases of young whales that were entangled in a way that could cause trauma and mortality as the whale grew. However, no further distinction was made in assessing injuries of calves as compared to larger animals.
Objective criteria are also needed for making serious injury determinations for vessel-struck small cetaceans, and a process for including serious injuries of vessel-struck small cetaceans in the estimates of human-caused takes needs to be developed. Questions include:

- Should guidelines differentiate what constitutes serious injury for smaller animals (including right whale calves) considering the size, behavior, and strength of the animal?
- How should we account for potential longer-term implications and effects on survivability if an animal appears to be behaving normally following vessel strike?
- Can we develop serious injury criteria for propeller lacerations?

Serious injury determinations in Hawaii (Karin Forney, NMFS SWFSC, and Bud Antonelis, NMFS PIFSC).

<u>Nature of interactions</u>
Cetaceans: The majority of interactions involve small cetaceans hooked in the mouth or with an ingested hook, presumably because they are taking catch or bait off the gear. Most of these animals are released when the line breaks or is cut, trailing variable amounts of gear ranging from about 1m of line to tens of meters of line and some floats or weights. There were a few cases of animals hooked in the fluke or other body part; some of these died but others were released with trailing line. Humpback and sperm whales were observed entangled in mainline and/or branchline, and all but one were released with some trailing gear (variable lengths of line, at times with floats and weights) wrapped around their bodies or flukes/pectoral fins.

Hawaiian monk seals: The majority of interactions involve monk seals becoming hooked, usually in the mouth, presumably because they are taking bait from the gear. NMFS rarely receives reports of the actual hooking event, but later documents seals hauled out with hooks and some trailing line or gear. Most hooked animals are captured by NMFS personnel who then remove the hook. In some instances, hooks fall out without intervention. In one instance, a deeply-ingested hook and attendant gear were removed surgically. Seals also become entangled in near-shore lay nets in the Main Hawaiian Islands (MHI). Finally, seals become entangled in derelict fishing gear and other flotsam, primarily in the Northwestern Hawaiian Islands (NWHI). NMFS field personnel remove the gear whenever possible. Injuries and mortalities have been documented.

Cause of Injuries

*Cetacean*s- *Pelagic longline*: Includes shallow sets targeting swordfish and deep sets targeting tunas. Cetacean species observed (reported as # killed/ # injured) in this fishery during 1994-2004 were: False killer whale (1/17), short- finned pilot whale (2/4), Risso's dolphin (0/7), bottlenose dolphin (1/2), short-beaked common dolphin (0/1), pan- tropical spotted dolphin (1/0), spinner dolphin (0/2), Blainville's beaked whale (1/0), humpback whale (0/3), sperm whale (0/2), unidentified cetaceans (0/14). False killer whale takes in this fishery are of the greatest concern, because they are a strategic stock (takes exceed PBR under MMPA).

Hawaiian monk seals:

Near-shore recreational shore-casting: Most interactions have occurred from a type of shore-casting known as slide-rig fishing, which targets primarily carangids (ulua), and ‘whipping’, which targets scad (akule). From 1994 through July 2007, 42 hooking incidents were reported in the MHI, with one mortality.

Near-shore lay net: This fishery involves setting underwater gill nets on near-shore reefs of the MHI for nonselective catch. From 1994 through July, 2007, 6 entanglement incidents have been documented, with 3 mortalities.

Debris entanglement: Entangling debris comprises items of fishery and non-fishery origins, and occurs primarily in the NWHI. During 1982-2006, 268 entanglements occurred, with 36 injuries and 8 mortalities.

Methods of determining serious injury

Based on the guidelines developed at the 1997 serious injury workshop (Angliss and DeMaster 1998), cetaceans injured in Hawaii-based longline fisheries are considered seriously injured if one or both of the following applies: 1) they are hooked in the mouth/head or have ingested a hook; and/or 2) they are released with trailing gear that is likely to impair feeding or locomotion. Serious injury determinations are made on a case-by-case basis using the observer's description of the interaction, the behavior and body size of the animal, the amount and types of gear attached when the animal was released, and where on the body the animal was hooked/entangled. If insufficient information is available for a given interaction, a prorating method is used to categorize injuries, based on previously documented interactions for each species. Monk seals are considered seriously injured if one or more of the following conditions apply: 1) they are hooked in the mouth deeper than the lip (i.e. inside the mandible, at base of tongue, or having swallowed the hook); 2) they are entangled in an actively fishing lay net; 3) they are entangled in debris which has cut through the skin of the animal; 4) they are entangled in debris and are subsequently disentangled, and the intervenor(s) specifically state in a field report that the animal could not have escaped unaided; and/or 5) they are entangled in debris which is in turn caught on shallow substrate, effectively immobilizing the animal.

Key issues/questions

Cetaceans: Hooked cetaceans are often very active, complicating an assessment of where and how the animals are hooked. Many animals break the line and swim away with varying amounts of gear attached before they are close enough for the observer to see details. Tuna sets (the majority) are hauled after dark, making it difficult for observers to identify species and observe details of the interaction events. To increase the collection of data relevant to serious injury determinations, new forms are currently being tested that have check boxes allowing observers to quickly record information on location and type of hook or entangled gear, amount and types of gear left attached to the animal, and the animal's behavior. Questions include:

- What is fate of small cetaceans released with a hook in their mouth (lip? jaw? skull?) or with an ingested hook?
- Is there any evidence they shed the hook on their own? Would a hook in the mouth significantly impair feeding, cause infection, or lead to death?
- At what point does trailing gear become a problem likely to cause death for small cetaceans (how much and what type of gear)?
- How does the impact of trailing gear differ:
    - when an animal is hooked in the mouth, head, body, pectoral fin, fluke?
    - when an animal has line entangled around the head, body, pectoral fins, fluke?
- What types of additional data would be useful to try to collect regarding the nature of the injury or the types and amounts of gear involved?
- Can any behaviors appropriately be used to indicate that an animal has sustained a serious injury (e.g., swimming abnormally', 'squealing', active/lethargic)?

Hawaiian monk seals: Seals are presumed to become hooked by taking bait rather than catch, but additional data need to be collected to confirm this presumed sequence of events. Moreover, interviews with fishermen who have inadvertently hooked and released seals can provide information on what types of bait may be more or less likely to be taken by seals. A key issue is that the subpopulation of seals in the MHI is increasing, so fishery interactions are likely to increase. Some steps have been taken to mitigate the effects of hookings. PIFSC personnel have been advocating the use of barbless hooks in the shorecasting fishery, a practice which would not diminish hookings, but would lead to a hooked animal more likely to lose the hook without human intervention.

In determining serious injuries, the effect of human intervention has not been considered, and perhaps this warrants further discussion, at least on the management side. If humans remove a deeply embedded (or ingested) hook, or release an animal from a lay net, and the animal survives, should the event still be considered a serious injury?

Cetacean serious injury determinations off the U.S. Western Contiguous Coast (Karin Forney, NMFS SWFSC)

Nature of interactions

Most cetacean-fishery interactions on the U.S. West coast involve small cetaceans, and the interaction generally leads to the death of the animal. Large whales, however, may swim away with gear attached. Since 1999, at least ten humpback whales off the U.S. West Coast have been observed entangled in fishing gear, including line from crab pots, traps, and nets. In some cases, the animals were freed or subsequently stranded dead, but in most cases, the fate of the animal is unknown. Ship strikes have also been implicated in the deaths of humpback whales, blue whales, and fin whales. Additional whales have been observed with ship strike injuries (e.g., propeller gashes), but their fate is not generally known. A few humpback whales have been observed with healed scars from apparent ship strikes.

Cause of Injuries

Pelagic drift gillnet fishery (~20" mesh). Large whales are occasionally entangled and released with a portion of the net, or they may swim through the net and continue with or without gear attached. Pingers may be attached.

Traps/pots: Humpback whales occasionally get entangled in traps/pots set for spot prawns or crabs, and may swim away with lines, traps and/or floats attached. They may also become anchored.

Ship strikes: Ship strike injuries and deaths have been documented for several cetacean species, including humpback, blue, and fin whales.

Current methods of determining serious injury

Carretta *et al.* (2005) summarizes the approach used to determine serious injury in marine mammals entangled in driftnet fishing gear:

"Occasionally, entangled animals were released with injuries that made future survival doubtful. These cases of "serious injuries" were defined by reviewing observer notes and comparing the extent of the injuries with the serious injury guidelines used by NMFS (Angliss and DeMaster, 1998). A serious injury is defined as 'any injury that will likely to lead to mortality'. Serious injuries may include--but are not limited to--the following: animals released with trailing gear that would impair the animal's mobility or ability to feed, ingested hooks, visible blood flow, loss or damage to an appendage, listless appearance or inability to defend itself, inability to swim or dive upon release from fishing gear, signs of equilibrium imbalance, perforation of any part of the body by fishing gear, and animals that swim abnormally after release."

Ship strike injuries are evaluated on a case-by-case basis, but serious injury determinations are not always possible.

Key issues/questions

- How much and what type of trailing gear is likely to cause the mortality of large whales?
- How does the impact differ:
    - when an animal has gear entangled around the head, body, pectoral fins, fluke?
    - if the animal is entangled in bottom-anchored gear and struggles for a period of time?
    - by type of gear (monofilament line, multifilament line, netting, pots, floats attached, etc.)?
- What types of entanglement injuries are whales known to have survived (or not)?
- What types of ship strike injuries are whales known to have survived (or not)?

Large whale and pinniped serious injury determinations in Alaska (Robyn Angliss, NMFS AKFSC)

Nature of interactions

Injuries to several different marine mammal stocks in Alaska result from vessel strikes and incidental entanglement in a variety of fishing gear. Most of the federally-regulated fisheries (groundfish trawl, longline, and pot fisheries) have some level of observer coverage: there are occasional reports of marine mammal incidental mortalities reported for some of these fisheries, but very few reported injuries. However, because most fisheries that may cause incidental injury or mortality of marine mammals in Alaska are not observed, information on the entanglements can be collected only through opportunistic accounts from commercial fishers, researchers, and the general public.

Due to the opportunistic nature of the reporting, many entanglement/injury reports are received in areas where there is substantial research effort, public boating, and public awareness of entanglements, such as in Southeast Alaska. Far fewer reports of injury or entanglement are available in less populated areas, such as Bristol Bay. The extent of entanglement ranges from loose loops of line around the body and/or pectoral fins with no apparent wounds, to gear that has cut deeply into the flesh, to gear that is so tightly wound around the animal that the head and flukes were bound together. In many cases, the entangling line cannot be identified to a fishery. A disentanglement program in Southeast Alaska aids some of the entangled humpback whales and thus reduces the total number of animals that would otherwise be considered injured. A few injuries of bowhead whales and fin whales due to entanglement or ship strikes have been reported, but the frequency of these reports is under one animal per year.

Cause of Injuries

Traps/pots: Large whales—primarily humpbacks and grey whales--are entangled in a variety of pot fisheries. Types of pot fisheries include commercial crab pot, commercial shrimp pot, personal use pot, subsistence use pot, or unspecified. In many cases, it is not possible to determine from the records what type of pot fishery was responsible for the entanglement.

Salmon gillnet: Ranks second in entanglement rates for humpback and grey whales.

Salmon purse seine: Infrequent entanglement of humpback and grey whales.

Troll gear: Steller sea lions have been reported with hooks and flashers in their mouths. Reports are currently infrequent, but occurrence of this type of event is also known to be underreported.

Ship strikes: Collisions between humpback whales and pleasure craft in Southeast Alaska occur at a rate of ~1/year.

Methods of determining serious injury

Until 2004, the method to assess whether an injury should be considered "serious" involved only one individual who reviewed a stranding report summary. Entanglements or other injuries reported through the observer program or through stranding reports were considered serious if they were deemed to be likely to impede movement or feeding, per the serious injury guidelines. Entanglements that clearly bound an animal's appendages sufficiently to prevent movement or that wrapped around an animals' mouth were considered to be likely to impede movement or feeding. Entanglement in or dragging of large quantities of gear were considered to be likely to impede movement, and were considered serious injuries. If the report of the entanglement/injury was poor, a best guess was made; the assessment erred on the conservative side and designated an injury as "serious".

Due to concerns about how the serious injury designation was being made for humpback whales, the Alaska SRG convened a subcommittee to review the raw data for each entanglement and make recommendations regarding whether each entanglement should be considered serious, not serious, or "cannot be determined" (Wynne *et al.* 2003). The 2005 draft Stock Assessment Report (SAR) included the majority opinion of the SRG for each humpback whale entanglement event. In 2006, the Alaska Fisheries Science Center and Alaska Regional Office reviewed the SRG's assessment of each entanglement event for consistency with the serious injury guidelines, and with the exception of three records, accepted the SRG's advice. For the 2006 draft SARs, of the 38 injuries of humpback whales between 2001-05, 9 (24%) were considered seriously injured, 18 (47%) were considered not seriously injured, and the information on the remaining interactions was insufficient to make a determination.

<u>Key issues/questions</u>

- It would be helpful to learn how some types of entanglements directly affect survival of an individual large whale in the short-term (days to weeks) and long-term (a year). Entanglement types include: single or multiple wraps of line, line through the mouth or restricted to other parts of the body, trailing small or large amounts of pot gear, and trailing small or large amounts of gillnet gear.
- There are a variety of opinions as to whether a hook in a pinniped's mouth should be considered a serious injury. Whether this does, in fact, commonly cause mortality of the pinniped should be explored.
- The Wynne *et al.* 2003 white paper documented a remarkable lack of consensus among several experts as to whether many different types of humpback whale entanglements or injuries should be considered serious or not serious. It would be helpful to develop a set of guidelines or a process that can be used to reduce this variability.

The SRG has suggested that "serious injury" be assessed in a probabilistic manner (e.g., stating that there is a 50% chance the animal would die as a result of the injury) instead of simply using the terms "injured" or "seriously injured".

Large whale disentanglement systems (Dave Mattila, NOS, Hawaiian Islands Humpback Whale National Marine Sanctuary)

<u>Introduction</u>

Responding to reports of entangled whales and releasing them, along with documentation of the animal, can supply data about the causes, extent and severity of the entanglement problem. Using disentanglement techniques developed by Jon Lien, the Provincetown Center for Coastal Studies and others, under the supervision and authorization of the National Marine Mammal Health and Stranding Response Program (MMHSRP), and in cooperation with many Federal, State and NGO entities, response networks are in various stages of development throughout the country. The safe and professional documentation of the whale, entanglement, and gear are becoming an integral part of the disentanglement response. Amongst other management issues, some of these data gathered through the disentanglement response are useful in making serious injury determinations. In particular, identification of released individuals in order to determine survivorship through long-term tracking studies, documentation of wounds for ground-truthing scar studies, other newly developed assays of individual health, and the verification of events in order to clarify the reliability of opportunistic reports (see background materials Robbins et al, 2007).

Current Assessment Techniques

Some aspects of the current assessment criteria used by the disentanglement networks to determine if an entanglement is potentially life threatening, and therefore warrants intervention, may be of use to this workshop. These criteria have evolved over time, as our understanding of which entanglements are life threatening (short and long term) and which are likely to be shed on their own. They rely on a determination of the species and body part(s) involved, the type and constriction (immediate and potential) of the entangling material, as well as the wounds (acute and chronic) and estimated overall health of the animal. In addition, the animal's behavior and location are sometimes factors considered.

Current and Potential Data Collection (with discussion of limitations) Mattila et al, 2007 (background material) summarized some of the data that are, and can be, safely collected during large whale disentanglement operations. Those aspects which are applicable to helping to assess serious injury will be summarized, including: the data collected to help understand entanglement impacts and to ground-truth scarring studies, the safe collection of visual and physical samples, and some experimental tools being developed (e.g. breath collection). Aspects of the documentation of events and some of the data collected are currently distributed to members of disentanglement networks through network web sites. Some caveats in using these data include, but are not limited to: absence of negative data (e.g. what was not seen), real time report narratives that are assumed to be "incorrect", some of which may be updated but may still include inaccuracies.

Key issues/questions

Since large whale entanglements are cryptic, rarely witnessed events, and the animals often swim off with the gear that they become entangled in, determining the actual number of deaths and serious injuries is extremely problematic. Key questions remain:

- What are the respective survival rates of released (vs. non-released) animals?
- What types of data can we safely collect in order to determine the likely fate of individuals?
- What type of data may help to illuminate the overall extent of the problem?
- What are the "trade offs": injuries from the disentanglement process?

A Note on Vessel Collisions in Hawaii

Reports of vessel collisions are increasing in Hawaii. Several factors are likely to contribute to this increase in collisions, including: increasing whale population, increasing numbers and speed of vessels, increased outreach and subsequent reporting. The advent of high-speed ferry transport to the Islands has increased public and NOAA's concern about potential collisions. Part of the response of NOAA (Fisheries and Sanctuaries) and the State of Hawaii's response is to attempt to more fully document any collisions and their subsequent outcomes.

2.3 Evaluation of serious injury determination systems

Two presentations provided syntheses across all of the regional approaches to serious injury determinations. This was followed by plenary discussion.

Synthesis of regional approaches to serious injury determinations (Tim Cole, NMFS NEFSC)

Across the regions, the *species groups* involved in interactions with humans potentially leading to serious injury include: mysticetes, odontocetes, otariids, phocids, and sirenians.

Primary *data sources* for making serious injury determinations include: fisheries observer programs, opportunistic reports from researchers, opportunistic reports from public, and stranding and disentanglement networks

Key *causes of injury* include: hooking (longline, troll, recreational), entanglement (trap/pot, gillnet, monofilament), entrapment (trawl, seine), and collisions (vessel hull, propeller).

Key *variables contributing to serious injury* include:

- Animal age
- Animal health
- Animal behavior
- Injury type (e.g., puncture, laceration, blunt trauma, compression)
- Injury location (e.g., mouth, head, body, flipper, tail, internal)
- Injury size
- Injury duration (e.g., short, repeated or chronic)
- Entanglement type (e.g., hooked, constricting line, loose line, anchored, enveloped)
- Entanglement size (e.g., size, length and branches of line; number of buoys, traps or anchors; volume of netting)
- Entanglement constriction (e.g., tight, loose, multiple wraps)
- Entanglement duration

The task of making serious injury determinations across regions is characterized by the following key issues and challenges:

- The quality of primary data varies
- Assessing internal injuries on free-swimming animals is a challenge
- The usefulness of behavior as an indicator of serious injury is another challenge
- Susceptibility of animals to other health threats or complications following injury
- Accounting for serious injury in stock assessments (whether to use procedures that are either absolute or probabilistic, e.g., 50% chance the animal would die as a result of the injury; anecdotal data for smaller species)
- Estimating populations' actual rate of serious injury from opportunistic data is difficult

Report from the Serious Injury Subcommittee of the Alaska Scientific Review Group (Kate Wynne, University of Alaska)

The Alaska SRG was asked by NMFS staff to review a table of humpback whale entanglements planned for inclusion in the 2004 Alaska Stock Assessment Report ("SAR Table"). For each event, the group was asked to determine those events that would result in "Serious Injury or Death" and those that would not.

No category was provided for outcomes that "Cannot Be Determined" and the scoring grid did not provide a place to code "Criteria Used" in making the determination. Members of the SRG submitted divergent responses, which raised issues for discussion at the November 2003 meeting. Alaska SRG members raised concerns that, while dichotomous outcome determinations (Will Die *vs.* Won't Die) are ideally suited for MMPA implementation, they were difficult to make based on the data provided.

Alaska SRG participants discussed several sources of uncertainty and interpretational discrepancies that led to differences among Alaska SRG responses. Given the management implications of this ambiguity, the Alaska SRG suggested that the definition and determination of lethal entanglement should be a NMFS priority, warranting a joint discussion among Alaska SRG and formal advice to NMFS.

To address this issue, Alaska SRG formed a subcommittee to provide more detailed response to NMFS regarding "Serious Injury" determinations and to develop a report outlining the results (Wynne *et. al*, 2003). The subcommittee included five experienced Alaskan marine mammalogists (i.e., the authors of the Alaska SRG report), three of whom have received NMFS training in whale disentanglement assessment and response. The subcommittee agreed to reassess the outcome of humpback whale entanglement events reported in the "SAR Table" and to identify the criteria they used to determine which events likely represented lethal interactions. While completing this task, the subcommittee encountered inconsistencies in information provided in the SAR Table that could alter their outcome determinations.

The scoring grid enabled the reporting of the level of agreement for coding the set of entanglement and collision events. The group of mammalogists reached complete agreement on the anticipated outcome of entanglement or collision less than 18% of the cases presented. Committee members' comments indicated their difficulties making objective outcome determinations were due to insufficient information and/or sources of subjectivity. In more than 80% of cases, at least one member believed the information provided was inadequate to determine the likely outcome of the incident. As a result of this exercise, three sources of subjectivity were identified by subcommittee members with suggestions for their minimization.

Plenary discussion – cross-cutting themes

During a brief plenary discussion period, participants identified the following key cross-cutting themes from the above presentations:

- Significant diversity exists across the regions as to the method used to make serious injury determinations. This diversity is due in part to the amount of information available in the different regions. The Northeast region, for instance, has collected more information for many species than has been done in some of the other regions. This allows for refinement of serious injury determinations.

- Greater coordination and standardization is needed across the regions.
- Improved coordination and integration with observer and stranding programs is also needed.
- Key information management challenges continue to exist.
- Significantly different amounts of data exist for different species groups.
- Relatively simple criteria are needed to perform serious injury determinations in a timely fashion.
- Some debate exists as to whether the current definition of "serious injury" is sufficient or adequate.
- A probabilistic approach might be helpful, but it would apply differently to different species groups. In general, it is much more difficult to use probabilities for marine mammals than for sea turtles.

2.4 Breakout group discussion on the evaluation of current data and serious injury determination systems

Following the presentations on current data and serious injury determination systems, workshop participants were organized into three concurrent breakout groups to continue discussions on this topic in a small group setting. Each breakout group was organized to contain a mix of expertise. Each breakout group addressed the following three questions:

1) What has worked well with serious injury determinations?
2) What has not worked well?
3) How have constraints on data collection affected our serious injury determinations?

Summaries of each of the breakout group's discussions for each question are reported below.

1) What has worked well with serious injury determinations?

Group 1:

- Applying decision trees has worked well.
- Documenting and tracking the fates of animals (e.g., long-term catalogues) has been important. And example was presented by Michael Moore. A female North Atlantic right whale with ship strike injuries that seemed fatal, survived for multiple years. In doing so she earned the name "Lucky." However, once Lucky became pregnant for the first time, her pregnancy caused her years-old wounds from the ship strike to rupture, killing her.
- Fishery observer programs have made huge improvements in recent years in terms of the amount of data collected and the quality of those data.
- Data collection and standardized protocols are improving serious injury determinations.
- Strandings may be a helpful tool to promote observer programs in certain coastal fisheries.
- Involving pathologists with stranding networks is improving the process.

- Stranding coordinators collate all information into individual event case folders, which get sent to NEFSC for the determinations about once a year. Resightings and other relevant information tend to get included after the initial report.
- Interacting with the original source is important. It is important that the staff members responsible for making serious injury determinations directly interact with the observer program and individual observers. It is helpful to attend observer trainings, explain how the work of observers is important, take questions, and provide feedback (and "thank yous").
- The Alaska SRG independent review was helpful. Other centers should do that.

<u>Group 2:</u>

- It is important to maintain the current level of training for observers and include additional training as necessary.
    - Increase training on species identification techniques to increase mark-recapture data.
    - Current data collections are impressive. Efforts should be continued.

- The Hawaii disentanglement website has proved useful. This website should be expanded from the current focus on Hawaii to become a National website. Potentially, the website could be expanded to bi-national by including information from injured animals in Mexican waters.

- On the East coast, Take Reduction Teams drive much of the data needs and collection of marine mammal-human interactions (fisheries and vessels). There needs to be a similar and consistent approach on the West coast, if the science supports it.

<u>Group 3:</u>

- Taking a case-by-case approach has worked well.
- Information collected by fisheries observers has improved considerably over the past several years.
- The 1997 Guidelines have served NMFS fairly well in the interim; the agency is now ready to bring the process to the next level.
- Longitudinal data have been very helpful for following up on individual cases. The agency should continue longitudinal studies and expand its efforts in this regard.
- Aerial surveys have been a good tool for providing longitudinal data and should be continued.
- Requesting external review (e.g., Alaska SRG) was a good idea and a useful exercise.
- External expertise is currently sought on a case-by-case basis (i.e., not part of the formal determination process), but is very informative to the process.
- Web-based collaborative tools that allow all available information to be viewed by a variety of people and archive raw data and the rationale for determinations greatly facilitate the learning process for serious injury determinations (i.e., they are important to maintain history/documentation of decisions, more than what appears in stock assessment reports)
- The flexibility allowed by the current process is critical (i.e., ability to adapt to new information)

- Observers carrying digital cameras have greatly enhanced the quality of information available to the staff responsible for making serious injury determinations.

2) What has not worked well?

Group 1:

- There is a lack of consistency among regions in making serious injury determinations. This applies to collection and interpretation as well as whether regions pursue a more risk-averse versus risk-prone approach. Inconsistency within regions among species and fisheries as well as between regions. Inconsistent on ALL levels. Flexibility = subjectivity.
- The agency needs to move from qualitative to quantitative process.
- Presently, databases are insufficient and not necessarily adaptable to changes to observer logs.

Group 2:

- There needs to be more directed education and outreach to stranding network participants and the public to raise awareness of how to report an injured, stranded and/or entangled animal. This may help to speed communication between parties.
- There needs to be additional focus on ship strikes and the resulting injuries.
- There is a need for increased communication and coordination in both the reporting and follow-up between stranding organizations and NMFS along the West coast.
- The need exists for the West coast regional stranding coordinator to pursue this issue as an agenda.

Group 3:

- There are regional inconsistencies in the way the guidelines are interpreted and applied.
- Inconsistencies exist in original data collected by observers (e.g., inconsistent interpretations of terminology).
- As well, there are inconsistencies in interpretation of information at all levels of the process (observers, stranding staff, staff responsible for making serious injury determinations).
- There are inconsistencies in each region's degree of conservativeness and precautionary approach.
- Lack of communication, collaboration, and adequate feedback loops at all levels of the process (from original data collectors, to stranding staff, to staff responsible for making serious injury determinations, and back to observer program) hamper the program.
- Responsibility for determinations often rests with one person. This responsibility should be distributed among a broader panel of experts, perhaps at a national level.
- Observer training should be targeted more specifically to the data users' needs.

3) How have constraints on data collection affected our serious injury determinations?

Group 1:

- Communication must be improved on all on all levels,, e.g., between end user (i.e., those making the determinations) and observer program/stranding network as well as Take

Reduction Teams, etc., so they can have a better understanding of how data are used, what data needs are, and how they are evolving.
- Outreach and reporting system needs to be improved- the Alaska region needs a better reporting system. Need to have a 1-800 number like in Hawaii for people to call. An improved outreach effort is needed.
- Data interpretation needs to be standardized among regions.
- Data collection needs to be expanded. For example, there is a lack of observer data in state fisheries.
- Standardization of data amongst regions in a significant need.
- There is a need to provide incentives to fishers to collect and enable collection all possible data. Providing a situation where we are risk-averse versus risk-prone to encourage fishers.
- There is a need to investigate novel tools for monitoring injuries and mortalities in unobserved fisheries (e.g., sonar for trap/pot or gillnet fisheries in high-density fishing areas, thermal sensing tools)
- There is a need for studies targeted in time and space where fisheries and stocks overlap (e.g., pilot whales in the mid-Atlantic portion of the pelagic longline fishery).

<u>Group 2:</u>
- Identify and "mine" the existing data sets (stranding records, tissue bank, ship strike database, disentanglement website, etc.) to see if and where there are connections between necropsy findings and visual observations.
- Train observers and those making serious injury determinations to increase knowledge of physiology of the animals.
- Follow-up observations of injured small and large cetaceans should be increased. The more follow-up that can be done, the better the serious injury determination that can be made.
- Should the current interpretation that any hook in mouth of a marine mammal is a serious injury remain the standard? The group plans to discuss over the next 2 days of the workshop.
- There should be better attempts to collect data on offshore animals. This could include at-sea necropsies, increased effort to tow offshore stranded animals to shore, and more thorough documentation.

<u>Group 3:</u>
- Estimates made by data collectors (observers) are often inaccurate and highly variable (e.g., estimates of age and length).
- Observers may be inexperienced or lack sufficient training.
- Lack of observer coverage is an obstacle.
- There is a lack of prioritization of data needs.
- Observer effort can be allocated more efficiently to collect the desired information.
- There is a lack of information about what happens with each individual case (i.e., there is not enough follow up, not enough longitudinal data).
- Data are lacking for cases where there are no observers present (e.g., ship strikes).
- Analysis of genetic samples collected hampered by delays and a lack of resources.
- We need more tagging studies to collect follow up information on individual cases.

- A ship strike database or web site is needed where information about each case can be viewed (such as the Center for Coastal Studies disentanglement network web site).
- There is a need for better hindcasting and drift pattern analyses for ship strike cases.
- There is a need to develop and define a common vocabulary/terminology to support serious injury determinations (e.g., “scar” vs. “mark”; “healed” vs. “unhealed”)
- There is a need to develop species-specific clues for assessing body condition and overall health of the animal.
- There is a need to define characteristics of injuries leading to survivorship or death.

3.0 Overview of New Information on Survival of Injured Marine Mammals

Day 2 of the workshop focused on an overview and discussion of new information obtained over the past decade on the survival of injured marine mammals. The discussion was organized into two main parts:

1) *Large cetaceans*. Participants provided presentations on the survival of injured North Atlantic right whales as well as humpback and other large whales in both the Atlantic and Pacific oceans.
2) *Small cetaceans and manatees*. Participants presented recent information on fishery interactions with small cetaceans in the Atlantic, Gulf of Mexico, and the Pacific, as well as an overview of serious injuries to Florida manatees.

3.1 Large Cetaceans

3.1.1 Presentations

Serious injury determinations for right whales: What's missing? (Richard Pace, NMFS NEFSC, with contributions from A. Knowlton, New England Aquarium, Boston, MA)

Richard Pace reviewed the linkage between serious injury determination and the stock assessment process as guided by GAMMS. Stock assessments require an accounting of human caused mortality incurred by any stock in order to assess the stock's status. Unlike most small cetacean and pinniped stocks for which fishing-related mortality is estimated from a potentially unbiased sampling process, large whale human-caused mortality assessments are direct counts of dead whales that are almost surely biased strongly downward due to low recovery rates of carcasses and fate determination rates of discovered carcasses (Number dying > Number detected > Number of necropsies > Number causes determined). Historically, assigning mortality causes to large whale deaths required significant (nearly irrefutable) pathological evidence. Similarly, the criteria for labeling an observed injury of a large whale as serious (*sesu* MMPA) required there to be little doubt among experts that said injury would result in mortality.

Serious injury evaluations produce one of three outcomes: 1) no error when the determination matches the outcome, 2) an error of commission when an injury is declared serious but does not result in mortality, or 3) an error of omission when a fatal injury is not labeled as serious (which also occurs in the case of insufficient information). Pace compared the longitudinal re-sighting data of individually recognized North Atlantic right whales (RIWH) to the record of serious injury determinations for the years 1991-2004. During that period, serious injuries were declared for 12 catalogued individual RIWHs. All but 2 of these individual whales had significant sighting histories prior to their injuries, but were documented as seen more than 1 year post injury. One whale had a relatively sparse sighting history, but has not been seen during the 10 years post injury. The remaining whale was seen 2 years post injury during which sightings noted declines in apparent health status, and it has not been seen since. Additionally, 5 RIWHs sustained injuries that met the criteria for being declared serious but did not appear in stock assessment reports as such because their subsequent mortalities were observed and were reported as such. Therefore, NEFSC made no obvious errors of commission in RIWH serious injury determinations reported for 1991-2004.

Richard also examined a set of serious injury determinations from an "alternative knowledgebase" that resulted from well-defined criteria applied to entanglement related injuries to RIWHs. The alternative knowledgebase declared 48 injuries as serious including 11 declared by NEFSC, 5 that would have been declared by NEFSC had they not been ultimately reported as deaths, and 5 others for which their sightings histories end soon after their injuries were reported. Thus, NEFSC made a minimum of 5 errors of omission (rate= 5/21 x 100 = 24%). Further, the alternative knowledgebase had a moderately high commission to correct serious injury declaration ratio (27:21 or 1.3 errors of commission per correct serious injury declaration).

Richard pointed out that any refinement of the process to determine serious injury will continue to miss the assessment gap in counting human caused mortality of RIWHs. The addition of the 5 apparent omissions over a 14 year periods amounts to <0.4/yr additional fishing related deaths. This hardly adjusts for the estimated/reasoned difference of 4 human caused mortalities per year not accounted for in recent SARs. He concluded that staff developing serious injury criteria for large whales need not fear that errors of commission will result in inflated human caused mortality assessments.

Scar-based inference into entanglement and serious injury (Jooke Robbins, Provincetown Center for Coastal Studies)

Entanglement in fishing gear is a documented source of injury and mortality to humpback whales and other cetaceans. Although any body part can be involved, at least 53% of humpback whale entanglements involve the flukes and caudal peduncle (Johnson *et al.*, 2005). Even short-term, mitigated events produce scars at this location that persist from one year to the next (Robbins and Mattila, 2001). These injuries generally take the form of wrapping linear scars and abrasions, notches and other penetrating injuries, and occasionally substantial deformation.

Since 1997, systematic photographic sampling and scar analysis have been used to study entanglement scarring on free-ranging Gulf of Maine humpback whales (Robbins and Mattila, 2001, 2004). More recently, the same techniques have been applied to humpback whales in other U.S. areas, including Hawaii (Robbins and Mattila, 2004; Robbins *et al.*, 2007), Southeast Alaska (Neilson, 2006; Robbins *et al.*, 2007), and areas of the U.S. West Coast (Robbins *et al.*, 2007). Entanglement-related scarring has been detected in all of the areas in which research has been conducted to date. For example, more than half of the Gulf of Maine population has experienced at least one entanglement, and annual acquisition rates range from 8% to 25%. Yet, even where public awareness is high and a formal reporting network exists, fewer than 10% of new entanglement injuries correspond to successfully reported and adequately documented events.

Serious injury determinations presently depend on evidence that an event has occurred and that it is likely to lead to death. Scar analysis indicates that the vast majority of entanglement events are not witnessed.

Nearly all of the types of physical injuries observed in documented entanglements have also been observed among free-ranging (surviving) humpback whales. However, animals that die from entanglement do not necessarily have injuries as severe as those observed on free-ranging animals. Thus, external injuries alone may not be predictive of whether or not an entanglement will result in a serious injury. The mouth is involved in at least 43% of humpback whale entanglements, including cases known to have led to death (Johnson *et al.*, 2005). However, significant injuries at the head, such as those observed among North Atlantic right whales, are not common among free-ranging Gulf of Maine humpback whales.

Scar research has also provided insight into the fate of injuries over time. It is not uncommon for entanglement injuries to persist in a "raw" state from one year to the next, depending on the size of the original injury. In more rare cases, entanglement injuries appear not to ever heal. However, humpback whales also appear to tolerate persistent raw wounds from other sources, such as jaw scuffing acquired during bottom feeding. Therefore, it is unclear what the impact these persistent wounds might have on the health of the animal.

Occurrence of injuries on humpback, blue, and gray whales along the U.S. West Coast and in SPLASH (John Calambokidis, Cascadia Research)

Along the U.S. West Coast, long-term studies of three species, blue, humpback, and seasonal resident gray whales have provided information on the fate of seriously injured animals. Blue and humpback whales have been individually identified annually since 1986, and the catalog for each species numbers just under 2,000 individuals. For both species, the majority of feeding aggregation using this region has been identified. For gray whales, photographic identification from northern California to British Columbia has tracked a group about 250 regularly-returning seasonal residents as well as stragglers from the larger overall gray whale population. In each of these populations, seriously injured animals have been documented. Although the exact causes of these injuries are not always clear, some appear to be ship strikes, propeller scars, and entanglement. While it is difficult to measure survival rate in these injured animals, it is clear that many with fairly serious injuries are surviving and continuing to be observed over the course of multiple years. While some individuals have been directly observed entangled, in most cases identification photographs allowing long-term tracking of survival of these individuals have not been available.

One special case occurring this year was a mother and calf, both seriously injured from a possible collision, swimming far up the Sacramento River to the Port of Sacramento and becoming the focus of a major rescue effort. While the ultimate fate of these two animals after they left San Francisco Bay is not known, it did provide an opportunity to closely examine short-term changes in their injuries and their reaction to a prolonged period in fresh water.

SPLASH represents an extensive collaborative effort (more than 50 research groups) to examine the abundance, trends, and structure of the entire North Pacific population of humpback whales, including occurrence of injuries. A key strength of this dataset is the comparison if affords of different locations. The data set contains data collected in a consistent manner for all known feeding and wintering areas for humpback whales in the North Pacific Entanglement rates have been computed and will be summarized separately. Both entanglement and other types of injuries, including killer whale rake marks, are shown to vary by geographic region. The dataset identifies specific regions where certain types of injuries are more likely to occur.

A description of severe injuries on humpback whales in southeastern Alaska (Jan Straley, University of Alaska)

Humpback whales in southeastern Alaska have been studied since the late 1960s. These longitudinal studies have provided useful information on life history parameters, including reproduction and survival. Another useful outcome of these long term sighting histories of individual whales is health assessment, although this was not a consideration when these studies began. As such, determining when specific injuries occur remains difficult. Using photography, initially 35mm slides and black and white film and now digital, we documented 35 humpback whales with an injury and classified 18 as severe. A severe injury was defined as penetrating the blubber layer. The source of these injuries was not determined for certain; however, over half (10) of the injuries were most likely caused by a collision with a motorized vessel propeller (two were seen with fresh injuries). Three whales have injuries caused by probable entanglements with a line wrapped around the body. One whale has had an unhealed injury at the base of the tailstock for at least 20 years, possibly resulting from a line entanglement. The source of four injuries is unknown; two of these, which involved injuries to the flukes or tailstock, have not healed. All but two of the 18 whales seen with injuries have been sighted in two or more years. Six whales are known females, two are males, and 10 are of unknown sex. Of the six females, five have been seen with calves after the first sighting with the injury. It is apparent that humpback whales can sustain severe injuries, survive, and continue to reproduce. However, some whales with no visible outside injury do not survive, as evidenced by a humpback whale found dying with an inflated tongue and no obvious external severe injuries during the summer of 2007. The draft necropsy report concluded the probable cause of death was trauma, but this is not definitive. It is suspected that there was a blow to the chest/neck that caused a rupture of part of the respiratory tract with air exhaled into the tissues of the tongue, causing it to inflate.

Survival and fecundity rates of entangled humpback whales (Jooke Robbins, Provincetown Center for Coastal Studies)

Case studies show that individual humpback whales can survive severe injuries and that females with such injuries can go on to reproduce. However, the likelihood that a given type or level of injury will have a positive outcome is harder to determine. Animals without outwardly severe injuries can die after exposure to human activities, and mitigation efforts like disentanglement do not ensure animal survival.

In the Gulf of Maine, a well-established reporting network exists to detect and respond to entangled humpbacks. There has also been annually intensive photo-identification research on the free-ranging population since the 1970s. Provided that an entangled individual is sufficiently documented, there is a possibility of re-sighting should it survive. In such cases, mark-recapture statistical analyses can provide a framework for comparing apparent survival among individuals. They can also provide a means of estimating and comparing other vital rates, such as reproductive rates. Here, multi-state statistical models were used to study the survival and fecundity of entangled Gulf of Maine humpback whales.

Apparent survival was estimated among 865 Gulf of Maine humpback whales seen at least once between 1997 and 2006. Individuals were classified as either juveniles or adults and could occupy one of three entanglement states in a given year: 1) never reported entangled, 2) entangled in that year, or 3) entangled in any previous year. When an individual was entangled in a given year and also had a previous history, priority was given to the current case. This model structure allowed juveniles to be assessed separately from adults and for immediate survival impacts to be differentiated from chronic effects. Other factors considered were the initial assessment of the disentanglement team, the disentanglement action (if any), and the final "serious injury" determination.

In a second multi-state statistical analysis, annual calving probabilities were estimated for 203 mature Gulf of Maine females, including those reported to have been entangled. Each year that a mature female was documented, she was placed into one of four states depending on her calving status (accompanied by a calf or not) and her documented entanglement history. This model structure allowed us to compare annual calving probabilities among females with and without an entanglement history. Preliminary results show that the annual calving probability for females after entanglement is 44.8% (95% CI: 27.52 - 63.47%). For females for which there is no entanglement history, preliminary results show that the annual calving probability is 51.3% (95% CI: 46.23 - 56.25).

Preliminary results of these analyses and potential sources of bias were discussed.

3.1.2 Plenary discussion on large cetaceans

Following the presentations on serious injuries in large whales, workshop participants engaged in plenary discussion on the topic. In particular, participants were asked to consider which elements from these analyses could be incorporated into a new (national) system for distinguishing between serious and non-serious injuries. Key comments included the following:

- Any serious injury determination system needs to allow for parsimonious decisions to be made in the absence of data.
- Longitudinal analyses are important to ascertain the seriousness of an injury, but many species exist for which conducting longitudinal analyses is difficult. There are many injuries observed that are not observed again.
- A key bias in the current system for making serious injury determinations is as follows: we are good at documenting those animals we can follow, but we are not good at animals that we don't see again.
- We do not have statistically valid sample sizes to be able to determine probabilities of survival for most large whale species. Existing data is biased as well, as we are following the fates of survivors, not those that have died. Additionally, injuries that look the same can have different consequences.
- Depth of an injury (i.e., vascularization) is a key determinant of whether an injury should be considered serious.
- NMFS needs to determine how far into the future it wants to look to predict survival. This will have implications for management plans, such as take reduction plans.
- Mark and recapture analyses may be helpful. Problems remain with opportunistic reports.
- In considering potential changes to its present system for making serious injury determinations, NMFS needs to consider whether its serious injury determinations can hold up in court.

- A key consideration for NMFS is to figure out how to get "errors of omission" to approximately equal "errors of commission."
- Serious injury determinations need to take into account the role of "cumulative impacts" (e.g., how one time of injury may predispose an animal to another type of injury).

3.2 Small Cetaceans and Manatees

3.2.1 Presentations

Evidence of fishery interactions in small cetaceans in the mid-Atlantic (Aleta Hohn, NMFS SEFC)

In North Carolina, records of stranded marine mammals with signs of interactions with fisheries date to 1992, when a database of strandings was established. Since 1997, strandings have routinely and systematically have been examined for signs of interactions with fisheries. Since 1992, there have been six species of small cetaceans identified with signs of fishery interactions (*Delphinus delphis, Globicephala macrorhynchus, Grampus griseus, Phocoena phocoena, Stenella coeruleoalba, and Tursiops truncatus*), comprising 237 animals. Of these, 88% were *Tursiops*. Most of the identified marks were fresh rather than healed. Both *Phocoena* (n=1) and *Tursiops* (n=35) have been found with gear still attached. Marks found on carcasses are primarily from monofilament line, including recreational line and monofilament gillnet. Other gear types include braided line from unidentified sources, crab pot line, and trawl lines. Along other mid-Atlantic states, the primary gear types associated with strandings are gillnets and crabpot lines.

Four species of whale (*Balaenoptera acutorostrata, Balaenoptera edeni, Eubalaena glacialis, and Megaptera novaeangliae*) have been identified with marks or gear from fishery interactions. The majority (13 of 17 events) have been humpback whales.

In January 2005, there was a mass stranding on 33 pilot whales north of Cape Hatteras, NC. Of those, 27 were examined for signs of human interaction. Nine had well-healed scars (8 deep, 1 superficial) indicative of possible longline interactions, including five of the 21 (23.8%) females and four of six (66.7%) males. All of the females with scars were adults (16 of the 21 female were adults) while males of all age classes had scars (1 adult, 2 juveniles, 1 calf with scars, and one calf and one juvenile without). With one exception, the scars were limited to areas around the mouth, including broken teeth for three animals. The exception was a large female with healed scars around the leading and trailing edges of the dorsal fin. It is possible there were other healed scars post-cranially, however conditions during the stranding response prevented full evaluation of the animals for fishery interactions.

The mass stranding of pilot whales in January 2005 was the first in North Carolina in 10 years; three prior mass strandings occurred in 1994-1995, albeit comprising only 2-3 animals during each event. Thus, there is no comparative record for evaluating possible longline entanglements. None of the individually stranded pilot whales were noted to have healed scars; it is reasonable to suggest that they weren't examined for scars. However, including individual strandings, there has been a seasonal component to the strandings, with pilot whale strandings occurring in January – March. This finding is consistent with when the highest levels of take in the pelagic longline fishery off of North Carolina have occurred.

Healed line marks are rare. We identified a *Tursiops* and a *Stenella coeruleoalba* with deep, healed scars around the mouth, including broken teeth. A *Grampus griseus* showed a healed lesion on the right side of dorsal fin, cut through 1.5 cm deep at the deepest point and thought to have been caused by trailing gear. This case also showed a partially healed 1-2 mm lesion at the insertion of its flukes.

The paucity of healed scars due to monofilament from gillnets suggests low survival of animals entangled in that gear, while the 2005 mass stranding of pilot whales indicates that some interactions, presumed to be with longline gear, can be survived. The current sample size is too small and earlier observations not sufficiently detailed to draw conclusions about rates.

Consequences of injuries on survival and reproduction of bottlenose dolphins in Sarasota Bay, Florida (Randy Wells, Chicago Zoological Society/ Mote Marine Laboratory)

Research initiated in 1970 and continuing today on bottlenose dolphins along the central west coast of Florida has led to the development of several long-term datasets of relevance to examining the effects of serious injuries. Data have come from photographic identification studies, capture-release operations, and from Mote Marine Laboratory's Stranding Investigations Program. The sighting database compiled since 1975 includes 32,347 dolphin group sightings, with 91,059 identifications of distinctive individual dolphins, derived from a photographic identification catalog of 3,958 individually-identifiable dolphins.

The capture-release database, compiled since 1984, includes veterinary examination records and health data in 676 sets of measurements from 214 individuals (some sampled up to 14 times). Exams include examination of the oral cavity, and in some cases stomach tubing. The stranding program, operating since 1985, responds in three counties including and extending beyond the Sarasota Bay dolphin range.

To date, Level A data have been obtained from 413 bottlenose dolphins, with 319 necropsies. Sixty-seven of the examined dolphins have sighting histories in our database. Data from these sources have been used to investigate the effects of gear ingestion, entanglement, vessel strikes, and amputations from unknown causes. Details of specific cases were presented.

<u>Gear Ingestion:</u> Our records include 12 cases in which gear or severe scarring from gear were related to ingestion. One dolphin is still alive, with extensive healed scarring at the angle of the gape; she has produced multiple calves subsequent to the injury. Seven apparently died directly from gear: 4 with embedded hooks in the mouth, throat, or goosebeak, and 3 with line wrapped around the goosebeak (perhaps from regurgitation). In 2 cases, gear was considered to have contributed to mortality, but a shark attack or a stingray barb was identified as the primary causes of death. In 4 cases, non-embedded small hooks were found in the stomach, but these were not identified as the cause of death. Embedded gear has only been found in carcasses, never during more than 600 health assessment examinations, suggesting that embedded hooks are frequently fatal. In cases when embedded hooks were implicated as cause of death, the animals had lost 22-36% of their body weight, suggesting that mortality was delayed following hooking.

Gear Entanglement: Of 49 cases of entanglement in gear by well-known dolphins, most were based on scars, but 12 dolphins were observed with gear, including 8 in monofilament, 3 in crab trap float lines, and one in a bathing suit. Two of these died from entanglement, one died as a probable complication of entanglement, seven others might have died without intervention, and two shed the gear on their own and survived. Most injuries involved lines cutting through appendages, a process that occurred over periods of weeks to months. Nine of 10 adult females observed with entanglement wounds or scars subsequently produced calves.

Vessel Strikes: Ten cases of apparent vessel strikes have been recorded, involving mothers with calves, dependent calves, independent juveniles, and a compromised adult. Only two of these have resulted in death, and one of these involved an already-compromised juvenile. Propeller cuts on the backs or dorsal fins have been observed to heal in most cases, although permanent disfigurement is common. The surviving mother has produced and successfully reared 3 calves since the injury.

Amputations of Unknown Origin: Cases involving major disfigurement or loss of significant dorsal fin (n=34) or fluke (n=3) tissue were monitored over time. On average, individuals survived a minimum of 8 years with these wounds. All identified females with these injuries (n=8) produced calves.

Limited information on interaction outcomes for Pacific false killer whales (Karin Forney, NMFS SWFSC)

Background: False killer whales are the most frequently caught cetacean in the Hawaii-based tuna longline fishery, and the Hawaiian stock is considered strategic under the Marine Mammal Protection Act. Observer data suggest that false killer whales primarily become hooked while depredating tuna and other catch from the gear. Most of the false killer whales that have been observed caught by on-board observers were released alive with hooks in their mouth, esophagus, or ingested, and with varying amounts of gear still attached. In some cases, false killer whales broke free before the on-board observer could ascertain the nature of the hooking/entanglement, because the line parted or was cut by vessel crew. The fate of false killer whales injured by longline fishing gear is unknown, but animals hooked in the mouth/head or having ingested gear are considered seriously injured based on previous serious injury determination guidelines (Angliss and DeMaster 1998).

The presentation summarized limited photographic evidence of potential outcomes of interactions between false killer whales and fishing gear. It is difficult to put these observations into a broader context because of their opportunistic and circumstantial nature, but the information nonetheless may be useful to increase our understanding of injury outcomes.

Baird, R. W. and A. M. Gorgone (2005). False killer whale dorsal fin disfigurements as a possible indicator of long-line fishery interactions in Hawaiian waters.
In this study, the authors review rates of major dorsal fin disfigurements from photo-identification studies around the main Hawaiian Islands. Three of 80 distinctive individuals (3.75%) were photographically documented to have major dorsal fin disfigurements that appear to be to be most consistent with fishing line injuries. This rate of severe dorsal fin disfigurement is higher than in any other odontocete population for which published data are available. Two of

the three false killer whales with disfigured dorsal fins were seen with calves, suggesting they were adult females and reproductively active despite their injuries.

Photograph from Pacific Islands Cetacean and Ecosystem Assessment Survey (PICEAS)
The 2005 PICEAS cruise, conducted by SWFSC/NOAA, was designed to obtain abundance estimates of false killer whales and other cetaceans in an area between Hawaii, Johnston Atoll, and Palmyra Atoll. This is the region where the majority of takes of false killer whales in the Hawaii-based longline fishery have been documented. The survey included visual search effort and acoustic monitoring using a towed hydrophone array. Fourteen groups of false killer whales were sighted and approached by the vessel (8 were detected visually, 6 were detected acoustically and later confirmed visually). In one of these groups, a severely emaciated individual with a partially cut off dorsal fin was photographed. The animal may have had line around the head, but the photograph was too distant to determine unequivocally whether gear was present. It is possible that this observation represented an animal injured by fishing gear and no longer able to feed itself.

Serious injury to Florida manatees (Alexander Costidis, University of Florida, Florida Fish & Wildlife Conservation Commission)

Florida manatees (*Trichechus manatus latirostris*) are a subtropical subspecies of the West Indian manatee (*Trichechus manatus*). The Florida manatee ranges from the coastal and inshore waters of Florida in the winter months, to the southeastern United States in summer months. The coastal range of the manatee population has led to an inevitable interaction with human activities such as fishing and boating. In Florida, approximately 24% of annual Florida manatee mortality is due to collisions with watercraft (Lightsey *et al.* 2006).

While propeller lacerations (sharp-force trauma) are quite often cited as the cause of death of manatees struck by boats, impact injuries (blunt- force trauma) account for more deaths than do propeller injuries. There is a wide range of watercraft injuries sustained by manatees, some of which can be explained by some relatively unique behavioral, anatomical, and morphological features. Watercraft injuries can be separated into three categories based on the physical characteristics of the injury and the inciting structure. Impact injuries are most common, accounting for 58% of all watercraft-related mortality and can be caused by blunt objects such as keels, hulls, and gear casings, or sharper objects such as propellers, rudders, and skegs (Lightsey *et al.*, 2006, Rommel *et al.* 2007). Sequalae of impact injuries typically involve subdermal contusions, muscle/tissue shredding, bone fractures, vertebral separations, and inertial organ tears. The second most common type of injury accounts for 32% of all watercraft-related mortality and involves open propeller lacerations that expose muscle and bone, or open the pleural and/or abdominal cavities to the environment (Lightsey *et al.*, 2006).

Common findings from such injuries include lacerated organs and bones, exsanguinations, severed vertebral columns, and partial or complete body transection. Finally, approximately 10% of watercraft related mortality is caused by a combination of blunt- and sharp-force trauma which can present with any number of the afore-mentioned sequalae of each respective category (Lightsey *et al.*, 2006). Empirical and anecdotal evidence suggests that certain anatomical and physiological traits possessed by manatees allow them to survive injuries that would be considered fatal to most other mammals. As such, throughout their lives most manatees obtain numerous sublethal injuries that lead to substantial exostoses and bone remodeling as well as other chronic conditions such as pyothorax and abscessation.

It is estimated that over 90% of adult Florida manatees have evidence of at least one sublethal interaction with a watercraft (pers. comm. Sentiel Rommel). To date, little is known about the types and sizes of watercraft that injure manatees, or the activity (recreational vs. commercial) the vessels were conducting at the time of collision (Rommel *et al.* 2007). Finally, two other causes of death seen in Florida manatees involve other human activities and include such things as entanglement and floodgate or water control structure deaths. Entanglements seen in manatees usually involve either monofilament or crab pot rope around one or both pectoral flippers, however occasional entanglements with anchor or mooring lines do occur. The most common sequalae of entanglement are either complete or partial amputation of one or both pectoral flippers, with the manatee usually surviving the injury long after amputation. Some exceptions have occurred where an infectious or septic event was established. However, in most cases the flippers appear to necrotize gradually due to ischemic necrosis, thereby allowing the manatee to slowly isolate the flipper and any infections occurring within it.

A small number of manatees have been found with rope entanglements around the pectoral flippers and cranial thoracic region. These cases are relatively rare. A small percentage of manatees in Florida are also killed by crushing and/or drowning in floodgates and canal locks found in intercoastal bodies of water such as channels and canals. These types of injuries have only been documented when resulting in fatal interactions and therefore nothing is known about whether sublethal interactions of this type occur. Water control structure-related deaths frequently involve rectangular or symmetrically shaped, often-bilateral impressions on the dermis and epidermis, with substantial subdermal contusions, internal hemorrhage, muscle and organ shredding, and occasionally evidence of wet drowning.

3.2.2 Facilitated Discussion on Small Cetaceans and Manatees

Following the presentations on serious injuries in small cetaceans and manatees, workshop participants engaged in plenary discussion on the topic. Participants were again asked to consider which elements from these analyses could be incorporated into a new (national) system for distinguishing between serious and non-serious injuries. Key comments included the following:

- Key factors affecting serious injury for small cetaceans include: location of the hook, existence of any gear trailing from the mouth, and vascularity (i.e., depth of incisions).
- It might be helpful to provide incentives to fishermen to remove gear and hooks, although this may be limited by the practicality or feasibility of removing gear or hooks.
- Regarding hook strength, a balance needs to be found between hooks strong enough to retain catch but weak enough to allow marine mammals to escape. Larger animals are more able to straighten hooks than smaller animals.
- Given the information presented at this workshop, the observation that an "animal swam away strongly" may not be a good indication of survivability. This may have implications for any revisions to the existing guidance for serious injury determinations.
- Current injury data are biased, because they are based on analyses of "survivors."

4.0 Pathobiology of injuries

On the afternoon of Day 2, workshop participants addressed the pathobiology of injuries. Participants presented on the topics of predicting lethality from vessel and gear trauma, pathobiological consequences to serious injury, and injuries observed in pinnipeds.

4.1 Presentations

Predicting lethality from vessel and gear trauma in North Atlantic right whales (Michael Moore, Woods Hole Oceanographic Institute)

Human-induced traumas in North Atlantic right whales (*Eubalaena glacialis*) fall in to three categories (Campbell-Malone *et al.* In press; Moore *et al.* 2004): sharp propeller incisions, blunt vessel impacts, and constrictive laceration by fishing gear. Accurate prognoses from field observations of live but impacted animals are essential for triage of entanglements and accurate prognostication of the likelihood of a particular case being fatal. These forecasts are an essential part of governmental regulatory process. Data were synthesized from management records of persistent entanglement cases, photo identification of live sightings of entangled or vessel struck whales, and from necropsy reports. Vessel interactions tend to be peracute to acute whereas entanglement in animals that are unable to immediately shed the gear is typically very chronic with fatal cases having an average duration of 5 months, and persistent non-lethal cases up to many years (Moore *et al.* 2006).

Out of 77 mortalities recorded since 1970, a necropsy was performed on 45 cases (Campbell-Malone 2007; Moore *et al.* 2004): vessel collision has been the cause of death in 24 of them. Of the ship-strike related mortalities, the cause of death in 56% (15) of the cases was acute sharp trauma alone, while 20% (9) were attributed to blunt trauma. Other cases were more complex.

A scoring matrix was established to characterize and evaluate propeller wounds: a sum of the product of cut depth (0 to 4) and number of cuts for each of head, upper and lower back, peduncle and fluke. Results were (mean +/- SD (N): Alive 7.4+/- 4.5 (24) and Dead 16.0 +/- 15.2 (15). Cuts in the upper back and head were more likely to be lethal than in the caudal part of the body, although lethal cuts were observed in all body regions. External evidence was absent in 44% (4/9) of blunt trauma cases. Thus the extent of non-lethal blunt trauma is not known. Skeletal fractures were observed in 89% (8/9) of the lethal blunt trauma cases and a broken mandible was observed in 33% (3/9) of all lethal blunt trauma cases examined by necropsy. As a fully healed mandibular fracture has never been observed in a right whale, a fractured mandible is believed to represent a fatal injury. The apparent density and mechanical properties of bone tissue from the mandible were determined experimentally. These data were then used as inputs for a finite element model capable of predicting the stress sufficient to induce fatal fracture of a mandible (Campbell-Malone 2007). On-going work will compare such stresses with the forces produced by vessels to determine the vessel speed and size combinations capable of fracturing a mandible.

From 1970 to July 2007, there have been 47 reported cases of significant entanglement, 15 entanglement related deaths, and 6% of the cases are presumed to be dead given an absence from the sighting record for 6 or more years. For entanglement trauma, significant parameters were scored subjectively in terms of severity. For 18 persistent entanglement cases where a full data set were available, scores on a scale of 0-35, were lethal above 17 and non lethal below 14, and of mixed outcome between those numbers. We are still refining the model to deal with cases where data are missing. We hope to rank cases in terms of severity, and compare the ultimate outcome.

Ongoing development of the biomechanical model and a simple scoring system to evaluate entanglement and propeller cut cases should enhance our prognostic capacity.

Consequences to serious injury (David Rotstein, University of Tennessee/NMFS)

Serious injury can be defined as that which results in death instantaneously (peracute), within a short period (acute), or over time (chronic) or in significant debilitation that affects feeding, mobility, or reproduction. For marine mammals, sources of injury include gunshot/projectiles/arrows, entanglements and ingestions, and sharp and blunt force trauma. While these injuries may have grossly observable changes such as lacerations, amputations, and hemorrhage, internal changes may be less evident and could be of incredible significance to survival.

Pathologic consequences of injury fall into two categories: anatomic and physiologic. The anatomic location of an injury could lead to peracute to acute death (e.g., head trauma) or chronic debilitation (e.g., fracture of mandible and starvation). Physiologic consequences of injury include shock, pain, or blood loss leading to an inflammatory cascade, activation of the sympathetic nervous system, hormone release (epinephrine and norepinepherine) and vascular changes with potential end results of hypothermia, coagulation defects, organ failure, and death. However, these may not be readily determinable in an animal surviving a traumatic event, and in animals that die, tissue autolysis or loss may prevent a complete assessment.

Factoring into all of this are the signalment (species, gender, age class) and history (nutritional status (body condition), reproductive status, natural history (indigenous, migratory), and pre-existing disease states) that may adversely affect healing or ability to avoid an insult. If the sources of trauma and animal factors are considered, then these could provide components of a categorization of injury and possible response to injury similar to human traumatic insult categorization.

Capture myopathy in mammals and how this condition may apply to marine mammals (Terry Spraker, Colorado State University)

Capture myopathy is a condition that has been described in terrestrial mammals and birds following capture, handling, and/or transportation, but it appears to be rare in marine mammals and carnivores. There are numerous names for capture myopathy, including muscular dystrophy, capture disease, degenerative polymyopathy, overstraining disease, white muscle disease, leg paralysis, muscle necrosis, idiopathic muscle necrosis and exertional rhabdomyolysis.

The pathophysiology associated with capture, handling and transportation of animals is extremely complex and associated with the sex, body condition, health of the animal, length of time of chase/pursuit, method/roughness of handling and the environmental condition (heat/cold) and other factors. The primary pathophysiological changes are characterized by intra- and intercellular lactic acidosis and regional ischemia that predispose to rhabdomyolysis and necrosis of various internal organs especially in the cortex of the kidneys. Hyperthermia or hypothermia can play a vital role in the outcome of capture myopathy.

There are at least four stages or forms of capture myopathy: capture shock syndrome, ataxic myoglobinuric form, ruptured muscle form, and the delayed-peracute form. The most likely scenarios in which capture myopathy may be a problem in marine mammals would be in dolphins that have been caught several times in tuna fisheries in a short period of time (perhaps a week) and perhaps in eared seals following capture (acute shock) or during recapture on the second or third day following the initial capture (peracute form).

<u>Hidden Trauma in pinnipeds</u>
Trauma is a common cause of death in pinnipeds. There are two primary types of trauma: sharp and blunt trauma. Gunshot is a third condition that may be placed under the category of sharp trauma (bullets/arrows, etc.). Usually sharp trauma can be observed on external examination, but blunt trauma is often missed. Primary causes of sharp trauma include bite wounds, boat propellers, entanglement by netting and perhaps gun shot/arrows.

Causes of blunt trauma are most common in young animals and are usually caused by crushing type wounds. Pups are commonly crushed by older animals, especially in crowded condition and during territorial fighting by the males. Other scenarios include being hit by boats, falling off of cliffs during times of excitement, etc. An important type of blunt trauma to the head and abdomen associated with dystocia is not uncommon in northern fur seals. The most common types of hidden trauma are caused by blunt trauma. Necropsy of pinnipeds is of utmost importance to confirm trauma especially blunt trauma. A tremendous degree of internal damage (i.e., fractured liver, kidney, skull) can follow blunt trauma and be totally missed following external exanimation.

4.2 Plenary Discussion on the Pathobiology of Injuries

Following the presentations on the pathobiology of injuries, workshop participants engaged in plenary discussion on the topic. Participants were again asked to consider which elements from the analyses presented could be incorporated into a new (national) system for distinguishing between serious and non-serious injuries. Key comments included the following:

- Due to the effects of capture myopathy, it is possible that animals that “swim away vigorously” from vessels may still suffer from serious injury.
- While there is no simple predictor(s) of capture myopathy, the chance of capture myopathy occurring increases with the number of captures.
- Improved terminology or precision of terminology is needed to distinguish between different types of injuries (e.g., laceration, incision, sharp trauma, etc.)

5.0 Breakout Session Discussions on Key Topics -- Summaries

Day 3 of the workshop was devoted to breakout session discussions. Individual breakout groups were organized to address the following six topics:

1) Longitudinal/survival rates from a modeling perspective
2) Categorization of injuries and pathological consequences: Gear-related injuries
3) Categorization of injuries and pathological consequences: Sharp, blunt force, and penetrating injuries
4) Large cetaceans
5) Small cetaceans
6) Pinnipeds and other species

Each breakout group was presented with a series of questions to address during a 2-hour discussion period. The first three breakout groups proceeded concurrently during the morning of Day 3; the second three groups took place concurrently in the afternoon. During the morning session, participants were grouped according to expertise on the subjects listed as 1-3 above. For the afternoon session, participants were grouped according to species expertise, thus providing participant overlap across the morning and afternoon sessions. Summary responses from each of the breakout groups are presented below.

5.1 Longitudinal/survival rates from a modeling perspective

Question 1: What needs to be in a model to accurately predict long-term survival?

- Factors potentially important when predicting survival include:
    - Individual level: stage, sex, animal condition, detection probability
    - Population level: sampling effort, natural survival rate
    - Injury specific: injury timing and classification
- Basic data should be standardized, but innovation in data collection should be permitted.
- It is important to connect and coordinate the various sources of information available for each population (e.g. sightings, observer, strandings).
- Longitudinal studies provide valuable data and are already established for many cetacean populations. These long-term data sets are extremely valuable for the study of survival and are important to continue. In other populations, individuals cannot necessarily be reliably re-encountered or re-identified. These pose a challenge for studies of survival, but satellite or VHF tagging is one possible option for filling gaps.
- A tiered approach may be necessary given the different state of knowledge among populations and species. Well-studied populations may allow a different level or type of analysis than those for which only opportunistic data are available. Well-studied populations might provide a foundation for developing approaches to be used for data-poor populations.
- Performance testing should be conducted to look at errors.

Question 2: What is the most viable model currently available? What types of models, if any, need to be developed taking into account new information?

- Experimental designs would be the most directly informative, but generally not possible or appropriate.
- Mark recapture models are informative provided that animals can be re-encountered and recognized.
- Analyses of stranding data have been used in the absence of both, although this can be problematic.

Question 3: Are sufficient data (quantity and types) available for testing?

- Well-documented events are a subset of the total, and this reduces the data available for study.
- Longitudinal data exist for a variety of species, such as North Atlantic right whales, humpback whales in the North Atlantic and Pacific, and some well-studied small cetaceans.
- Where analyses are still data-limited, injury types and outcomes could potentially be studied across populations with similar characteristics, such as humpback whales in the Gulf of Maine and southeast Alaska.

Question 4: Are the predictors applicable across taxa?

- Some predictors may be applicable across large whales (e.g., cyamid load). Capture myopathy of most vulnerable species could be used until we know more about other species (in same suborder/family?).

5.2 Categorization of injuries and pathological consequences: Gear-related injuries (i.e., entanglements, hookings, and ingestions)

Question 1: What type of nationally consistent categorization of injuries and outcomes will be functional for classification of injuries using data collected by various methods?

See answer to question 4 below.

Question 2: Are there categories of injuries that are: a) likely to have a serious outcome (i.e., mortality or reproductive impairment), b) unlikely to have a serious outcome; or c) not clearly determinable (CBD)? How do we evaluate those gray areas?:

a) Serious injuries include:
   - Ingestion of gear.
   - Hook in mouth/head (especially small cetaceans).
   - Gear attached on body with potential to wrap around pectoral fins, peduncle or head, or to be ingested (e.g., hook with line that might be ingested).
   - Foreign bodies penetrating into body cavity.
   - Multiple wraps of line around pectoral fin, peduncle, head, abdomen, or chest.
   - Deep external injuries (depth criteria TBD, e.g., muscle/bone/organs vs. skin/blubber).
   - Partially missing flukes, especially when midline affected.
   - Small cetaceans brought on vessel deck following interaction/entanglement.

b) Non-serious injuries include:
   - Small cetaceans: Hook in fluke with minimal trailing gear that does not have potential to wrap around body parts or accumulate drag (e.g., algal growth or marine debris).

c) Gray areas include:
   - Small cetaceans: Loss or severe disfigurement of dorsal fin. There is evidence that animals can survive and reproduce without fins, but these are only the survivors and the nature of the injury will affect the likelihood of surviving.
   - Large whales: Entanglement of line/gear in the mouth. Some whales may survive, but the proportion is unknown.
   - Animals released without gear following entanglement. These were previously considered not serious, but capture myopathy considerations suggest some of these animals may subsequently die (e.g., freed humpback that stranded two days later).

Question 3a: What factors play a role in an animal's response to traumatic injuries and how would we evaluate them in the field?

Key factors that play a role in an animal's responses to traumatic injuries include:

- The condition of the animal (e.g., did injury take place during the fasting part of the animal's life cycle?).
- The duration of the stressor (e.g., duration of the entanglement).
- The animal's age, sex, and reproductive status (e.g., juveniles may 'grow into' gear).
- Environmental factors (e.g., climate stressors, 'out of habitat' individuals).
- Social stressors (e.g., separation of individuals from the group, cow/calf separation).
- The cumulative effects of repeated exposures.
- The susceptibility of species to capture myopathy (e.g., pelagic dolphins vs. coastal *Tursiops* or pinnipeds).

Question 3b. How do we address hidden factors that may affect the risk for serious injury over time?

- Whenever possible, conduct follow-up (tracking, re-sights) to help identify additional causal factors.
- Conduct real-time communications about ongoing entanglements to raise awareness among stranding network participants and increase information exchange about potential factors affecting the animal's survival.
- Researchers doing at-sea surveys should document and report any injuries or other relevant observations on marine mammal injuries.

Question 4: Based on the information we have from longitudinal studies, what is the most appropriate way to evaluate or score severity of injury and response of the animal?

- A risk assessment/decision analysis framework should be developed based on factors affecting survival for each taxonomic species group and gear/injury type, to assign mortality risks to individuals. This will require examination of current data and the collection of additional data in the future. The decision analysis framework should be developed by a panel of marine mammal and veterinary experts in cooperation with risk assessment experts.

5.3 Categorization of injuries and pathological consequences: Sharp, blunt force, and penetrating injuries

Question 1: What type of nationally consistent categorization of injuries and outcomes will be functional for classification of injuries using data collected by various methods?

- A risk assessment matrix/approach would assist in developing a nationally consistent categorization of injuries and outcomes.
- Key variables to consider in developing of such a categorization system may include:
  - Geographic location.
  - Species.
  - Type of injury (blunt, sharp, penetrating, appendage loss): this could be further organized into subcategories such as percent coverage of wounds, number of wounds, blood loss, etc.
  - Location of wound on body.
  - Level of experience of observer.
  - Previous history of animal (such as previously injured or entangled, sighting history, etc.).
  - Environmental events (such as high fishing activity, Marine Mammal Unusual Mortality Events, Harmful Algal Blooms).
  - Overall body condition of animal.
  - Behavior changes (how did the animal react to the incident?).
  - Ship type (size).
  - Ship speed.
  - Life history characteristics of animal (lactating, pregnant, fasting or feeding, age class, disease status (covered by cyamids?), skin color (is it gray?), body condition (emaciated or robust), body condition changes over time).
  - Environmental conditions (water temperature, salinity, etc.).

- However, we still need terms of reference and definitions for the matrix. These should be developed by an interdisciplinary panel of experts with combined expertise in forensics, animal health, and risk assessment.

- A similar national panel should also be convened to help NMFS with their serious injury determinations and case-by-case consultations on “gray area” determinations.

- The matrix should be tested with data from right whale cases. Also, the matrix should be tested against injury cases where the animal is known to have died to assess whether the serious injury determinations match actual outcomes or coincide with the animal’s actual fate.

- The CBD (cannot be determined) cases may need to have some regional and species-specific flexibility.

Question 2: Are there categories of injuries that are: a) likely to have a serious outcome (i.e., mortality or reproductive impairment), b) unlikely to have a serious outcome; or c) not clearly determinable (CBD)? How do we evaluate those gray areas?:

Participants prefaced their answers to question 2 with several general comments:

- Key injury terms need rephrasing. Rather than sharp, blunt force or penetrating injuries, use physical injuries that you can actually describe, such as incision, laceration, swelling.

- The New England Aquarium used a wound depth of 4 cm depth or greater as the serious category for their published study on North Atlantic right whales (Knowlton and Kraus, 2001).

- Chronicity of the wound may be important. If the injured animal has survived a certain amount of time, then it may be more likely to survive into the future. It is also important to know if there were previous wounds or injuries, as injuries may be cumulative.

a) Serious injury includes:

- Location of injury: head trauma, vertebral transection, and body cavity penetration or body cavity exposure are all 100% serious.
- Source of Injury: A direct hit by a vessel of a certain size (need to determine the size) has the inertia to seriously injure a whale.
- Type of injury: Wounds deep through the blubber into muscle may require a few more descriptors from the observer to determine whether they are serious.

b) Not serious injury includes:

- Type of injury: Wounds into blubber, but not deeper than blubber, are not serious for large whales.
- Location of injury: Shallow injuries not in head or chest or body cavity area are not serious.

Question 3: What factors play a role in an animal's response to traumatic injuries and how would we evaluate them in the field? How do we address hidden factors that may affect the risk for serious injury over time?

Key factors that play a role in an animal's responses to traumatic injuries include:

- Life history of animal. For example, is it a pregnant or lactating female? Is it fasting or feeding? What is the relative age (or age class) of the animal?
- Species type. For example, seals that have lost an eye have a better chance of survival in the wild than cetaceans that have lost an eye; *Tursiops* are more robust than porpoises; and *Delphinus* are more fractious than other species.

- Movement patterns of animal, water temperature, and salinity. For example, low salinity may impede the healing of wounds (e.g., Delta and Dawn).
- Other environmental factors such as harmful algal blooms may impact recovery and susceptibility.

Question 4: Based on the information we have from longitudinal studies, what is the most appropriate way to evaluate or score severity of injury and response of the animal?

- Data from longitudinal studies can inform a revised process for making serious injury determinations.

5.4 Large Cetaceans

Question 1: Given the data we have, do the categorizations and classifications of injuries identified in the preceding breakout groups fit this taxonomic group? What are the unique characteristics in this taxonomic group that would change the categorization and classification of injuries? How does age, type of injury, location of injury, species, etc., impact the classification of an injury?

The following ideas would help improve serious injury classifications:

- Develop more classes of injuries, not just "serious injury", to monitor the fate of animals.
- There are different levels of information available for different populations, which provide opportunities for different levels of analysis (e.g., estimating mortality rates for different injury types for well-studied populations).
- The criteria that should be considered when developing a classification scheme could include: (1) any changes to the status quo should be an improvement over the current system, (2) the system should be as simple as possible, and (3) the system should be scientifically and legally defensible.
- Classify as "seriously injured" animals that have evidence of a human interaction that are clearly in poor condition (e.g., observed at the time of the interaction and then observed again in worse condition, or observed in poor condition with evidence of recent or not-so-recent interaction).
- Serious injury determinations can be informed by the way fishing lines/gear are on the animal--e.g., if the gear is hanging vertically (i.e., heavy) or horizontally off the animal, and if it might be cutting into the animal.
- If an animal is anchored or immobilized, this event should be regarded as a serious injury.
- Nationally consistent criteria.
- Adding criteria or data requests, because this information may become available from high-quality observers, stranding networks, necropsies, etc.
- Use longitudinal information to figure out which injuries are serious and then use that information to make determinations. In other words, we should not wait until longitudinal data indicate a mortality to decide that an injury is serious.
- Consider extrapolating information regarding the fates of animals with similar injuries from other populations.

Question 2: What are our data needs, and how do we address these?

Breakout session participants offered the following suggestions to address data needs:

- Conduct follow-up research on observed injuries, and develop long-term longitudinal databases. Breakout group members emphasized this point.
- Increase investigation of capture myopathy, including collecting new data (e.g., ketones in breath samples), and researching sighting/disentanglement databases for animals that exhibited suspicious symptoms (e.g., animal stayed in place once disentangled), looking at their survival.
- Improve data collection in Alaska, increase staffing.
- Continue biomechanical testing of the way gear interacts with animals, and how different parts of gear interact with different parts of body.
- Investigate wounds that don't seem to heal.
- Take photos of injuries, not just for photo-identification. This applies to researchers conducting sighting efforts.
- Improve coordination between stranding networks, regional offices, researchers (sighting), disentanglement networks, and staff responsible for making serious injury determinations.
- Conduct health assessments on animals, develop new techniques and tools for health assessments, and calibrate those assessments.
- Increase support for necropsy response, including responses to "floaters" (dead whales at sea). Also, expand necropsies to additional whales, not just those whales with external evidence of human-caused injury.
- Improve communication with Canadian colleagues regarding serious injury events and determinations.
- Develop improved, more consistent definitions of terminology, including injury categories like serious, moderate, severe, etc.
- Model survival based on different injury categories.
- Tag and track the fate of injured animals.
- Involve forensic experts more in necropsy analyses, and train more people in forensic analysis for necropsies.
- Investigate whether rope in the mouth decreases survivorship (mouth suction theory).
- Review cases and case histories where gear was removed from whales to better understand the nature of the interactions. Involve fishermen, veterinarians, etc. in this review to improve the ability to recreate the entanglement.

Question 3: How can the scientific uncertainty concerning the impact of an injury (short- or long-term) be handled in making serious injury determinations?

Participants offered the following suggestions for addressing uncertainty in the serious injury determination process:

- Extrapolate information regarding the fates of animals with similar injuries from other populations.
- Use a Bayesian approach to help make serious injury determinations.
- Start with the assumption that everything is a serious injury.

- Create a “cannot be determined” (CBD) category to address cases where “uncertainty” exists, and develop a risk-assessment matrix to remove cases from the CBD category.
- Pro-rate CBD cases based on what we do know (reference Forney’s approach in Pacific)
- Shift from a base count of injuries to an extrapolation to account for unobserved injuries and mortalities.
- Address other uncertainties, such as size of vessels causing interactions, which uncertainty around the fishery and stock to which serious injury should be attributed.

5.5 Small Cetaceans (defined as all odontocetes, except sperm whales)

Note: This breakout group defined small cetaceans as all odontocetes excluding sperm whales.

Question 1: Given the data we have, do the categorizations and classifications of injuries identified in the preceding breakout groups fit this taxonomic group? What are the unique characteristics in this taxonomic group that would change the categorization and classification of injuries? How does age, type of injury, location of injury, species, etc., impact the classification of an injury?

The breakout group considered key findings presented from the morning breakout session discussions, attempted to clarify points that were vague, and folded into the to discussions the issues that may be specific to small cetaceans. The response to question 1 is both a fleshing-out of the morning discussions as well as an expansion.

The breakout group focused its deliberations on the topics of fishing gear-related injuries, traumatic injury, and other issues. Key comments are summarized below.

<u>Gear</u>:

- Some injuries are similar across all taxa (e.g., multiple wraps, ingestion of gear).
- Some injuries have more of an effect in small cetaceans: e.g., hook in mouth, duration of entrapment (large animals more apt to free themselves), and stress response (more “urgent” in small cetaceans than in larger cetaceans).
- Our ability to differentiate robustness among species and species groups is important for determining seriousness of the injury.
- The type and amount of gear remaining on animal should be recorded.
- “Cleanness” of cut and depth of the wound made by gear are also important.
- Presence of blood should be a “yes/no” answer, instead of using subjectivity associated with determining amount of blood present (“little/lots”).
- We should distinguish between actively fished and ghost or passive gear. In the case of actively fished gear, observers will have a better idea of maximum amount of time the gear has been on the animal, whereas opportunistic sightings of animals in passive or ghost gear, or strandings, do not give an indication of how long the animal has been entangled.
- If the animal is pinned or movement is significantly impaired, there may be different impacts for animals that feast/fast versus those that require eating every day.
- Social structure and age of animal are key factors in determining injury (i.e., a social or dependent animal released alone may be subject to additional stress).

- Any marine mammal that is brought on deck should be designated as a serious injury.

Traumatic injuries:

- The location of propeller wounds on the body is an important factor in determining serious injury. For example, not considering the depth of the wound, propeller wounds on the head or neck are more likely to be serious injuries than wounds on the animal's midsection.
- Resighting may be more difficult with small cetaceans, but at least observers should try to look.
- A key issue to consider is whether a blanket serious injury determination should be made based on vessel size or speed alone.
- We should differentiate between pelagic versus coastal animals and their response to stress in a risk analysis/decision framework.

Other issues:

- How should pregnant cetaceans or cetaceans with calves be treated? Is it a serious injury to the mom, the fetus or calf, or both?
- How should the effects of whale-watching and dolphins being chased by recreationists be incorporated into serious injury determinations. Would they make it into the SARs?
- How should research-related serious injuries be incorporated into serious injury determinations?

Question 2: What are our data needs, and how do we address these?

Breakout session participants offered the following suggestions to address data needs:

- Collect additional data on post-release survival. Additional comments here included:
    - There are tools for collecting data on post-release survival (e.g., telemetry, tagging), but telemetry or tagging would need strict experimental boundaries and design to have controls and experimental groups.
    - We would have to balance the cost, effort involved, stress on the animal, and small sample size with the difficulties in interpreting the data collected.
    - The survival window would have to be defined, and tag failure rate would have to be taken into account.
    - We should consider chartering vessels to do the additional work that observers may not able to do and do the follow up.
    - Provisions should be made for redundant tag systems so there is more than one way to determine whether a mortality has occurred or the tag has failed/been lost.
- Increase the number of genetic tags. Biopsies are taken in some observer programs and not in others—they should be done across the board if possible.
- Increase the number of photo IDs for observed and stranded animals so comparisons can be made.
- Photo-identification and genetics data should be paired.
- Provide improved support for stranding networks, and encourage thorough necropsies on every animal possible.

- Focus on improving observer data and providing observers with better tools and resources at sea, getting carcasses back to shore (call SeaTow if necessary), better release techniques and training, and a consistent set of questions to answer.
- Better inform observers of the characteristics of dying animals, and have observers look for and record this information (e.g. arching of the back in small cetaceans is indicative of imminent death).

Participants also suggested conducting the following analyses:
- Conduct propeller scar studies for small cetaceans.
- Examine all available observer data ("data mining"), especially in fisheries which lack key drivers such as take reduction teams or strategic stocks.
- Investigate existing long-term study areas similar to Sarasota dolphin research program, such as for killer whales or Hector's dolphins.
- Investigate stress response in animals.
- Develop better identification for beaked whales and collect more biopsies.
- Investigate the effect of noise on marine mammals as a potential serious injury (this topic was not specifically addressed at this workshop).

Question 3: How can the scientific uncertainty concerning the impact of an injury (short- or long-term) be handled in making serious injury determinations?)

Participants offered the following suggestions for addressing uncertainty in the serious injury determination process:

- Develop a risk analysis and a decision framework. Alternative approaches might include:
    - Bring the staff responsible for making serious injury determinations together with decision analysis experts. Use policy input to make sure the framework is moving in the right direction. A key product would be a decision tree for making serious injury determinations based on a set of criteria.
    - Convene a small group of experts to work on a white paper. Have this reviewed by the SRG.
- Modify the serious injury determination process so that determinations are being made by a group, possibly a national group, rather than by individuals.
- Consider a policy decision that shifts the burden of proof. That is, recognizing that there is a continuum of injuries, create a system that makes the working assumption that an injury is serious, unless contradicted by empirical evidence or a consensus of professional judgment to the contrary.
- Data presented at this workshop, such as on capture myopathy, suggest the agency has not been sufficiently precautionary.
    - When there is uncertainty, determine that the injury is a serious injury.
    - This would cause a fundamental change in how determinations are made and would have management implications.
- Institute a training or certification process for staff responsible for making serious injury determinations. This would help increase the consistency of serious injury determinations.

5.6 Pinnipeds and other species

Question 1: Given the data we have, do the categorizations and classifications of injuries identified in the preceding breakout groups fit this taxonomic group? What are the unique characteristics in this taxonomic group that would change the categorization and classification of injuries? How does age, type of injury, location of injury, species, etc., impact the classification of an injury?

Breakout session participants discussed two types of pinniped injuries: those related to gear, and those stemming from blunt trauma and penetration. They also discussed the unique characteristics of pinnipeds as well as the impact of key contextual features on the classification of an injury.

<u>Gear-related injuries</u>

Serious injury:

- Ingestion of gear.
- Trailing gear (e.g. flasher), when it has the potential to anchor or drag, or when it can get wrapped around the animal.
- Gear attached on the body with the potential to wrap around flippers, body, or head
- Foreign bodies penetrating into a body cavity.
- Multiple wraps.
- Missing flippers – front and back flipper (serious), for both otariids/phocids.
- Deep external injuries.
- Note: Pinnipeds generally not observed with ingested line (unlike small cetaceans and sea turtles).

Non-serious:

- Confirmed hooked in the lip.
- Hooked in flipper, etc. with minimal trailing gear that does not have the potential to wrap around body parts, accumulate drag, or anchor.
- Freely swimming animals encircled by purse seine nets.

Gray area:

- Hooked in head. Here, serious injury could be assumed, but it depends on several factors, including where on the head the hooking took place, the depth of the hooking, the type of hook, etc.
- Animals stressed by being encircled or trapped (e.g., purse seine).
- Animals released without gear following entanglement. Designation depends on the extent of the injury or how long the animal was submerged, how long the gear was on the animal, and the degree of restraint.
- Pinniped brought on vessel. Unlike with small cetaceans, this is typically considered non serious, except when the animal has been shot or hit with a bat or blunt object (see below). It also depends on how the animal was brought up (e.g., in net or a roller, or through the power block.

Injuries caused by blunt trauma and penetration

Serious injury:

- Head trauma (including broken jaw, eye popped out), vertebral transection, and cavity penetration or exposure (includes bullets).
- Any detectable fractures; the animal will strand eventually due to thrombosis (a blood clot in the heart or blood vessel) or a secondary infection.

Grey area:

- Dog bites: serious injury depends on the extent of the injury.
- Direct hit by a vessel: serious injury depends on the size, speed, and inertia of the vessel relative to the size of the animal; the depth of propeller wound (into blubber, muscle), and the type of vessel (water ski, car, boat).
- Direct hit by blunt object (e.g., baseball bat, etc.): serious injury depends on the extent of the impact.

Unique characteristics of pinnipeds that affect the categorization and classification of injuries

- Sea lions and seals can be examined relatively closely. So it is possible in many cases to get an accurate description of an injury and assess seriousness.
- Some pinnipeds have adapted to fishing operations such that they don't appear to experience the same level of stress from fishing operations or human interactions that other taxa might experience.
- Certain pinniped behaviors may predispose them to serious injuries. For instance, those likely to interact with fishing gear repetitively are more likely to get shot (e.g., CA sea lions).

Key contextual features that affect the classification of an injury

- What applies for cetaceans generally applies to pinnipeds and other marine mammal. species. Pups and young-of-the-year animals have soft craniums and are more vulnerable to blunt trauma. Dependent animals are generally more at risk.
- Pinniped species may be treated differently, depending on the status of the population (e.g., monk seals v. California sea lions).

Question 2: What are our data needs and how do we address these?

Participants noted that, in general, there is good reporting and follow-up (including re-sight) from stranding and response networks (especially in Hawaii). They made the following suggestions for addressing data needs:

- Standardize data collection.
- Conduct more fate and survival studies.
- Increase efforts to enumerate and capture sighted entangled animals that are not and cannot be responded to. Mark non-rehabbed animals with paint, etc.
- Identify existing databases to work on risk assessment and probability of survival.
- Emphasize the use of high quality photos.

Question 3: How can the scientific uncertainty concerning the impact of an injury (short or long-term) be handled in making serious injury determinations?

Breakout group participants offered the following suggestions for addressing uncertainty in the serious injury determination process:

- Include confidence levels (codes) for reliance of data in the determination process.
- As a starting point, assume serious injury for cases marked by insufficient data, until a non-serious determination can be made.
- Err on the precautionary side for strategic stocks. The importance of including scientific uncertainty is heightened when dealing with an endangered/threatened or strategic stock.

Appendix A
Workshop Agenda

SERIOUS INJURY TECHNICAL WORKSHOP
September 10-12, 2007
Seattle, WA

MEETING OBJECTIVES

1) Review information obtained since 1997 workshop
    a. Types and frequencies of observed injuries
    b. Evidence of survival of marine mammals sustaining such injuries

2) Discuss the use of, and needed changes to, existing guidance in making serious injury determinations
    a. Identify when information is insufficient to determine the severity of the injury
    b. Identify data needs for making serious injury determinations
    c. Review existing data sources for making serious injury determinations, and identify constraints

3) Discuss potential implications of the workshop

DAY 1, MONDAY, SEPTEMBER 10, 2007 (8:30 AM-5:30 PM)
Review and Discuss Existing Processes for Making Serious Injury Determinations
Register through https://reefshark.nmfs.noaa.gov/pr/siw/

8:00 AM **Late Registration**

8:30 AM **Welcome, Introductions, and Getting Organized**

- Welcome and opening (John Bengtson, AKFSC; David Cottingham, NMFS Headquarters)
- Participant introductions (CONCUR, Inc.)
- Objectives of the workshop (Tom Eagle, NMFS Headquarters)
- Process for the workshop (CONCUR, Inc.)
    - Ground rules
    - Agenda overview

9:00 AM **Review of Existing Guidelines to Distinguish Serious from Non-Serious Injuries (1997 workshop report) (**Robyn Angliss- AKFSC)

9:15 AM **Evaluate Current Data and Determination Systems** (*Session Chair: Tim Cole)*
Current Data Sources

- National Observer Program (Amy Van Atten, NER Observer Program)
- Health and Stranding Program (Teri Rowles, HQ MMHSRP)

9:45 AM Current Determination Systems

- Baleen whale serious injury determinations in the Atlantic and Gulf of Mexico (Tim Cole-NEFSC)
- Small cetacean serious injury determinations in the Atlantic and Gulf of Mexico (Lance Garrison- SEFSC)

10:25 AM **BREAK**

10:40 AM
- Serious injury determinations in Hawaii (Karin Forney- SWFSC and Bud Antonelis- PIFSC)
- Cetacean serious injury determinations off the U.S. Western Contiguous Coast (Karin Forney- SWFSC)
- Large whale and pinniped serious injury determinations in Alaska (Robyn Angliss- AKFSC)

Synthesis

11:40 PM
- Synthesis of regional case studies (Tim Cole- NEFSC)
- Non-NMFS evaluation of serious injury determination processes: White Paper of the AK Scientific Review Group (Kate Wynne- AK SRG)

12:20 PM **LUNCH (On Your Own)**

1:45 PM
- Large whale disentanglement systems (David Mattila- NOS, Humpback Whale National Marine Sanctuary)

2:05 PM
- Introduction to breakout group session (Melissa Andersen- NMFS Headquarters)

2:15 PM **Facilitated Breakout Group Discussion on the Evaluation of Current Data and Serious Injury Determination Systems**
Breakout group structure and questions TBD

4:15 PM Breakout group leaders and reporters summarize breakout group discussions

4:30 PM Breakout groups present summary statements

5:30 PM **ADJOURN DAY 1**

6:30 *Please join fellow workshop participants at "forty-two", a unique wine bar in the lobby of the Watertown Hotel.*

DAY 2, TUESDAY, SEPTEMBER 11, 2007 (8:30 AM-5:30 PM)
Review and Discuss New Information from Survival Evaluations and the Pathobiology of Injuries

8:30 AM **Overview: Questions from Day 1 and Review Day 2 Agenda**

8:45 AM **Overview of New Information on Survival of Injured Marine Mammals**

Large Whales (*Session Chair: Tom Eagle)*

- Survival of injured North Atlantic right whales based on photo-id data and longitudinal tracking (Richard Pace- NEFSC)
- Survival of injured humpback whales, and other large whales, in the Atlantic and Pacific (Jooke Robbins- Center for Coastal Studies; John Calambokidis- Cascadia Research; Jan Straley- University of Alaska)
  1) Scar-based insight into entanglement and serious injury (Jooke Robbins)
  2) Case studies of injuries and survival along the U.S. west coast (John Calambokidis)
  3) Case studies of injuries and survival in Southeast Alaska (Jan Straley)
  4) Statistical analysis of survival (Jooke Robbins)

9:50 AM **BREAK**

10:05 AM Facilitated Discussion on Large Whales

11:05 AM Small Cetaceans and Manatees (*Session Chair: Karin Forney)*

- Fishery interactions in small cetaceans in the mid-Atlantic (Aleta Hohn- SEFSC)
- Bottlenose dolphins in Sarasota Bay, FL (Randy Wells- Chicago Zoological Society/Mote Marine Lab)
- Limited information on interaction outcomes for Pacific false killer whales (Karin Forney to present Baird *et al.* scarring study and other photos)
- Injuries and outcomes in manatees (Alexander Costidis- FL Fish & Wildlife Conservation Commission)

12:35 PM **LUNCH (On Your Own)**

1:45 PM Facilitated Discussion on Small Cetaceans and Manatees

2:45 PM **Pathobiology of Injuries** (*Session Chair: Teri Rowles)*

- Predicting lethality from vessel and gear trauma in North Atlantic right whales (Michael Moore- Woods Hole Oceanographic Inst.*)*
- Categories and consequences of injuries (David Rotstein- University of Tennessee/NMFS)

3:45 PM **BREAK**

4:00 PM

- Injuries observed in pinnipeds (CA sea lions, Northern Fur seals, and monk seals) (Terry Spraker- Colorado State University)

4:30 PM Facilitated Discussion on the Pathobiology of Injuries

5:30 PM **ADJOURN DAY 2**

DAY 3, WEDNESDAY, SEPTEMBER 12, 2007 (9:00 AM-5:00 PM)
Breakout Groups Sessions

9:00 AM **Overview: Questions from Day 2 and Review Day 3 Agenda**
- Outline breakout group sessions (CONCUR, Inc.)
  - Group composition (TBD)
  - Questions for discussion (TBD)

9:30 AM **Breakouts Group Activity**
Session One
Group 1: Longitudinal/survival rates from a modeling perspective
Group 2: Categorization of injuries and pathological consequences: Gear-related injuries (i.e., entanglements, hookings, and ingestions)
Group 3: Categorization of injuries and pathological consequences: Sharp, blunt force, and penetrating injuries

11:30 AM Breakout group leaders and reporters summarize breakout group discussions

11:45 AM Breakout groups present summary statements

12:30 PM **LUNCH (On Your Own)**

1:45 PM Session Two
Group 1: Large cetaceans
Group 2: Small cetaceans
Group 3: Pinnipeds and other species

3:45 PM Breakout group leaders and reporters summarize breakout group discussions

4:00 PM Breakout groups present summary statement/ Plenary Discussion

5:00 PM **ADJOURN DAY 3**

Appendix B
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Serious Injury Technical Workshop
Seattle, Washington
September 10-12, 2007

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Appendix C
Adopted Ground Rules

NOAA Fisheries Serious Injury Technical Workshop
September 10-13, 2007
Seattle, Washington

The purposes of the workshop are to: review guidelines for distinguishing between serious and non-serious injury of marine mammals incidental to certain human activities, review application of these guidelines and information gained since 1997, evaluate performance of the guidelines, and discuss changes to these guidelines as appropriate. The following ground rules are intended to foster and reinforce constructive interaction and deliberation among the workshop participants. They emphasize clear communication, respect for divergent views, creative thinking, and collaborative problem solving. To that end:

1. **Workshop organization.** Days 1-3 of the workshop are open to invited participants and public observers. Day 4 will be a closed session in which only Federal Government officials will participate. For Days 1-3 of the workshop, we do not seek consensus of viewpoints. As such, the workshop is not subject to the requirements of the Federal Advisory Committee Act. Rather, we seek to incorporate a diversity of views according to individual comments. The entire set of information will be considered by Federal employees on Day 4.

2. **Participation and roles.**
   - Role of Participants: Participants have been recruited based upon their expertise in one or more fields, including marine mammal bycatch, biology, physiology, pathobiology, veterinary medicine, and fishing gear and practices. In their role of providing expert input for NMFS' consideration, participants are responsible for sharing pertinent information, asking clarifying questions, and expressing professional views in both plenary and breakout sessions. Everyone will participate in discussions and each participant's view will be considered. Everyone will help stay on track.
   - Role of Observers: Observers may view and track the deliberations on Days 1-3. They may be called upon by the workshop conveners or facilitators to help clarify an unresolved point of discussion based on their expertise.

3. **Respectful interaction.** Participants will respect each other's personal integrity, values, and legitimacy of interests. This includes avoiding personal attacks and stereotyping. Comments will be made and taken in a constructive manner.

4. **Integration.** All participants will strive to integrate participants' various ideas and perspectives into the discussions. If disagreements arise, they will be regarded as problems to be solved rather than battles to be won.

5. **Day 4 closed session meeting.** Day 4 will be a closed session meeting for Federal Government officials. Its purpose is to discuss and recommend changes, if needed, to specific guidelines for distinguishing serious injury from non-serious injury. Agency participants will consider the presentations, discussions, and outcomes of Days 1-3 in their deliberations.

Appendix D
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