Best Practices for the Collection of Longline Data to Facilitate Research and Analysis to Reduce Bycatch of Protected Species

Report of a workshop held at the International Fisheries Observer Conference Sydney, Australia, November 8, 2004

Prepared by:

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U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

NOAA Technical Memorandum NMFS-OPR-35
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List of Acronyms

AFMA	Australian Fisheries Management Authority (Australia)
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources (Australia)
CCSBT	Commission for the Conservation of Southern Bluefin Tuna (Australia)
CSFOP	Commercial Shark Fishery Observer Program (U.S.)
DFO	Department of Fisheries and Oceans (Canada)
ESA	Endangered Species Act (U.S.)
FAO	Food and Agriculture Organization of the United Nations (Italy)
FFA	(South Pacific) Forum Fisheries Agency (Solomon's Island)
GIS	Geographic Information System
GPS	Geographic Positioning System
IATTC	Inter-American Tropical Tuna Commission (U.S.)
ICCAT	International Commission for the Conservation of Atlantic Tunas (Spain)
INIDEP	Instituto Nacional de Investigación y Desarrollo Pesquero (Argentina)
IOTC	Indian Ocean Tuna Commission (Seychelles)
ISMP	Integrated Scientific Monitoring Program (Australia)
LORAN	Long-range navigational system
MAFF	Ministry of Agriculture, Forestry,and Fisheries (East Timor)
MARPOL	International Convention for the Prevention of Pollution From Ships
MMPA	Marine Mammal Protection Act (U.S.)
NEFOP	Northeast Fisheries Observer Program (U.S.)
NMFS	National Marine Fisheries Service, also NOAA Fisheries Service (U.S.)
NOAA	National Oceanic and Atmospheric Administration (U.S.)
NPFMC	North Pacific Fisheries Management Council (U.S.)
NPGOP	North Pacific Groundfish Observer Program (U.S.)
NZMOF	New Zealand Ministry of Fisheries (New Zealand)
PBR	Potential Biological Removal
PIRO	Pacific Islands Regional Office (U.S.)
RADAR	Radio Detection And Ranging
RFMO	Regional Fisheries Management Organization
SEFSC POP	Southeast Fisheries Science Center, Pelagic Observer Program (U.S.)
SLP	Sea Level Pressure
SPC	Secretariat of the Pacific Community (New Caledonia)
SST	Sea Surface Temperature
TDR	Time Depth Recorder
TRP/TRT	Take Reduction Plan/Take Reduction Team
U.S./USA	United States of America
UTC	Coordinated Universal Time
VMS	Vessel Monitoring System
WCGOP	West Coast Groundfish Observer Program (U.S.)
WCPFC	Western Central Pacific Fisheries Commission (Federated States of Micronesia)

EXECUTIVE SUMMARY

Workshops focusing specifically on the reduction of sea turtle, marine mammal, and seabird incidental catch (i.e., bycatch) in longline fisheries have recommended the need for standardized data collection procedures employed by fisheries observers onboard commercial longline fishing vessels (Anon. 2003; Donoghue et al. 2003; Food and Agriculture Organization (FAO) 1998/1999a/1999b; FAO and BirdLife International 2004; Inter-American Tropical Tuna Commission (IATTC) 2004; Long and Schroeder 2004). However, these reports lack sufficient detail regarding what these standardized data collections should be.

The development and implementation of data collection standards for longline fishery observer programs is challenging at many levels. First, there is the lack of detail in the recommendations regarding what data collections need to be standardized. Second, observer programs worldwide have diverse objectives that may make standardization seem unfeasible or unwarranted. For example, if bycatch monitoring is not the primary objective of a given observer program, increasing observer data collection responsibilities regarding seabirds, sea turtles, and marine mammals may be seen as infringing on the ability of an observer to collect data for a program's primary objectives. Finally, instituting the use of consistent data fields at the observer program level may impact long-term data series, add to database management costs, and increase time required for observer training. Despite these challenges, there are benefits to standardizing certain aspects of observer data collection procedures for longline fisheries. Information collected consistently could improve global assessments of the impacts of longline fisheries on bycatch species, and facilitate research to develop gear modifications or changes in fishing practices to reduce bycatch.

To facilitate research and analysis of factors influencing bycatch of marine mammals, sea turtles, and seabirds in longline fisheries, a workshop was organized to develop "best practices" in observer data collections. The workshop was held in conjunction with the International Fisheries Observer Conference, November 8-11, 2004, in Sydney, Australia.

The objectives of the workshop were to:

- Share information on current data collection practices and methodologies (i.e., why are certain variables collected, which variables are collected, and how are they collected by observer programs worldwide).
- Solicit information from data users on variables that are **critical**, **preferred**, **optimal**, or **not important** to facilitate research and analysis to reduce bycatch of protected species.
- Identify data not being gathered systematically that might facilitate research and analysis to reduce bycatch of protected species.
- Coordinate with observer program staff to understand data collection limitations.
- Recommend best practices for observer data collection in longline fisheries that would facilitate research and analysis to reduce bycatch of protected species, in the form of a prioritized list of variables and consistent procedures.
- Establish a network to continue to develop, refine, and implement best practices.

Prior to the workshop, two web-based surveys were developed and distributed to observer program managers and data users worldwide. The objectives of the survey were to ensure broad input from researchers and observer program staff who may not be able to attend the workshop, and to provide a base of information from which to focus discussions during the workshop. At the workshop, participants discussed the results of the surveys and need to develop best practices for observer data collections.

Critical and **preferred** variables were identified, based on the responses provided by data users in the pre-workshop survey and discussions by workshop participants. The list of variables represents "best practices" that should be included in the collection of longline data by fisheries observers (Table 1). The workshop participants generally agreed with the list of variables identified as **critical** or **preferred** by data users in the pre-workshop survey, but in some cases other variables were added to the list based on further discussions at the workshop.

Table 1: Best Practices--Recommended minimum variables to be collected in all longline fisheries.

Gear Type Fished	**Category**	**Variables**
All	Temporal	Date gear was deployed Start time of gear deployment End time of gear deployment Date gear was retrieved Start time of gear retrieval End time of gear retrieval
Pelagic	Spatial	Latitude at beginning of gear deployment Longitude at beginning of gear deployment Latitude at end of gear deployment Longitude at end of gear deployment Latitude at beginning of gear retrieval Longitude at beginning of gear retrieval Latitude at end of gear retrieval Longitude at end of gear retrieval
Demersal[a]		Latitude at beginning of either gear deployment or retrieval Longitude at beginning of either gear deployment or retrieval Latitude at end of either gear deployment or retrieval Longitude at end of either gear deployment or retrieval
Pelagic	Physical and Environmental	Sea surface temperature Depth fished at beginning of gear deployment [b] Depth fished at end of gear deployment [b] Depth of bottom at beginning of gear deployment Depth of bottom at end of gear deployment
Demersal		Sea surface temperature Depth fished at beginning of gear deployment[b,c] Depth fished at end of gear deployment[b,c] Depth of bottom at beginning of gear deployment Depth of bottom at end of gear deployment

Gear Type Fished	Category	Variables
All	Vessel and Fishing	Unique vessel identifier Unique observer identifier Vessel length Total number of hooks deployed Direction of haulback Target species[d] Bait species Bait condition (live/fresh/frozen/thawed, whole/cut) Autobaiter used? (if used, also record bait efficiency) Weight of added weight (if used) Direction of gear retrieval
All	Gear[e]	Groundline/mainline length[f] Branchline/gangion length Distance between branchlines Hook size[g] Hook type
All	Catch	Total catch, actual or estimated (number and/or weight) Catch by species (number and/or weight) Observed effort (total number of hooks observed during retrieval)
All	Mitigation Measure/ Deterrent Device	Presence of any type of deterrent used or required to be used, and how it was used
All	Bycatch	Species identification Number of each species captured Type of interaction (hooking/entanglement) Disposition (dead/alive) Description of condition/viability of the animal upon release (if released alive)

[a] Demersal gear fished on the bottom is stationary, thus collecting data on either where gear is deployed or retrieved is sufficient.
[b] In some observer programs, fishing depth is derived from the sum of the floatline/dropline length and the branchline/gangion length.
[c] For demersal gear, depth fished should also be collected it if is different than bottom depth.
[d] Target species may be derived in some programs from the catch composition.
[e] Although ≥50% data users responding to the pre-workshop survey identified these 5 gear variables as critical or preferred, workshop attendees were reluctant to identify specific gear variables for inclusion as best practices, instead noting these will vary by fishery depending on bycatch species and regulatory measures in place. Emphasis was instead placed on standardized definitions of terms and data collection methods.
[f] Groundline/mainline length is rarely an exact measurement, due to the length of the line. Instead it is either derived (by multiplying distance between floats by number of floats), estimated by the observer, or reported by the vessel.
[g] Hook size is often reported by the vessel or provided by the manufacturer rather than measured by the observer.

Optimal data specific to bycatch species was identified by data users in the pre-workshop survey and workshop participants. They recommended the following variables and material be collected when possible:

- Collection of whole carcasses (seabirds) or parts/biopsies (sea turtles and marine mammals)
- Photographs and species identification forms
- Age (as derived from collection of teeth or other samples)
- Sex (observed, or blood sample/biopsy dart if cannot be observed)
- Size of animal (type of measurements vary by species, and may be limited to an estimate of total length if animal is not boarded)
- Time and location of capture of bycatch species within the set (although there may be constraints on the precision of these variables)

- Systematic sightings of protected species around gear during gear deployment/retrieval
- Tags (presence/absence, attached prior to release)
- Evidence of depredation on catch (by marine mammals or other species), including species of fish damaged, description of type of damage, photographs of damaged fish, and number of fish damaged.

Data variables considered **not important** for data collection were not discussed in detail at the workshop, as there were very few responses in this category. The lack of responses indicating a particular variable was not important made interpretation of the survey results difficult and subject to potential bias.

When incorporating these best practices into observer data collections, workshop participants recommended that each program should:

- Establish a process for periodically reviewing and prioritizing data needs, in coordination with data users. Priorities may be set according to fishery-specific data needs, but should incorporate broader priorities where possible.
- Clearly communicate data collection priorities to all stakeholders.
- Establish and disseminate metadata for observer databases that describe each variable collected, how it is collected and when data collection methodologies change, why it is collected (long-term operational vs. short-term research project), and the level of precision of measurements.
- Identify which variables are or can be derived from other variables; consider eliminating collection of variables that can be derived from other variables.
- Ensure the use of standard and objective definitions and data collection methodologies.
- Clarify when data are “reported” (by the vessel) as opposed to “measured independently” (by the observer).
- Strive to meet data collection needs while keeping observer health and safety a priority.
- Keep informed regarding current bycatch reduction research and emerging data needs to support research.

Workshop conveners and participants believe that the workshop was a success, but was only a first step toward implementing best practices in observer programs globally. Workshop participants recommended that next steps should include:

- Dissemination of the results of this workshop to all observer programs and data users, and to Regional Fisheries Management Organizations (RFMOs).
- A follow-up assessment of how well recommended variables are being incorporated into observer program data collections, including those programs that may not have been represented in the initial survey or at the workshop, as well as programs that are involved in bycatch reduction research.
- The establishment of a longline working group, or use of new or existing listservs, as a vehicle for sharing information and further developing best practices in sampling design, data collection methodologies, and observer training.
- Development of best practices for observer data collection to facilitate research and analysis to reduce bycatch of protected species for other gear types (such as purse seine, trawl, and gillnet).

In conclusion, workshop participants recognized that decisions regarding the incorporation of these best practices would necessarily be made at the program level, but that these decisions should be informed by consideration of data needs to facilitate bycatch assessments and research on protected species bycatch on a global scale.

STATEMENT OF PROBLEM

I. Need for Standardized Observer Data Collections

Global fisheries harvest has reached an annual plateau of about 80million metric tons, of which approximately 8% is incidental catch, or bycatch (FAO 2004a). Incidental catch is defined as any species caught but not retained during normal fishing operations and may include target and non-target fish as well as invertebrates, marine mammals, sea turtles, and seabirds (Hall 1996; Alverson 1999). Although the incidental catch of marine mammals, sea turtles, and seabirds is a small component of global catch biomass, this inadvertent capture has been shown to significantly impact some populations (Rojas-Bracho 1999; Spotila 2000; Weimerskirch and Jouventin 1987). Protected species exhibit high adult survival, delayed maturity, and various fecundity strategies and traits rendering a population sensitive to even 1% or 2% increases in adult mortality (Wade 1998; Tuck 2001; Crowder 1994). Although fisheries may not be the primary cause of some population declines, reducing mortality of protected species caused by fisheries is a management control that can have a positive impact.

Workshops focusing specifically on the reduction of sea turtle, marine mammal, and seabird incidental catch in longline fisheries have recommended the need for standardized data collection procedures employed by fisheries observers on board commercial longline fishing vessels (Anon. 2003; Donoghue et al. 2003; FAO 1998/1999a/1999b; FAO and BirdLife International 2004; IATTC 2004; Long and Schroeder 2004); however, these reports lack sufficient detail regarding what these standards, or best practices, should be.

For example, the highest priority recommendations from a technical workshop focusing on sea turtle catch included the establishment of minimum standards for data collection for observer programs and to characterize all existing longline fisheries, re-analyze existing data, identify data gaps, and prioritize efforts in those areas (Long and Schroeder 2004). The Inter-American Tropical Tuna Commission (IATTC) recommended, as a short-term measure, to standardize data collection systems for longline vessels, including information useful for identifying factors affecting sea turtle bycatch (IATTC 2004).

Several projects devised to monitor and reduce seabird bycatch in fisheries were identified for joint development among the South American nations represented at a workshop to implement a National Plan of Action for Seabirds in those countries. These projects included: improved training of observers; standardized methodologies for bycatch monitoring research, and assessment; and improved mitigation methods and devices (FAO and BirdLife International 2004).

Unlike sea turtles and seabirds, Donoghue et al. (2003) provided more detail regarding information to be collected in order to assess the scope and nature of marine mammal depredation of longline gear (bait and catch). They recommended observers collect the following:

- Details on depredation, predators and their behavior such as:
    - Did depredation occur? If so, at which stage of operation?

    - Could depredation be attributed to a particular predator category (e.g., cetaceans, sharks, squid, bony fish, etc.)?
    - On what basis was the predator identified (head only, tooth marks, etc.)?
    - Were marine mammals observed in the vicinity of fishing activity?

- Vessel, operational and environmental variables such as:
    - Vessel description and operating procedures
    - Total catch – number and weight
    - Time and latitude/longitude of set (beginning and end)
    - Number of hooks deployed
    - Other data relevant to Catch Per Unit Effort (CPUE)
    - Meteorological and oceanographic data.

Donoghue et al. (2003) also recommended linking depredation and vessel characteristics (both design and operational) to examine the reasons why different vessels within a particular fishery often experience markedly different levels of depredation.

Implementation of data collection standards is challenging at many levels. First, there is the lack of detail in the recommendations to standardize, as discussed above. Second, observer programs worldwide have diverse objectives, and incidental catch monitoring may not be the primary objective of a given program. Therefore, increasing observer duties regarding seabirds, sea turtles, and marine mammals may infringe on the ability of an observer to collect data for a given program's primary objectives. Finally, adding additional data fields to be collected may impact long-term data series, add to database management costs, and increase observer training time. Despite these challenges, there are also immense benefits. Consistently collected information would improve global assessments of fishing impacts on bycatch species and facilitate research to develop gear modifications or changes in fishing practices to reduce bycatch.

II. Workshop Objectives

A workshop was held to initiate the development of best practices for the collection of fisheries-dependent mammal, sea turtle, and seabird bycatch data in pelagic and demersal longline fisheries. The workshop was held at the International Fisheries Observer Conference (http://www.fisheriesobserverconference.com), November 8-11, 2004, in Sydney, Australia.

The objectives of the workshop were to:

- Share information on current data collection practices and methodologies (i.e., why are certain variables collected, which variables are collected, and how are they collected by observer programs worldwide).
- Solicit information from data users on variables that are **critical**, **preferred**, **optimal**, or not important to facilitate research and analysis to reduce bycatch of protected species.
- Identify data not being gathered systematically that might facilitate research and analysis to reduce bycatch of protected species.
- Coordinate with observer program staff to understand data collection limitations.

- Recommend best practices for observer data collection in longline fisheries that would facilitate research and analysis to reduce bycatch of protected species, in the form of a prioritized list of variables and consistent procedures.
- Establish a network to continue to develop, refine, and implement best practices.

WORKSHOP APPROACH

I. Pre-Workshop Surveys

Prior to the workshop, two web-based surveys were developed, one for observer program staff and one for observer data users, in order to achieve several workshop objectives: share information on current data collection practices and methodologies; identify variables that are critical or optimal to research; and identify variables that are not being gathered. The use of pre-workshop surveys also allowed for input from observer programs and data users who could not attend the workshop and to focus discussions during the workshop. More details regarding the surveys and the responses can be found in Workshop Presentations, Section III.

II. Workshop Format

The workshop was held on November 7, 2004, in conjunction with the International Fisheries Observer Conference, November 8-11, 2004, in Sydney, Australia (www.fisheriesobserverconference.com). The workshop had a combined presentation and discussion format. During the first half of the workshop, the conveners outlined the objectives of the workshop and provided brief overviews of bycatch reduction research and data collection recommendations relevant to protected species (marine mammals, sea turtles, and seabirds). This was followed by a presentation of the primary results of the pre-workshop surveys. Following a discussion period, the workshop participants broke into smaller working groups to discuss the results of the survey and validate the results against their own experiences. The group then reassembled to review the work of the break-out groups and develop an overall set of recommendations on best practices for data collection.

There were 42 workshop participants, including observer program staff, fishing industry representatives, data users, resource managers, and observers, representing a broad diversity of programs from around the world (the list of workshop participants is provided in Appendix A, and the workshop agenda is provided in Appendix B).

WORKSHOP PRESENTATIONS

I. Overview of Workshop Objectives

An overview of the impetus for the workshop was provided, which outlined the objectives of the workshop and explained the format for the workshop.

The term "best practices" was chosen to be used as opposed to "standards," as the objective of the workshop was not to impose requirements on observer programs but rather to identify what data collection practices currently work best for data users involved in bycatch reduction research, and to identify specific variables and data collection practices that, if collected by all observer programs, would facilitate global research in bycatch reduction strategies. It was stressed that due to the limited time available for the workshop, the recommendations from this workshop may benefit from further refinements in the future.

Several important issues were noted as beyond the scope of the objectives of this workshop, but may be addressed in other venues:

- Observer data collections in non-longline fisheries that also have bycatch of protected species (e.g., gillnet and trawl fisheries)
- Fishery-independent research needs
- Best practices in other fishery-dependent data collection programs (logbooks, VMS, effort collection, etc.)
- Recommended bycatch mitigation measures
- Data needs in currently unobserved fisheries (although the recommendations identified in the workshop may help to develop a template for data collections in unobserved fisheries).

II. Overviews of Species-Specific Bycatch

Sea Turtles

<u>Incidental Catch of Sea Turtles and an Overview of U.S. Involvement</u> (Therese Conant, NOAA Fisheries Service)

The U.S. has two pelagic longline observer programs monitoring tuna and swordfish fisheries in the Pacific Ocean, one based in Hawaii and the other in California (CA). The Hawaii-based program began in 1994 and observer coverage averaged approximately 4% of fishing effort until 2000. In 2001, sea turtle conservation measures were implemented; therefore, a higher level of coverage was needed to adequately document effectiveness of those measures. The CA-based program has maintained nearly 12% coverage since its inception in 2001. Prior to the implementation of conservation measures, annual sea turtle catch in the Pacific was nearly 1,500 sea turtles per year (McCracken 2000, NMFS 2004a). Catch has dropped significantly (100/year) since the measures were implemented (NMFS 2004a, NMFS 2004b).

In the Atlantic Ocean, the U.S. has observed the pelagic longline fishery since 1992 averaging 2.5% to 5% annual coverage (NMFS 2004c). Turtle catch estimates have ranged widely from year to year (between 800 and 3,500) with high sea turtle interaction rates in the Gulf of Mexico through the mid-Atlantic and Grand Banks (NMFS 2004c).

Although most sea turtle species interact with U.S. pelagic longline fisheries (with the possible exception of Kemp's Ridley turtles; *Lepiochelys kempii*), two species are of most concern: leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*). In the Pacific, leatherback turtles have likely declined over 95% since 1980 (Spotila et al. 2000) and are likely to become extirpated in parts of the Pacific. Loggerhead turtles have also declined in the Pacific (74% to 86% since 1980) at key nesting sites in Japan and Australia (Kamezaki et al. 2003, Limpus and Limpus 2003). In the Atlantic, leatherback turtles appear to be stable or increasing at certain key nesting beaches (e.g., St. Croix, U.S. Virgin Islands), but extirpated from others (e.g., St. John and St. Thomas, U.S. Virgin Islands) (NMFS 2004c). Loggerhead turtles appear to be stable, but some subpopulations may still be vulnerable in the Atlantic (NMFS 2004c).

Due to concern for these populations the U.S. has implemented several measures to reduce bycatch in domestic longline fisheries. The U.S. has implemented regulations to control effort, mostly in the swordfish fishery, such as prohibiting shallow sets in areas of Atlantic and Pacific Oceans. A tuna fishing closure also occurs in Pacific during certain times of year. In addition, the U.S. has conducted and supported research on gear modifications to reduce sea turtle bycatch over the last 3-4 years, finding that large (18/0) circle hooks and the use of different bait combinations have been very effective at reducing sea turtle bycatch (Watson et al. 2004a, Watson et al. 2004b). As a result, certain closed areas were opened as long as these circle hook and bait combinations are used, although there is still a limit on effort, set depth, and the number of sets that can be deployed.

International efforts to reduce sea turtle bycatch that are relevant to this workshop include:

- 2000 – NOAA Fisheries Service and the U.S. Department of State developed a strategy to address sea turtle bycatch in global longline fisheries (Dean Swanson, NOAA Fisheries Service, pers. comm.). The objectives were to quantify sea turtle bycatch and to share bycatch data with the global community. Key to these objectives was the standardization of data collection methods and the identification of critical data elements as well as the development and implementation of solutions to reduce bycatch. Fora used to achieve these objectives included the United Nations Food and Agriculture Organization (FAO), Regional Fisheries Management Organizations (RFMOs), and bilateral fisheries discussions.
- February 2003 – NOAA Fisheries convened an International Technical Expert Workshop on Marine Turtle Bycatch in Longline Fisheries (Long and Schroeder 2004). Nineteen nations contributed to recommendations, including the following related to data collection:
  – Establishing standards for data collection through observer programs
  – Identifying minimum data elements
  – Establishing regional and international fora for sharing and standardizing sea turtle bycatch data.
- June 2003 – An IATTC Recommendation on Sea Turtles (C-03-10) encouraged all Parties to collect available information on sea turtle interactions and bycatch. They also convened a Bycatch Working Group to develop a 3-year program to include mitigation of

bycatch, biological research, and improvement of fishing gears. The Bycatch Working Group recommended standardized data collection systems, including information useful for identifying factors affecting sea turtle bycatch (IATTC 2004).

- November 2003 – The International Commission for the Conservation of Atlantic Tunas (ICCAT) set forth a Resolution on Sea Turtles that encouraged Parties to collect all available information on interactions with sea turtles, and sought the development of data collection and reporting methods for the incidental catch of sea turtles.
- November 2004 – FAO is convening a Technical Consultation on Sea Turtles in all fisheries (all gear types). Prior to the consultation, an Expert Working Group convened in March 2004 to review relevant information. The Expert Working Group has submitted recommendations to FAO to consider during the Technical Consultation (FAO 2004b). The Expert Working Group recommended implementation of reliable data collection on fisheries/sea turtle interactions and where data collection already exists, efforts should be made to improve quality and reliability (FAO 2004b).

In summary, there is significant international effort and interest in creating best practices for data collection on sea turtle bycatch. This workshop is timely and needed because the best way to facilitate the development of data collection methodologies is to look to observer program managers, observers, and data users for input on best collection practices.

<u>Estimating Turtle Bycatch from Pelagic Longline Fisheries Worldwide: Identifying Key Data Elements</u> (Rebecca Lewison, Sloan Freeman, and Larry Crowder - Duke University Marine Lab; presented by Therese Conant, NOAA Fisheries Service)

Earlier this year, Lewison et al. (2004) published a paper calculating global estimates of turtle bycatch from pelagic longlines. Funding for this research was provided by Pew Charitable Trusts. The following is a summary of this analysis, focusing in particular on what key data elements are necessary to be able to put this analysis into a real-world context.

The objective of this research was to use existing fishing effort data from the various fishing commissions and the available and released bycatch data to generate bounded estimates of cumulative bycatch, particularly for loggerhead and leatherback turtles, from the worldwide pelagic longline fishery. The authors decided to take a global approach because it was clear after some preliminary work mapping fishing effort and current estimates of turtle distributions that both longline fishing vessels and the turtles are found across the world's ocean basins.

Mapping pelagic fishing effort from the year 2000 showed that combined effort from tuna and swordfish fisheries account for 1.4 billion hooks (see Figure 2 in Lewison et al. 2004), with the majority of effort in the South Pacific, the South Central Atlantic, the Mediterranean, and waters surrounding Indonesia and the Philippines. In terms of the available data, some type of bycatch data was available from approximately 13 of the 40 nations that conduct pelagic longline fishing. The data were in different forms – including raw data, data summaries, and surveys from dockside interviews. Observer data coverage accounts for approximately 25% of the total fishing effort based on reported fishing in 2000 (see Figure 1 in Lewison et al. 2004). Based on the authors' research thus far, 25% coverage may be one of the best cases of observer coverage for a global, industrial fishery.

By overlaying the bycatch and fishing effort data and using several extrapolation techniques, the authors obtained rough global estimates of 200,000 loggerheads and 50,000 leatherbacks interacted with pelagic longline fisheries each year. Based on the variability in bycatch estimates over space and time, they calculated interval estimates for each of the ocean basins. Given the amount of observer data that was available for these calculations (25% of fishing effort), there is uncertainty in these estimates. Better observer coverage is needed to understand what is happening on the remaining 75% of the hooks that longline fisheries are deploying, as observer data are the foundation for producing a more adequate assessment of bycatch.

Beyond the need for more observer coverage, there are some key data elements that are essential to understanding what these bycatch estimates actually mean. The first data element that was not standard across these data sets was species identification. In cases where this information is not collected, the authors had to use crude distribution maps to infer what species of turtle was likely to have interacted with the gear, had the observer recorded it. Having accurate species identification is essential to be able to accurately interpret observer data.

The second data element is really a class of data – demographic data. To understand how bycatch from any fishery is actually affecting a population, specific characteristics about which individuals in the population are being caught must be known. These characteristics include the size of the turtle caught (which is used as a proxy of age) and the sex of the individuals caught (determined from blood samples). Other useful demographic data include nesting beach origin or subpopulation the individual came from, which requires tissue or blood sampling.

Demographic data, though challenging for observers to collect, are critical to putting bycatch estimates into a population context. Setting aside the issue of limited observer coverage and subsequent uncertainty, if the bycatch estimates of 20,000 leatherbacks hooked or entangled in the Pacific are accurate, the real challenge is to be able to understand what this means to leatherback populations in the Pacific. The ultimate goal of this research is not just to know how many turtles are hooked or entangled by pelagic longlines or any fishery, but to be able to understand what this bycatch means to the turtle populations. The reason the sex of the individual matters is obviously one of reproduction – if more females were taken than males, then the population-level impact would be much greater. But why does the age of the individual matter? (Keep in mind, the authors used size as a proxy for age.) The age of the bycaught individual matters because of the population structure and life history strategy of sea turtles.

The different colored and different sized rectangles in Figure 1 (left) represent the number of individuals in each age class – the bigger the rectangle, the more individuals. This means that the leatherback population is made up of a large number of hatchlings, many juveniles, fewer sub-adults, and even fewer adults. This indicates that adults make up a very small percentage of the total population, maybe less than 4%. Like other long-lived animals, leatherbacks only reproduce when they reach sexual maturity, which is relatively late in life, around 12 years old.

Given the population structure of leatherbacks, it is clear why knowing the age of the individual caught is important to understanding the impacts of bycatch on the population. Changes in survival or mortality of individuals from each age class have a differential effect on overall population growth. To calculate this effect, a sensitivity analysis was performed. This analysis for loggerheads and leatherbacks suggests that adults and subadults, although numerically few, have a strong effect on what happens to the overall population growth rate (Figure 1, right). Although adults and subadults make a small proportion of the population, they have a disproportionately large affect on population growth rates. Therefore, knowing how many of these individuals may be caught as bycatch is critical.

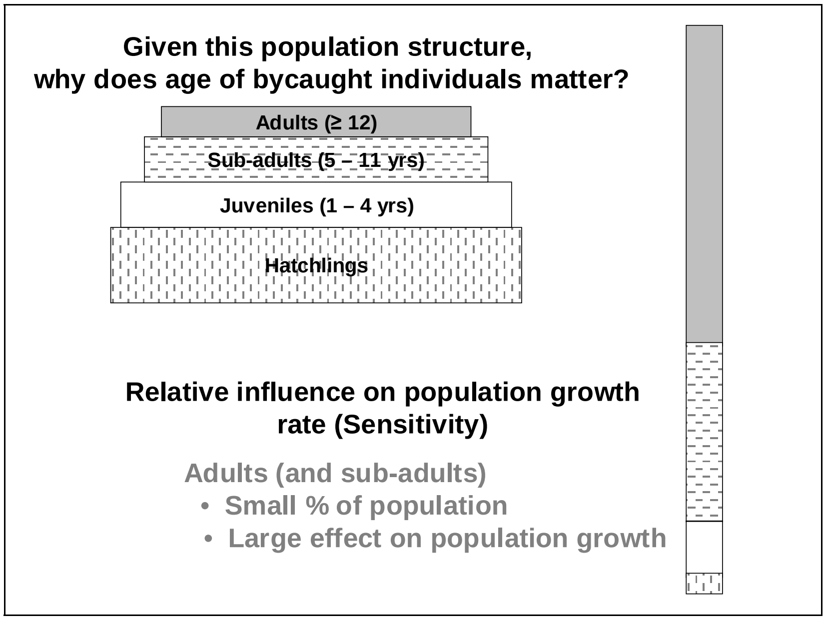

Figure 1: Illustration of relative proportion of each age class of sea turtles in population (left) and relative sensitivity of each age class to bycatch (right) (from Lewison et al. 2004).

In addition to understanding the population-level effects of bycatch, a second important question the authors were hoping to tackle is to understand whether there are links between bycatch trends in time, space, and oceanographic features. In some respects, this is one of the holy grails to bycatch research and management – the hope that there is a way to mitigate bycatch by implementing technological improvements in fishing gear and practices and by regulating access to ocean areas with a particular oceanographic profile that has been reliably associated with turtle bycatch. Observer programs collect several of these oceanographic features (such as positional data and sea surface temperature (SST)) and others can be derived from regional data sources, such as satellite remote sensing. There has been some progress in identifying whether there is a consistent link between bycatch patterns and oceanography, but this has been limited by the amount of observer data available and the number of turtles that have been tracked by satellite data.

The key data elements and requirements discussed here are not unique to sea turtles. There are likely to be similar data needs for other vulnerable taxa, for example seabirds and marine mammals. To be able to understand how fisheries bycatch is impacting a turtle population, we need:

- Standardized bycatch data that includes identification to species of each bycaught individual;
- Demographic data, including the age/size of the individual and sex;
- Oceanographic data, to determine if there are links between bycatch and oceanographic features.

Given the global distribution of fisheries and pelagic populations, and the more recent recognition that turtle bycatch is a global problem, the need for common data standards and data elements has become even more important to ensure the long-term viability of these populations.

Marine Mammals

Overview of Incidental Catch/Interactions of Marine Mammals (Vicki Cornish, NOAA Fisheries Service)

Marine mammals interactions with longline gear primarily take the form of depredation by marine mammals on the bait and/or caught fish on longline gear. Marine mammals have been observed to prey on the bait and/or catch and in the process either become fouled or entangled in the line or ingest the hook. These types of interactions may result in serious injuries or even mortalities to the marine mammal species involved. They may also result in significant fish or gear loss to fishermen.

Marine mammal interactions with longline gear were the focus of a Workshop on Interactions Between Cetaceans and Longline Fisheries held in Apia, Samoa, in November 2002 (Donoghue et al. 2003). At the workshop, researchers noted that depredation on longline gear by marine mammals is an increasing problem. Marine mammals seem to be interested in what is caught on the gear, as fish caught on longline gear may represent a foraging opportunity for certain marine mammal species. Workshop participants noted that depredation may result in loss of catch, loss of bait, damage to or loss of gear, and loss of time spent fishing. All of this results in increased vessel costs, so fishermen are highly motivated to find a solution to this problem.

The fisheries summarized in the Donoghue et al. 2003 report occur worldwide, and in some cases the amount of fish lost as a result of such interactions can be quantified. The following is a summary of some of the interactions noted (see Donoghue et al. 2003):

- Taiwan distant-water tuna/billfish fishery – Thirty to 60% of caught fish were estimated to have been lost, presumably to depredation by killer whales although species identification by fishermen was problematic.
- Brazil tuna/swordfish fishery – Depredation by both cetaceans and sharks were noted, with fish loss greater than 50% in the southern region of the fishery, which can lead to greater fishing effort and increased pressure on target fish stocks.
- Chilean artisanal toothfish fishery – Observers on fishing boats recorded depredation of catch and gear damage associated with sightings of sperm whales, Risso’s dolphins, and right whale dolphins, as well as entanglements of other small cetaceans. Attempts to deter whales were unsuccessful and included the use of rifles, harpoons, and bottle bombs.
- South Georgia toothfish fishery – Catch rates reported by observers from the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) were lower when

killer whales or sperm whales were present at haul back. Observations suggest that sperm whales take whole fish off the line, leaving only the "lips" of the fish. Observers also noted that some areas had higher interaction rates, suggesting the existence of "hot spots."

- Gulf of Alaska sablefish fishery – Fishery management actions that extended the fishing season may have resulted in increased interaction rates with sperm whales. Sperm whales were most commonly seen interacting with gear during the haul-back, and some whales may be keying in on the noise made by the hydraulics as a cue. Catch rates were observed to be 23% lower for sets that had evidence of depredation by sperm whales, and fish loss may also occur but cannot be quantified. Fishermen have tried various methods for deterring whales, including "dropping off" whales on competing vessels, hauling at night, and stopping hauling and waiting for the whale(s) to leave.
- Western and Central Pacific tuna fisheries – A systematic survey estimated that 0.8% of damaged catch was attributed to whales, and 2.1% of catch was damaged by sharks, emphasizing the importance of collecting data on the type of fish damage and making sure it is attributed to the correct species. Whales seemed to prefer yellowfin and bigeye tuna, whereas sharks preferred wahoo, yellowfin and bigeye tuna, and various billfish.

Impacts of depredation on cetacean species are varied. The most significant are the hooking or fouling of whales or ingestion of gear, which may cause serious injuries or mortality. Harm may also be inflicted on whales by fishermen attempting to deter animals from gear (using rifles or acoustic deterrents). Depredation on fishing gear may also alter normal foraging behavior of cetaceans, and make them more susceptible to boat strikes and propeller wounds.

Cetacean depredation on longline catches causes harm not only to the cetaceans involved, but also may have significant economic and environmental impacts. Economic impacts are primarily due to loss of bait, catch, gear, time, and increased vessel costs associated with moving to avoid whales or extended fishing trips to make up for lost catch. Environmental impacts are primarily on the target species, and may be hard to quantify as losses due to depredation are not accounted for in stock assessments. Depredation may also result in increased fishing effort by fishermen seeking to make up for fish loss and/or damage.

Several of the participants at the Samoa workshop made statements pertaining to their observations of depredation. They noted that fish damage due to cetacean depredation was significantly different than damage attributed to sharks. Evidence of this can be seen by examining damaged bait left on the hooks after haul back. Sharks leave small, circular bites, while cetaceans tear flesh away or take the entire fish, leaving only heads or fish lips, or in some cases nothing, which makes it difficult to quantify the level of depredation occurring. Workshop participants felt that such interactions primarily occur during the hauling of the gear, while several other participants suspected that the vessels themselves were acting as an attractant to whales. Participants also noted that depredation was not always correlated with sightings or activities of whales around the gear. Additionally, they expressed concerns about the difficulties of identifying the exact species of animal engaging in depredation.

Various mitigation measures to reduce depredation by marine mammals were explored at the Samoa workshop. Such mitigation measures included: using acoustic deterrents, such as seal scarers or tuna bombs, which participants noted as not being particularly effective; shooting at animals, also not particularly effective and which could actually cause injury to marine mammals; moving to a new fishing area; retaining bait and offal instead of dumping it overboard; masking vessel noises so that vessels do not know when a haul is occurring; and avoiding hot spots where depredation by marine mammals is known to occur. Additional measures included delaying the setting or hauling of gear until animals have left the area, or luring marine mammals away from the area and "dropping them off" on competing vessels.

The Samoa workshop participants outlined a set of priority data associated with depredation that observer programs should collect. These data include better information on: fish depredation, specifically when it occurs during the set, soak, or haul; suspected predator species (cetaceans, sharks, squids, bony fish, other); the basis for predator identification (e.g., remains of the catch on the gear, such as head only, and identifying features, such as tooth marks); and the number of fish damaged. Photographs of damaged fish should also be taken. The collection of better information on the nature and frequency of marine mammal interactions was also recommended, including the: abundance of cetaceans at the time of set/haul; marine mammal species involved; nature of the interaction/injury (entangled or hooked); and condition (alive or dead) at release. Other priority data needs were total catch (number and weight), spatial and temporal data for set/haul, vessel description and operating procedures, fishing effort (number of hooks), and oceanographic data and meteorological data.

An additional case study presented involved marine mammal interactions with the Atlantic swordfish/tuna/shark pelagic longline fishery, operating off the east coast of the United States. The Marine Mammal Protection Act (MMPA) mandates that Take Reduction Plans (TRPs) be developed for strategic marine mammal stocks impacted by commercial fishing. In 1995, a Take Reduction Team (TRT) was convened to address pilot whale takes (i.e., serious injury or mortality) in the Atlantic pelagic longline fishery. A team of fishermen, environmental industry representatives, scientists, and resource managers recommended several measures to reduce pilot whale interactions with the longline fishery, including reducing fishing effort in areas where interactions occurred (primarily in the mid-Atlantic) and reducing the length of the lines used. It was also recommended that fishing vessels move after one interaction, alert other longline vessels to the presence of marine mammals. Unfortunately, the effectiveness of these measures is difficult to assess, and interactions are still occurring. NOAA Fisheries Service will convene an Atlantic Pelagic Longline TRT in 2005 to reassess the situation, and explore further mitigation measures. Data to support the TRT process include better information on the type of interaction - specifically, if the animal was hooked or entangled, and, if so, where and how; species involved; and biopsy samples to confirm species identification. Better guidelines are also needed on what constitutes a serious injury.

One workshop participant noted a depredation study in which the species involved could be determined from the marks left behind on the catch species. For example, short-finned pilot whales leave a stringy mess, while false killer whales tend to leave nothing in the middle and teeth marks on the side. Participants agreed that this type of research is useful in determining what species are preying on the catch.

Participants discussed whether or not individual marine mammals within a population are causing problems, and if efforts are being made to tag individuals that are released alive from the gear. Jan Straley, a sperm whale researcher in Alaska, is looking at individual markings and hydrophone recordings of the sounds made by sperm whales interacting with bottom longline gear to verify if the same individuals are more apt to interact with the gear.

Seabirds

<u>Incidental Catch of Seabirds - Overview</u> (Kim Dietrich, University of Washington, and Kim Rivera, U.S. National Seabird Coordinator, NOAA Fisheries Service)

The declines of many seabird populations, predominantly Southern Hemisphere albatrosses and petrels, have been linked to longline fisheries (Weimerskirch and Jouventin 1987, Cuthbert et al. 2003). Unlike sea turtles, no global estimate of seabird incidental catch has been attempted – annual estimates have ranged between 100,000 to nearly half a million or more. Difficulties encountered have been a lack of observer coverage in longline fisheries and lack of information regarding total effort (defined as total hooks deployed), especially for demersal fisheries. In addition to effort, the catch of seabirds needs to be known to the lowest possible taxonomic group in order to make an estimate of global catch. Observers (or fishermen) also need to collect (or provide) information on variables to evaluate performance of mitigation measures.

On the management front, there are both international and national instruments in place. For instance, as part of the FAO's Code of Conduct for Responsible Fisheries, there are related international plans of action (IPOA) for several fisheries issues and species groups of special concern (FAO 1999b). The International Plan of Action for Reducing the Incidental Take of Seabirds (IPOA-Seabirds), adopted by FAO in 1999, calls for longline fishery assessments to be conducted. Member nations with incidental catch of seabirds should develop a National Plan of Action (NPOA). NPOAs could include: data collection programs (e.g., onboard observers collecting data on seabird incidental catch), prescribed mitigation measures, mitigation research, outreach, and education and training. Of the 68 nations with longline fleets, only a few nations have prepared NPOAs or implemented seabird catch reduction measures, either voluntarily or through regulation. FAO co-hosted a regional South American workshop with BirdLife International to promote the development of effective NPOAs in these countries. Although a recommendation was made to standardize observer data collection methodologies, no specific variables were identified (FAO and BirdLife International 2004).

Several international organizations and RFMOs, including CCAMLR and the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), have adopted seabird avoidance mitigation measures or permit restrictions. Seabird resolutions have been issued by CCAMLR, the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Inter-American Tropical Tuna Commission (IATTC), the Indian Ocean Tuna Commission (IOTC), and the Western Central Pacific Fisheries Commission (WCPFC). An international agreement to conserve seabirds--Agreement for the Conservation of Albatross and Petrels (ACAP)--has entered into force and provides a legal mechanism to address various threats to albatrosses and petrels, including the incidental catch in fisheries (www.acap.aq).

In the last 15 years a lot of research has been performed to assess levels of bycatch and to develop and implement effective bycatch reduction (mitigation) measures. More than a dozen studies evaluating factors influencing seabird bycatch have found a wide range of significant variables. Several variables were consistently significant (e.g., time-of-day) (Duckworth 1995) or not significant (e.g., wind speed and direction) (Reid and Sullivan 2003); however, a few were equally significant or not significant (e.g., month, bait type) depending on the study (Cherel *et al.*, 1996; Weimerskirch *et al.*, 2000; Garth and Huppop 1994). The latter are likely due to differences in the types of information observers collected and how these variables were defined. Due to this diversity in findings, in part due to lack of consistency in how data has been collected, it is imperative that standards in observer data collections be developed.

III. Overview of Pre-Workshop Surveys

Survey Methodology and Content

The process followed for conducting the pre-workshop surveys was outlined. Two web-based surveys were developed, one for observer program staff and one for researchers who utilize observer data or have potential to use the data collected by fisheries observers (hereafter referred to as data users), in order to allow the conveners to gather input from observer programs and data users who could not attend the workshop and to focus discussions during the workshop.

The surveys were developed and executed using Survey Monkey, a web-based survey instrument (www.surveymonkey.com). The results of the surveys were provided by Survey Monkey as a text file that was uploaded into a Microsoft Excel spreadsheet for data analysis.

The announcement for the survey was e-mailed to 25 observer program staff and more than 400 data users. Data user contact information was gleaned from published and "gray" literature as well as word of mouth.

Observer program staff and data users were asked to respond to questions regarding a list of 250 data variables. Data variables were grouped by the following categories: temporal, spatial, physical and environmental, vessel and fishing, fishing gear, catch, mitigation methods and deterrent devices, and bycatch species (sea turtles, marine mammals, and seabirds) (see Appendix C for complete list of variables included in the survey). The variables selected for inclusion in the survey were extracted from publicly available U.S. and international observer program manuals and included variables referenced by researchers in the literature.

Observer program staff were asked to respond to the following three questions for each of the variables:

1) Whether the program collects the data variable
2) Whether the variable was/would be feasible to collect
3) If gear or equipment is required to collect a given variable, who provides the gear (the program, the vessel, or the observer), and whether the program specifies what gear or equipment should be used.[1]

[1] These latter two questions were not presented or discussed at the workshop, due to lack of time. However, the complete results of the pre-conference observer program survey are available in Appendix C.

Data users were asked several questions relating to their background (e.g., how they use observer data, and which program(s)' data do they use), and were asked to rank the list of 250 variables into the following categories with regard to their research data needs and use:

Critical –	Data variables that should be collected in all longline observer programs
Preferred –	Data variables that they would like to have collected in all longline observer programs
Optimal –	Data variables that would be ideal if collected in all longline observer programs (but probably could not be achieved in all cases)
N/A –	Data not applicable to their research
Not important –	Data that were not important to their research and that could be omitted from data collections, or that could be derived by collecting other variables.

Summary of Survey Responses

Observer Program Respondents

Responses from 15 observer program staff were included in the survey, representing 14 unique longline observer programs from 6 countries (Australia, Canada, Namibia, New Zealand, South Africa, and the U.S.) and 1 RFMO (SPC). Variables collected by CCAMLR's Scientific Observer sampling program, NMFS' Northeast Fisheries Observer Program, and NMFS' West Coast Groundfish Observer Program were extracted from publicly available observer sampling manuals and also included in the survey, bringing the total of unique observer programs represented in the survey to 17.

Table 2 illustrates the area and gear type combinations represented in the survey by the observer program responses. Each distinct area and gear type (pelagic vs. demersal) combination is considered a separate response for the purpose of the survey, for a total of 24 sets of responses. There are 12 responses from programs observing pelagic fisheries and 12 from demersal fisheries.

Data User Respondents

A total of 43 data users responded to the survey. The respondents indicated that they used longline observer data from 10 countries (Argentina, Australia, Canada, Chile, Ecuador, Namibia, New Zealand, Peru, South Africa, U.S., and Venezuela), 1 region (Mediterranean), and 3 RFMOs (CCAMLR, CCSBT, and SPC).

Table 2 illustrates the countries/regions/RFMOs represented in the survey by data users. It shows that there was fairly good overlap between the country or RFMO represented by observer program respondents, and the country or RFMO observer program data accessed by data users respondents.

Table 2. Observer programs represented in pre-workshop survey. The observer program respondents are identified by country or RFMO, and by gear type. The data user respondents are identified by the countries/RFMOs from which the observer data comes from. (* - Data user respondents in many cases use data from more than one country/RFMO.)

Country/RFMO	**Number of observer program responses in each country/RFMO, by gear type**		**Number of data users that responded that they use data from the identified country/region/RFMO***
	Pelagic	**Demersal**	
CCAMLR	0	1	6
CCBST	0	0	2
SPC	1	0	4
Argentina	0	0	2
Australia	1	1	4
Canada			
Newfoundland	1	1	4
Scotia-Fundy	1	1	
Chile	0	0	1
Ecuador	0	0	1
Mediterranean	0	0	2
Namibia	1	1	0
New Zealand			
Ministry of Fisheries	1	1	2
Dept of Conservation	1	1	
Peru	0	0	1
South Africa	1	1	1
United States			
Northeast Fishery Observer Program (NEFOP)	1	1	
Southeast Fisheries Science Center Pelagic Observer Program (SEFSC POP)	1	0	
Commercial Shark Fishery Observer Program (CSFOP)	0	1	
California Pelagic Observer Program	1	0	32
West Coast Groundfish Observer Program(WCGOP)	0	1	
North Pacific Groundfish Observer Program (NPGOP)	0	1	
Hawaii (Pacific Islands) Longline Observer Program	1	0	
Venezuela	0	0	1

Demographics and Interests of Data User Respondents

Observer programs have a wide spectrum of data users who utilize the information collected by longline observers. Government scientists and academics made up the largest groups of data users, comprising 35% and 33% of all data users, respectively. The third largest group of data users was the private consulting sector, accounting for 16% of all data user respondents. Seven percent of data users were non-government organizations, while RFMO's and observer program staff accounted for 5% each of all data user respondents.

Data user respondents also varied greatly by region of interest. The majority of data users were focused on fisheries from the North Pacific (47%), followed by the South Pacific (42%), North Atlantic (30%), South Atlantic (23%), Indian Ocean (16%), Southern Ocean (16%), Mediterranean Sea (12), Arctic Ocean (2), and other (14%). These numbers are not additive, as data users may have responded that they use data from more than one geographic area of interest.

Data user groups were also categorized by species and target fishery of interest (keeping in mind that respondents of the survey were allowed to state more than one species or fishery of interest). The majority of respondents (60%) ranked seabirds as their top species of interest, followed by marine mammals (49%) and sea turtles (47%). Sharks and billfish were identified as species of interest for 35% of respondents, while 23% indicated billfish as their species of interest. Respondents ranked the tuna fishery highest (56%) as a target fishery of interest, followed by the swordfish fishery (47%), and the sablefish fishery (26%). Pacific cod, toothfish, and hake comprised 16% or less of the respondents.

Data users were also asked to indicate the type of fishery in which they were involved. Of the data users that responded, 47% used data from pelagic fisheries, 35% used data from demersal fisheries, and 19% indicated that they used data from both types of fisheries.

Data users were asked to indicate how they use the data, again keeping in mind that respondents were able to select more than one use of the data. Respondents use observer data for: estimating total bycatch for species of interest (88%), evaluating factors influencing bycatch (70%), evaluating ecological and general distribution (60%), formulating stock assessments of target species (28%), establishing quota management or management of potential biological removal levels (26%), conducting genetic studies (14%), and other purposes (12%).

<u>Data Variables</u>

The main focus of the workshop was on how data users ranked each variable in terms of priority for data collection, and how many observer programs collect each variable. Bar graphs were presented to the workshop participants summarizing the results of the surveys for each data variable, grouped by category (Figures 3-23)[2]. Bar graphs included the following:

- Data variables along the x axis
- Percentage of data users that ranked each variable along the y axis, expressed in terms of cumulative percent for each ranking category
- Percentage of observer programs that collect each variable along the top of the bar graph.

On each chart, a line was drawn horizontally at y=50% to provide a reference point to determine whether there was a majority of data users that indicated the variable was a priority for data collection (i.e., ranked as critical or preferred by data users). Using this simple measure, a majority is considered any number of respondents greater than 50%.

Each category of variables and set of bar graphs is accompanied by a brief summary identifying the variables included in that category and highlighting those variables in which $\geq$50% of data

[2] The bar graphs presented in this summary were updated from the ones presented at the workshop, after incorporating survey responses received shortly after the workshop.

users responded were either critical or preferred. For priority data variables, the narrative also indicates how observer programs rated each variable in terms of how feasible or easy it was to collect. Appendix C provides the full list of variables included in the surveys, grouped by category, as well as the number of responses received by data users for each category of response (critical, preferred, optimal, not important, and not applicable/blank), by variable. Appendix C also provides the actual number of observer program respondents that indicated they collect each variable. Appendix D provides observer program responses to feasibility of collecting each variable.

Temporal Variables

Nine temporal variables were included in the pre-workshop surveys: date of gear deployment, date of gear retrieval, time gear deployment began, time gear deployment ended, time gear retrieval began, time gear retrieval ended, time of capture (of the bycatch species)[3], time zone, and time-of-day[4] (Figure 3). Data users indicated that gear deployment and gear retrieval dates had the highest priority for data collection among the temporal variables. Seventy two percent of data user respondents ranked date of gear deployment as a critical or preferred variable, and 70% ranked it as critical or preferred. Gear deployment start and end times were also a high priority for data collection, with 65% of respondents ranking these variables as critical or preferred. Gear retrieval start and end times were rated as critical or preferred by <50% of data users. These results indicate that the ability to calculate total effort, as indicated by total fishing time (i.e., soak time), is important for data users. The majority ($\geq$92%) of observer programs collect these variables, and most (>80%) rated these variables as easy to collect.

Time of capture was rated by data user respondents as critical (28%), and preferred (19%), and time zone[5] was rated as critical (30%) and preferred (12%) (Figure 3). Time zone can be inferred given accurate position information. Time-of-day was rated by 33% of data users as critical and 17% as preferred; however, two respondents noted that if you have the deployment time, calculating time-of-day as a function of date, time and position can be done using a mathematical algorithm. Only 13% of observer program respondents reported they collect time-of-day. Where collected, this variable may be difficult to interpret due to variations or subjectivities in defining twilight[6].

[3] Time of capture refers to the time that the bycatch species of interest was caught (or more realistically was brought on board or next to the vessel).
[4] Time-of-day is a categorical variable which could be defined in many ways, although is frequently defined as day, night, and twilight.
[5] Respondents indicated that Coordinated Universal Time (UTC) is the most frequently used time zone designation, followed by local time.
[6] Civil, nautical and astronomical twilight are defined to begin in the morning and end in the evening when the center of the sun is geometrically 6, 12 and 18 degrees below the horizon, respectively (Seidelmann 1992).

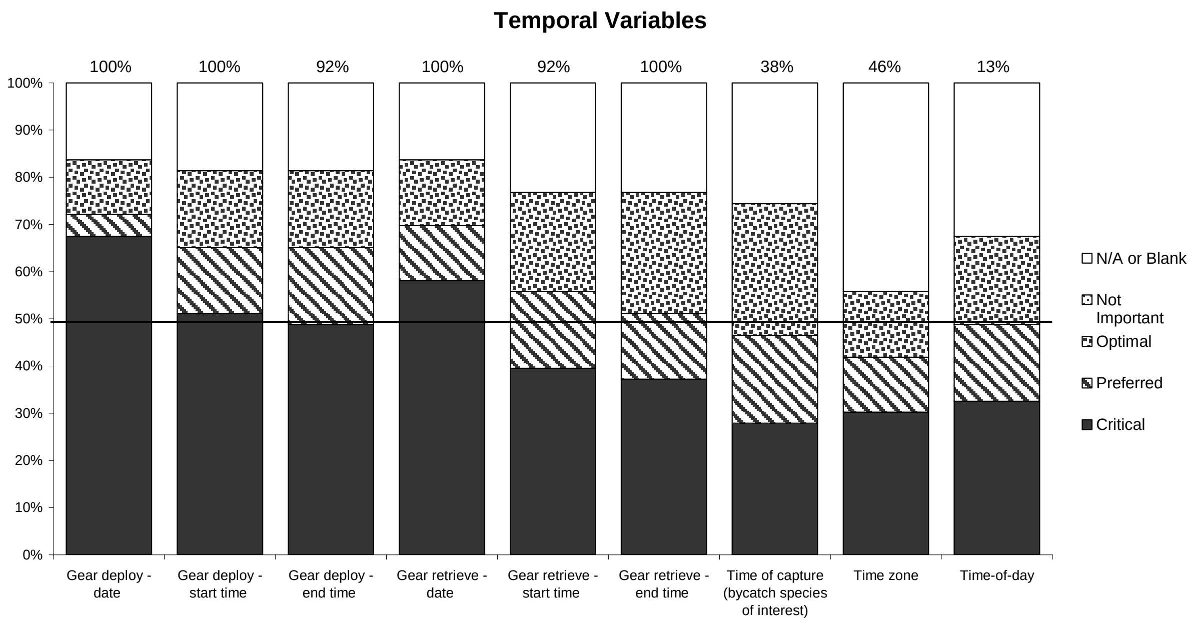

Figure 3: Ranking by data user respondents (n=43) of the relative importance of each of the temporal variables included in the survey. The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables.

Spatial Variables

Nine spatial variables were included in the survey: the latitude and longitude at which gear deployment begins and ends, the latitude and longitude at which gear retrieval begins and ends, and the management area in which fishing occurred (Figure 4).

Data users ranked latitude and longitude for the *start* of gear deployment as critical or preferred (70%) and latitude and longitude for the *end* of gear deployment as critical or preferred (60%) (Figure 4). These 4 variables were reported to be collected by ≥96% of the observer program respondents. Latitude and longitude for the start and end of gear retrieval was reported to be collected by 100% of the observer program respondents that monitor pelagic longline fisheries[7]. More than 65% of the observer program respondents indicated these variables were easily collected. Respondents were concerned about the level of precision needed, confidentiality of fishing positions, how the data were collected (observed directly vs. taken from the vessel's logbook), and which GPS unit (the vessel's or the observer's) was used to collect these positions. Management area was ranked relatively low by both data users and observer program respondents because this can be derived from latitude/longitude.

[7] Observer programs for demersal longline fisheries generally do not collect latitude and longitude at the start and end of gear retrieval because demersal gear is not likely to drift between deployment and retrieval; therefore, programs for demersal gear were not included in the percent of programs collecting these 4 variables.

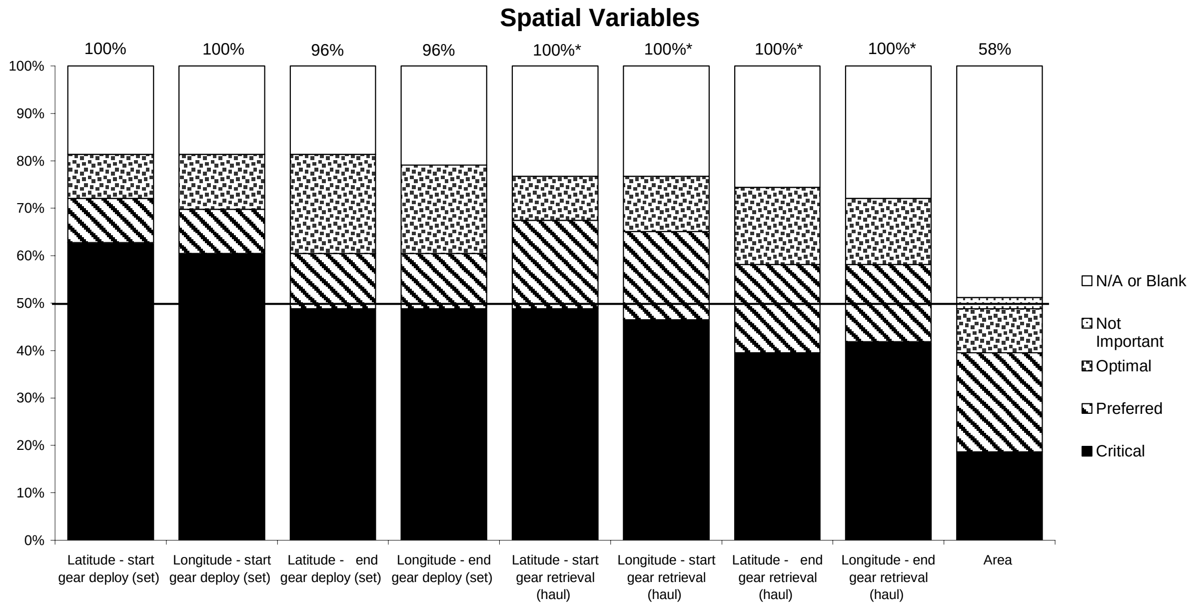

Figure 4: Ranking by data user respondents (n=43) of the relative importance of each of the spatial variables included in the survey. The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables. Those with marked with * represent only respondents from pelagic fisheries (n=12), as these variables are generally not collected for demersal longline fisheries.

Physical and Environmental Variables

Physical and environmental variables in the survey included: bottom depth at both the beginning and end of gear deployment, average bottom depth, fishing depth, depth range of hooks, maximum depth of hooks, sea surface temperature, sea level pressure, swell height and direction, wind speed and direction, Beaufort sea state, cloud cover, visibility, moon brightness and phase, and general weather conditions (Figures 5 and 6).

Respondents ranked bottom depth at the *start* of gear deployment as critical or preferred (44%), and bottom depth at the *end* of gear deployment as critical or preferred (37%) (Figure 5). Approximately 50% of observer program respondents reported they collect these variables, and the same number assessed these variables as easy to moderately easy to collect. Fishing depth is often not collected as a separate variable in demersal fisheries since the bottom depth and the fishing depth should be the same; in these cases only bottom depth is collected. Issues surrounding the collection of these variables, especially in pelagic fisheries, include limitations of the vessels' depth sounders. At least one program collects minimum and maximum depths rather than start and end depths, which was a variable option not provided in the survey. Thus, the number of programs collecting this variable is unknown. Average bottom depth was considered a critical or preferred variable by 33% of the respondents, and 4% of the observer program respondents reported they collect this variable (Figure 5). In pelagic fisheries, fishing depth is frequently derived from the length of the droplines and branchlines, rather than collected directly by observers. In a few pelagic fisheries, time depth recorders are attached to gear to get an accurate record of fishing depth, although this is considered specialized equipment not routinely deployed on gear.

Forty percent of data user respondents indicated that depth range of hooks or maximum hook depth were critical or preferred data variables; 38% of observer program respondents indicated they collect depth range of hooks and 25% indicated they collect maximum hook depth (Figure 5).

Sea surface temperature is the temperature recorded at the ocean's surface in any given location. Data users ranked sea surface temperature as critical or preferred (51%), and 67% of the observer program respondents stated they collect this variable. Approximately half the observer program respondents responded that collecting this variable is easy to collect, while the other half responded that it was moderately easy. Over half of the observer program respondents reported they use the vessel's thermometer to collect temperature data, while the other half uses program-supplied thermometers.

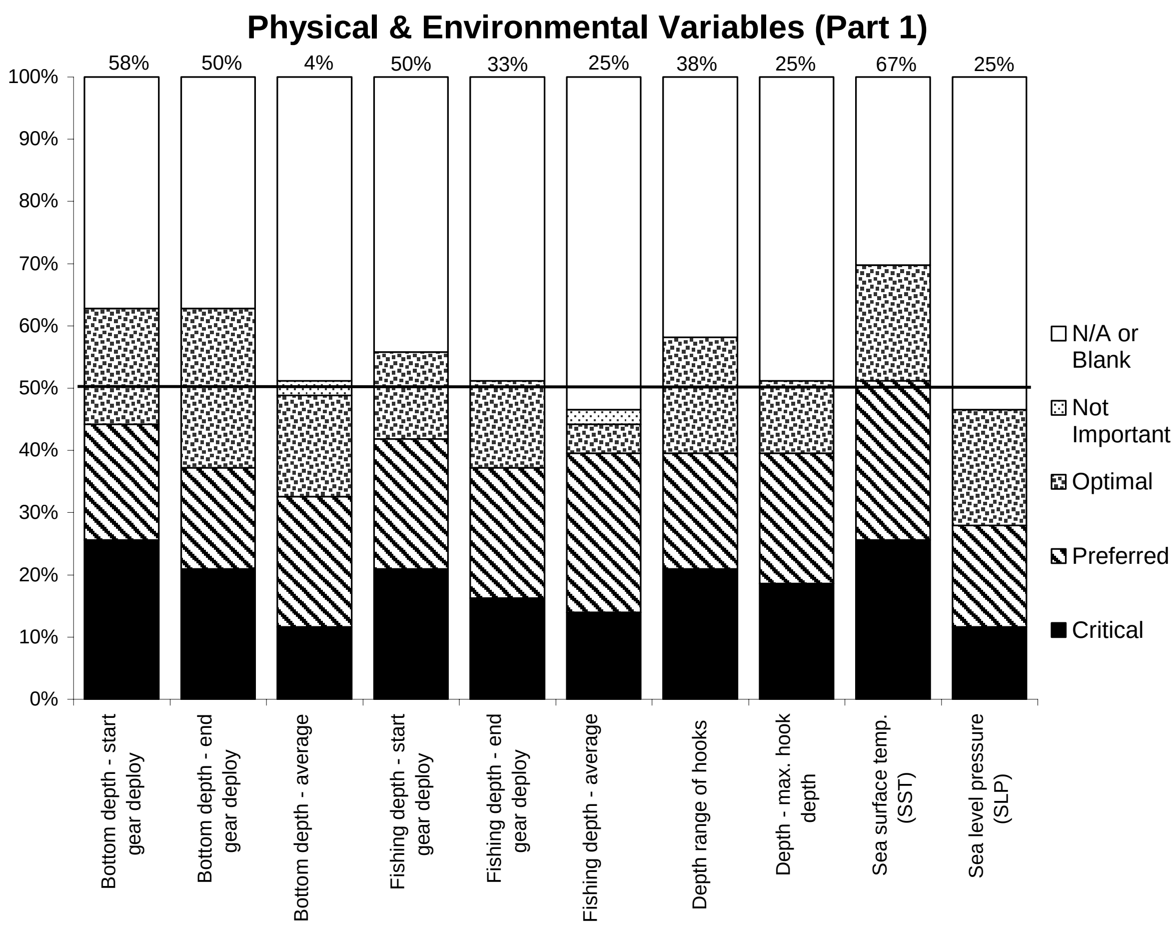

Figure 5: Ranking by data user respondents (n=43) of the relative importance of some of the physical and environmental variables included in the survey (see also Figure 6). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables.

Wind speed was ranked as critical or preferred by 47% of data user respondents and reported to be collected by 33% of observer program respondents. Wind direction was ranked as critical or preferred by 37% of data user respondents and reported to be collected by 13% of observer program respondents (Figure 6). Beaufort sea state was identified as critical or preferred by 42% of data users and was reported to be collected by 33% of observer program respondents. The recording of cloud cover and visibility were low priorities for both data user and observer program respondents. Moon brightness and moon phase were ranked as critical or preferred for 42% and 40% of data user respondents, respectively and reported to be collected by 4% and 13% of observer program respondents respectively. Weather[8] was considered critical or preferred by 44% of data user respondents and reported to be collected by 33% of observer program respondents. Fifty percent of observer program respondents stated this was an easy variable to collect, and 50% said that it was moderately easy to difficult to collect.

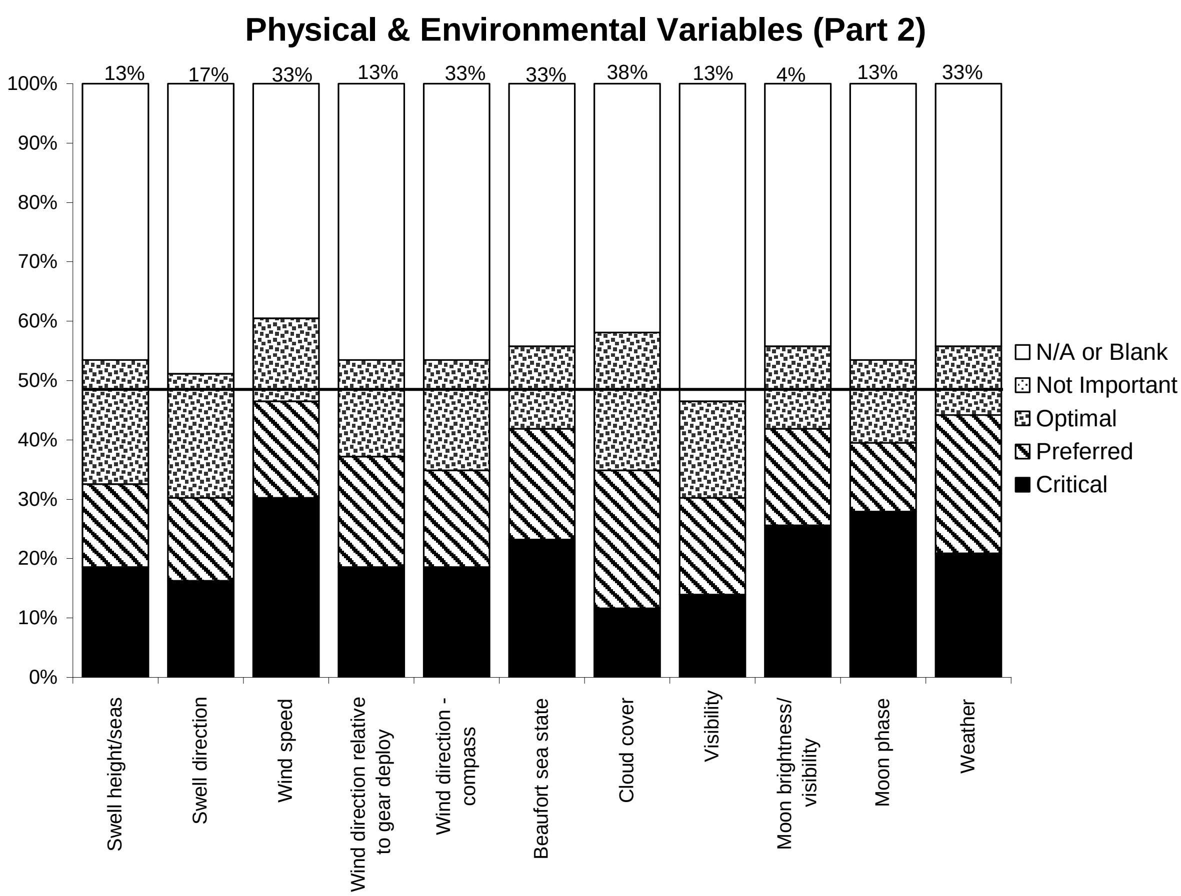

Figure 6: Ranking by data user respondents (n=43) of the relative importance of some of the physical and environmental variables included in the survey (see also Figure 5). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables.

[8] Defined in the survey as the state of the atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness or cloudiness.

Vessel and Fishing Information

Vessel and fishing information included 32 variables: unique vessel identifier, vessel length, engine (sound profile), captain's name or unique identifier, captain's experience, owner, unique observer identifier, target species, presence of other vessels in area, bait species, bait type, bait temperature, baiting method, bait size, ratio of bait types used, and bait efficiency (Figure 7), setting pattern, whether setting into propeller up or down wash, setting speed, line shooter speed, whether a bait throwing machine is used, whether offal was discharged while deploying/retrieving gear, type of offal discharge, offal dumping position, number of hooks deployed, number of hooks retrieved, number of floats per 1000 hooks, number of weights per 1000 hooks, distance between line weights, weight of line weights, and groundline (mainline) sink rate (Figure 8).

The unique vessel identifier is the name or registration number of the vessel being observed. This variable was ranked as critical or preferred by 56% of data user respondents, and 100% of observer program respondents indicated they collect this variable. All of the observer program respondents ranked this as easy to collect. Vessel length was ranked as critical or preferred by 53% of data user respondents, and 75% of observer program respondents indicated they collect this variable. Captain's name, captain's experience, and owner's name were indicated as critical or preferred variables for 42%, 33%, and 21% of data user respondents, respectively; 75%, 21%, and 58% of observer program respondents indicated these variables were collected. The observer unique identifier, usually indicated by a code used in lieu of the observer's name to maintain their anonymity, was ranked as critical or preferred by 70% of data user respondents. This variable was indicated as collected by 88% of observer program respondents (Figure 7). Of observer program respondents, 95% ranked this variable as easy to obtain, and 5% ranked it as moderately easy to collect.

Target species, or the species of fish targeted for catch by the vessel, was ranked as critical or preferred by 72% of data user respondents and reported to be collected by 13% of observer program respondents (Figure 7). Over 95% of those programs responded that this variable was easy to obtain. One caveat to note is that the survey did not explicitly ask whether the target species is declared prior to the deployment of each set, or if the species composition of the catch was used to derive this variable (perhaps explaining why so few programs collect this variable).

Certain vessel and fishing variables are collected by observer programs because of their potential relevance to bycatch of protected species. For example, engine sound profile[9] may be important in fisheries that have interactions with marine mammals. Of data users respondents, 23% indicated this variable was critical or preferred, and 13% of observer program respondents indicate they collect this variable. Bait characteristics may be relevant to bycatch of all protected species: sea turtles, marine mammals, and seabirds. Bait species was ranked as critical or preferred by 56% of data user respondents and reported to be collected by 46% of observer program respondents. Over 71% of observer program respondents ranked this as easy to obtain. Bait type, which refers to whether the bait is live, whole, or cut, was ranked as critical or

[9] Usually referring to such information as engine make, model, and horsepower.

preferred by 58% of data user respondents and reported to be collected by 21% of observer program respondents. Bait temperature, which refers to whether the bait is frozen, fresh, or thawed, was ranked as critical or preferred by 49% of data user respondents and reported to be collected by 42% of observer program respondents. Over 80% of the observer program respondents reported that bait type and temperature was easy to collect. Bait method is the means by which bait is placed on the hooks (manually or by using an auto-baiter). This variable was ranked as critical or preferred by 53% of data user respondents and reported to be collected by 17% of observer program respondents. The majority of observer program respondents ranked this information as easy to collect. Bait size and ratio of bait species were both ranked as critical or preferred by 37% of data user respondents. Bait size was reported to be collected by 29% of observer program respondents and ratio of bait species by 38% of respondents. Bait efficiency (which applies only to autobaiters) was a relatively low priority, with 23% of data user respondents ranking this as a critical or preferred variable, and 21% of observer program respondents reporting they collect this variable (Figure 7).

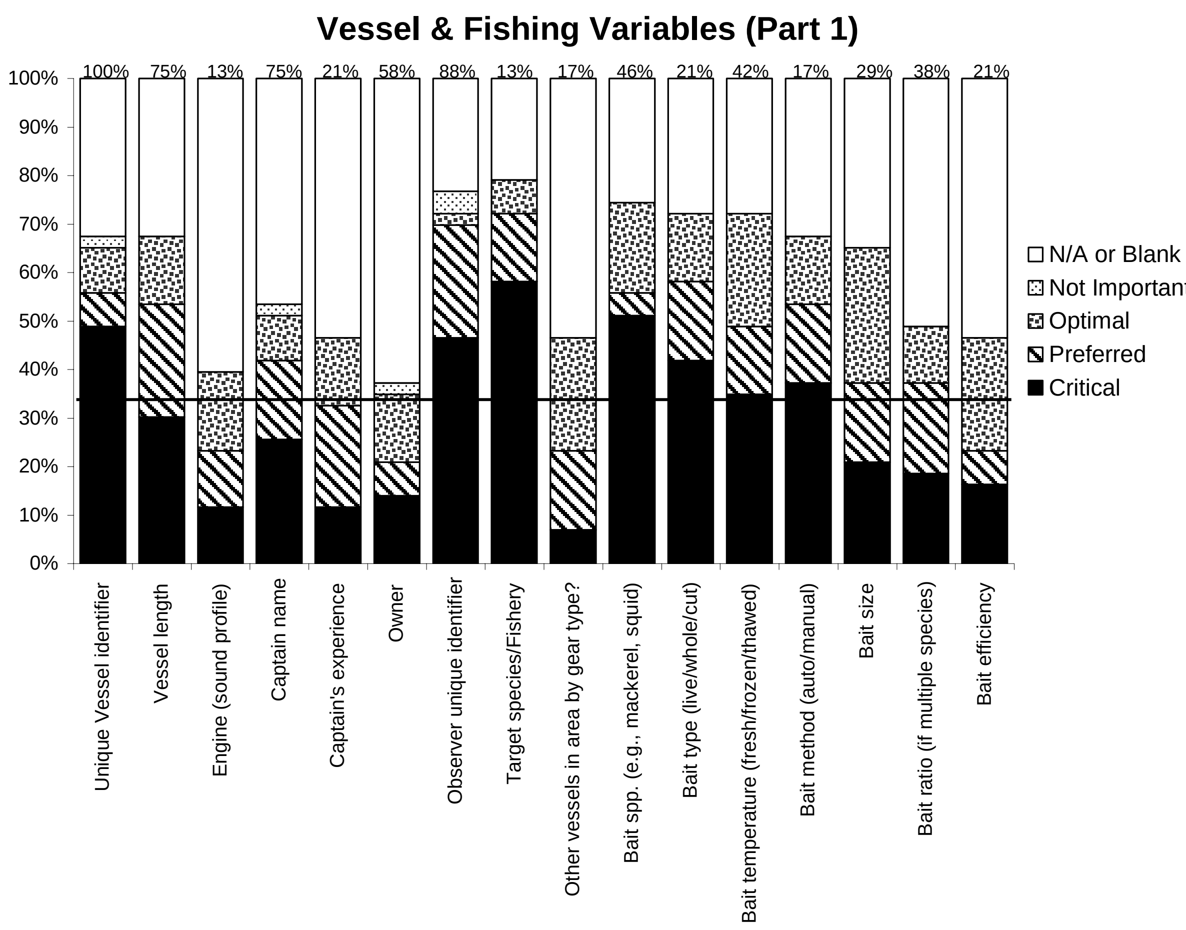

Figure 7: Ranking by data user respondents (n=43) of the relative importance of some of the vessel and fishing variables included in the survey (see also Figure 8). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables.

Fishing effort can be derived from information collected on number of hooks deployed or retrieved. The number of hooks deployed was ranked as critical or preferred by 81% of data user respondents and reported to be collected by 50% of observer program respondents (Figure 8). Approximately half of those programs considered this as easy to collect, while 50% considered it to be moderate to difficult to collect. Number of hooks retrieved can be an additional indicator of fishing effort. This variable was ranked as critical or preferred by 60% of data users and reported to be collected by 71% of observer program respondents.

Additional vessel and fishing variables may also be collected by observer programs because of their potential relevance to bycatch of protected species (Figure 8). For example, how the gear is set may be relevant to seabird bycatch. Factors such as gear setting pattern (whether the gear was set straight or in a meandering path, or along depth or temperature contours), whether the gear was set into propeller up or down wash, setting speed, line shooter speed, and the use of a bait throwing machine may affect seabird interaction rates. However, data users overall ranked each variable as a relatively low priority for data collection, with an average rank of critical or preferred for this suite of variables as 30%. A small percentage of observer program respondents reported they collect this data, with the highest reported for setting speed (54%) and the lowest for setting of gear in relation to propeller wash (13%). Groundline (mainline) sink rate was ranked as critical or preferred by 35% of data users, and 17% of observer program respondents reported they collect this information.

Discharge of offal by the vessel may have relevance for seabird bycatch. Offal discharge during gear deployment and gear retrieval were both ranked as critical or preferred by 42% of data user respondents; these variables were reported to be collected by 21% and 33% of observer program respondents, respectively. Size of offal discharge was ranked as critical or preferred by 30% of data users and reported to be collected by 8% of observer program respondents. Offal dumping position (i.e., over the stern or over the side) was ranked as critical or preferred by 35% of data user and reported to be collected by 21% of observer program respondents (Figure 8).

The configuration of the gear can be determined by the number of floats (for pelagic gear), number of weights, distance between weights, and weight of weights (for demersal gear[10]; Figure 8). Number of floats per 1000 hooks was ranked as critical or preferred by 49% of data users and reported to be collected by 58% of observer program respondents who monitor pelagic gear. Number of weights per 1000 hooks was ranked as critical or preferred by 49% of data users and reported to be collected by 25% of observer program respondents who monitor demersal gear. Distance between line weights was ranked as critical or preferred by 53% of data users and reported to be collected by 33% of observer program respondents who monitor demersal gear. Weight of line weight was ranked as critical or preferred by 44% of data users and reported to be collected by 33% of observer program respondents who monitor demersal gear.

[10] Results of the rankings provided by data user respondents for these variables did not distinguish between pelagic and demersal gear. Therefore, results may not accurately represent the priority of these variables for each specific gear type. However, responses from observer programs did distinguish between those monitoring pelagic vs. demersal longline gear.

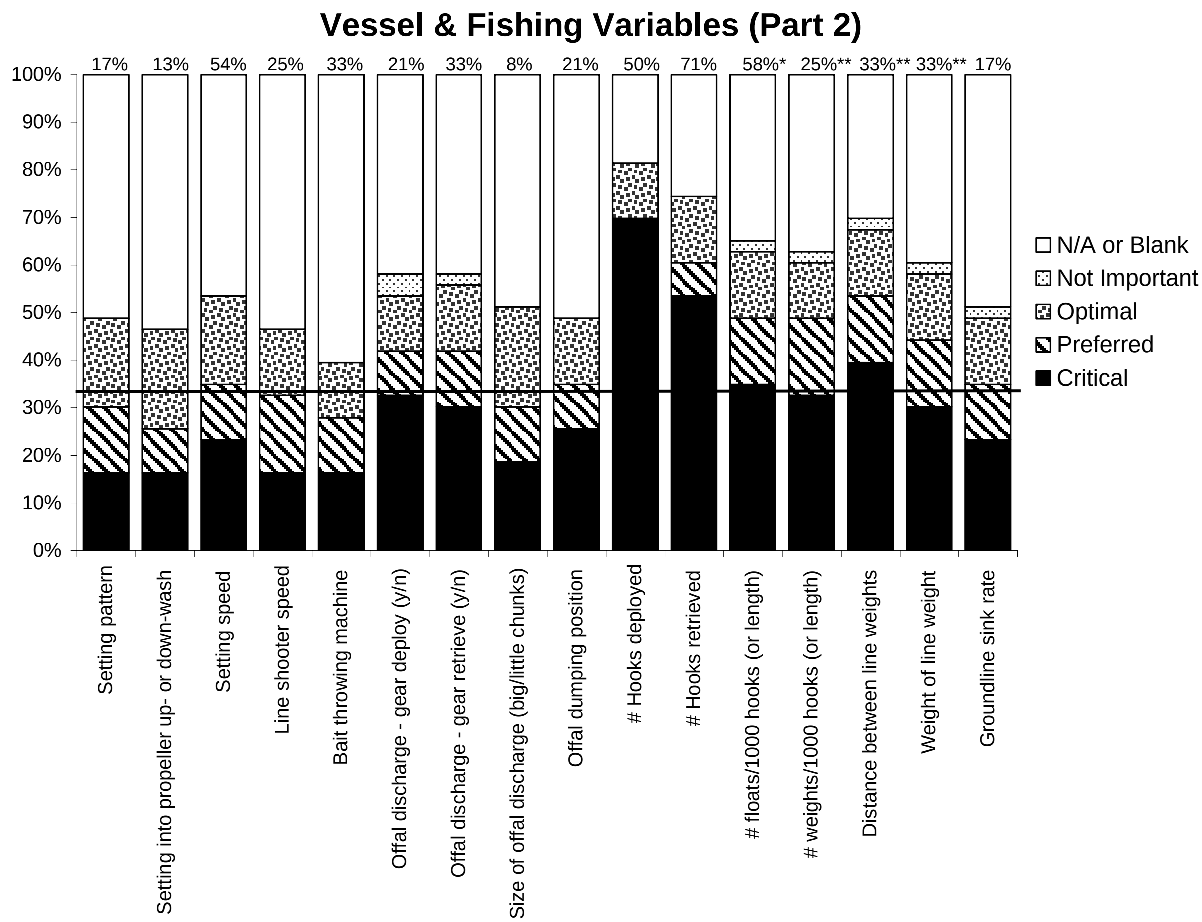

Figure 8: Ranking by data user respondents (n=43) of the relative importance of some of the fishing and vessel variables included in the survey (see also Figure 7). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables. Those with marked with * represent only respondents from pelagic fisheries (n=12), as these variables are generally not collected for demersal longline fisheries. Those with marked with ** represent only respondents from demersal fisheries (n=12), as these variables are generally not collected for pelagic longline fisheries.

Fishing Gear Variables

Gear variables are those that pertain to the type of gear used and how it is deployed (see Figure 9 for a schematic of the gear with terminology used). Survey variables included anchor weight, groundlines (material, number of strands, length, diameter, breaking strength, color), floatlines/droplines (material, length, diameter, distance between floatlines), branchlines/gangions/snood (material, length, diameter, color, test, distance between branchlines), leaders (material, length, diameter, test, weight), swivels, hooks (make, size, type, offset), light device/type, lightsticks (number, color), gear condition upon retrieval, float type/size, height of gear deployment, and line setting position (Figures 10 and 11). The relative priority of gear variables may be dependent upon bycatch species of concern, target species, gear type, and geographic region. This may explain why responses varied as to relative priority.

The fishing gear variables that were ranked as either critical or preferred by ≥50% of data user respondents were groundline length (Figure 10), hook size, and hook type (Figure 11).

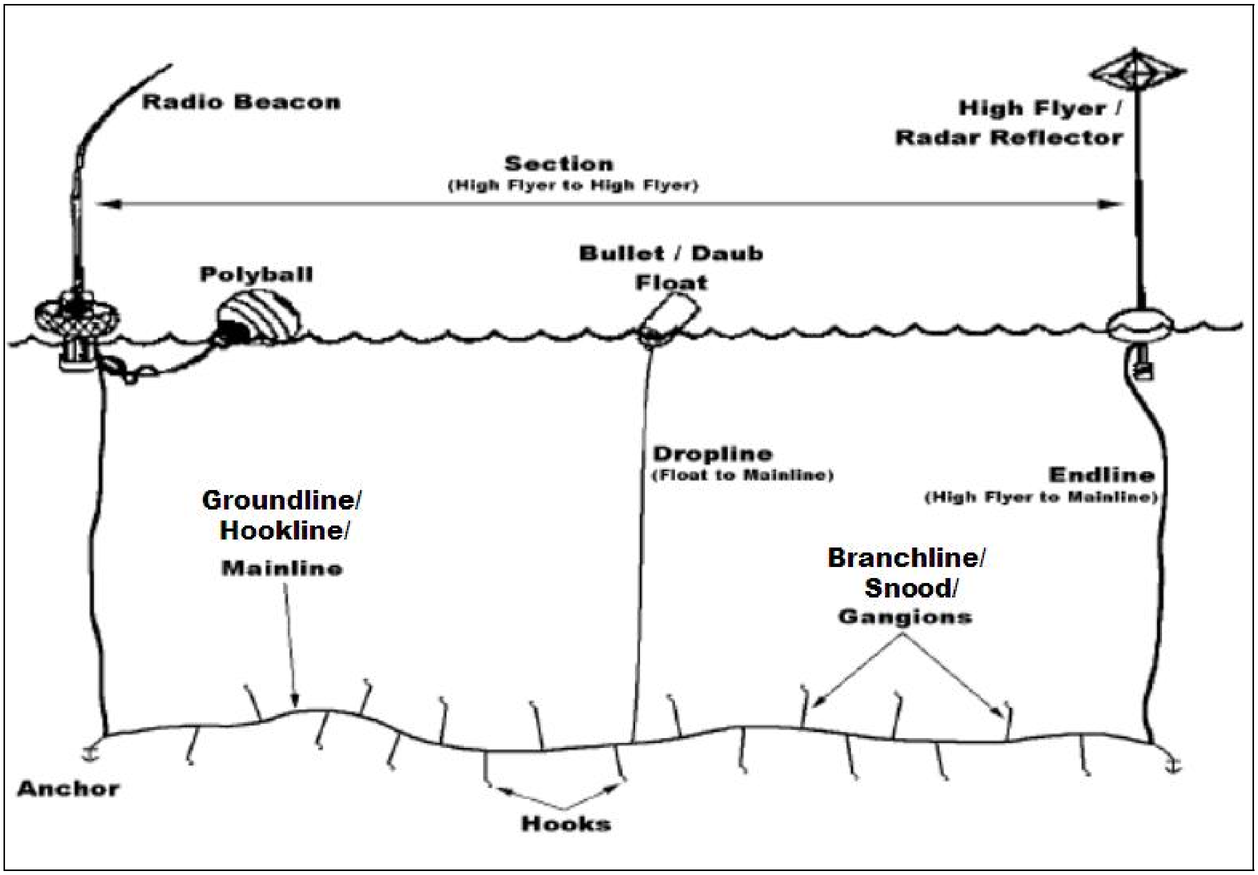

Figure 9: Graphic illustration of typical longline gear parts and their terminology.

Information on the length of the various lines used in gear deployment, as well as the distance between these lines, had varying priority for data users. Groundline/mainline length is the length of line to which all of the hooks are attached. Fifty one percent of data users ranked this variable as critical or preferred, and 38% of observer program respondents reported they collect this information (Figure 10). Some noted that groundline/mainline length can be derived from other variables. Floatline/dropline length refers to the line that connects the floats on the water's surface to the groundline/mainline. This variable can be important in deriving fishing depth. Floatline/dropline length was ranked as critical or preferred by 35% of data user respondents and reported to be collected by 38% of observer program respondents. The majority of observer program respondents considered floatline/dropline length as easy to collect. Distance between floatlines/dropline was ranked as critical or preferred by 35% of data users and reported to be collected by 25% of observer program respondents. Branchline/gangion length is the length of the line that connects a hook to the groundline/mainline. Depending on the program, branchline/gangion length may or may not include the length of the leader, which is a relatively short section of monofilament or steel wire between the swivel and hook. Branchline/gangion length was ranked as critical or preferred by 47% of data user respondents and reported to be collected by 63% of observer program respondents. The distance between branchlines/gangions was ranked as critical or preferred by 49% of data users and reported to be collected by 50% of observer program respondents (Figure 10).

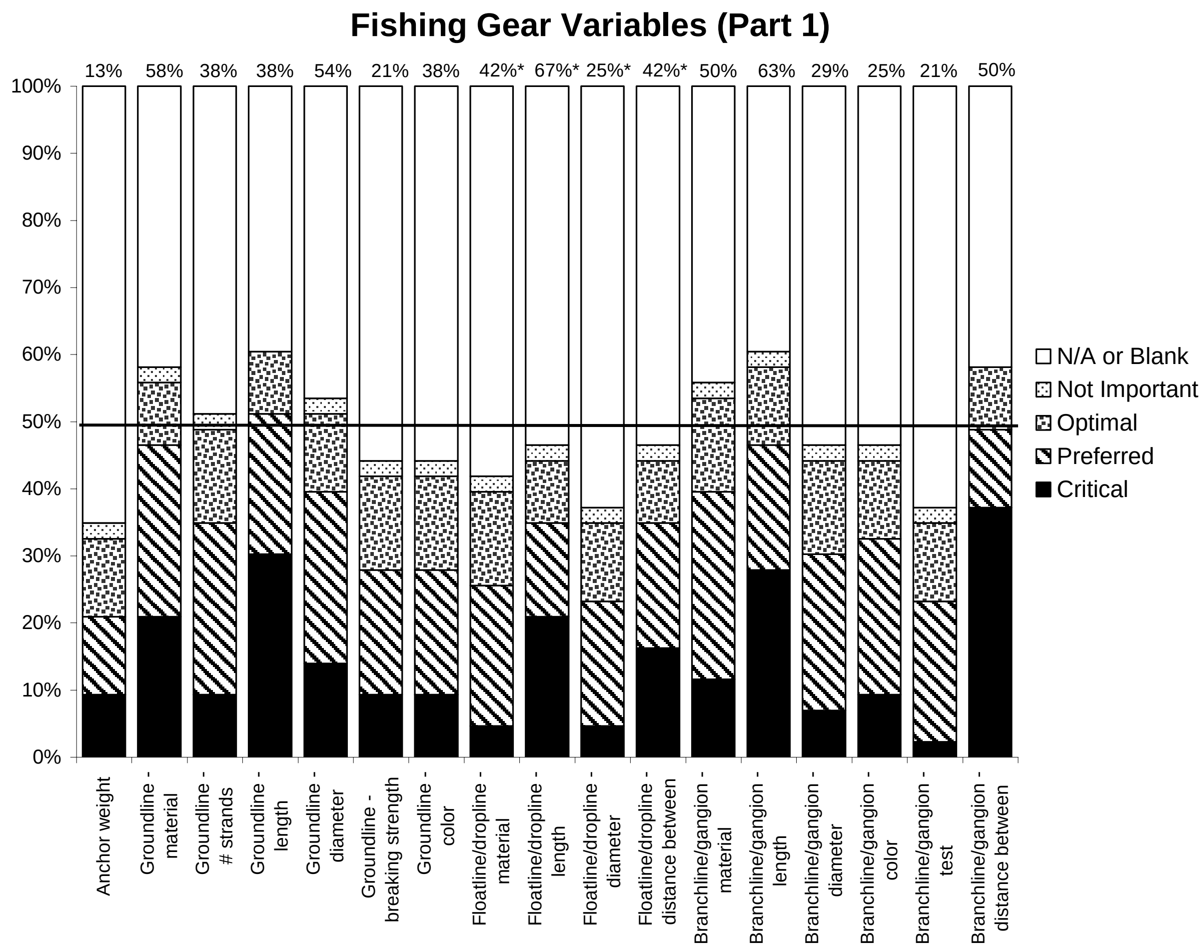

Figure 10: Ranking by data user respondents (n=43) of the relative importance of some of the fishing gear variables included in the survey (see also Figure 11). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables. Those marked with * represent only respondents from pelagic fisheries (n=12), as these variables are generally not collected for demersal longline fisheries.

Other characteristics of the lines include material, diameter, breaking strength, color, test, and number of strands. Of these, the material and diameter of the groundline/mainline and material of the branchline/gangion had the highest priority for data users (Figure 10). Groundline/mainline material was ranked as critical or preferred by 47% of data users and reported to be collected by 58% of observer program respondents. Groundline/mainline diameter was ranked as critical or preferred by 40% of data users and reported to be collected by 54% of observer program. Forty percent of data users ranked branchline/gangion material as critical or preferred and reported to be collected by 50% of observer program respondents. Other variables were not ranked particularly high by data users, and were not collected consistently by observer program respondents (Figure 10).

Hook type, size, and to a lesser degree, offset, is a relative priority for several data users, as it has been shown to be correlated with bycatch of sea turtles (Watson et al. 2004), and may have relevance for bycatch rates of other species. Hook size is the general dimension of the hook, including the gap distance, as indicated by the manufacturer (i.e., it is not generally "measured" by the observer). Hook size was ranked as a critical or preferred variable by 53% of data user respondents, and 71% of observer program respondents reported they collect this information (Figure 11). Hook type refers to the style of hook used in fishing operations. These styles primarily include "J" hooks and circle hooks. Hook type was ranked as critical or preferred by 56% of data user respondents and reported to be collected by 67% of observer program respondents. Over half of those programs considered this information easy to acquire. Hook offset is the degree to which a hooks' point deviates from the general plane of the hook, and is usually expressed in degrees. It was ranked as critical or preferred by 40% of data user respondents. However, only 8% of observer program respondents reported they collect this information (Figure 11). Half of the observer programs responded that hook offset was easy to obtain, while the other half considered it to be difficult information to collect. Again, this information is generally provided by the manufacturer and not measured by the observer.

The use of light sticks is of interest to determine its possible correlation with bycatch, and therefore had some priority for data users. The number of light sticks used was ranked as critical or preferred by 44% of data users and reported to be collected by 46% of observer program respondents. The type of light device used was ranked as a critical or preferred variable by 37% of data users and reported to be collected by 33% of observer program respondents. The color of light sticks used was ranked as critical or preferred by 35% of data users, and 42% of observer program respondents reported they collect this information (Figure 11).

Height of gear deployment can be quite useful in studies pertaining to seabird bycatch and sink rate of gear. Height of gear deployment was ranked as critical or preferred by 35% of data user respondents and reported to be collected by 21% of observer program. Just over half of those programs felt height of gear deployment was easy to collect, whereas about 40% of respondents ranked it as difficult information to obtain. Line setting position refers to where the line was deployed from the ship (stern, port, starboard). This variable was ranked as critical or preferred by 37% of data user respondents and reported to be collected by 25% of observer program respondents. The difficulty of obtaining the deployment location was considered easy, moderately easy, and difficult to collect by equal numbers of those programs (Figure 11).

Other fishing gear variables collected with some consistency by observer program respondents included the length and material of leaders, and the condition of gear upon retrieval (Figure 11). Forty-six percent of observer program respondents reported they collect leader material, and 33% of data users ranked this as critical or preferred. Forty-two percent of observer program respondents reported they collect leader length, and 37% of data users ranked this as critical or preferred. The condition of the gear upon its retrieval is of interest to fishermen and fishery managers from an economic perspective. Forty-two percent of observer program respondents reported they collect this variable, and 26% of data users rank this as critical or preferred (Figure 11).

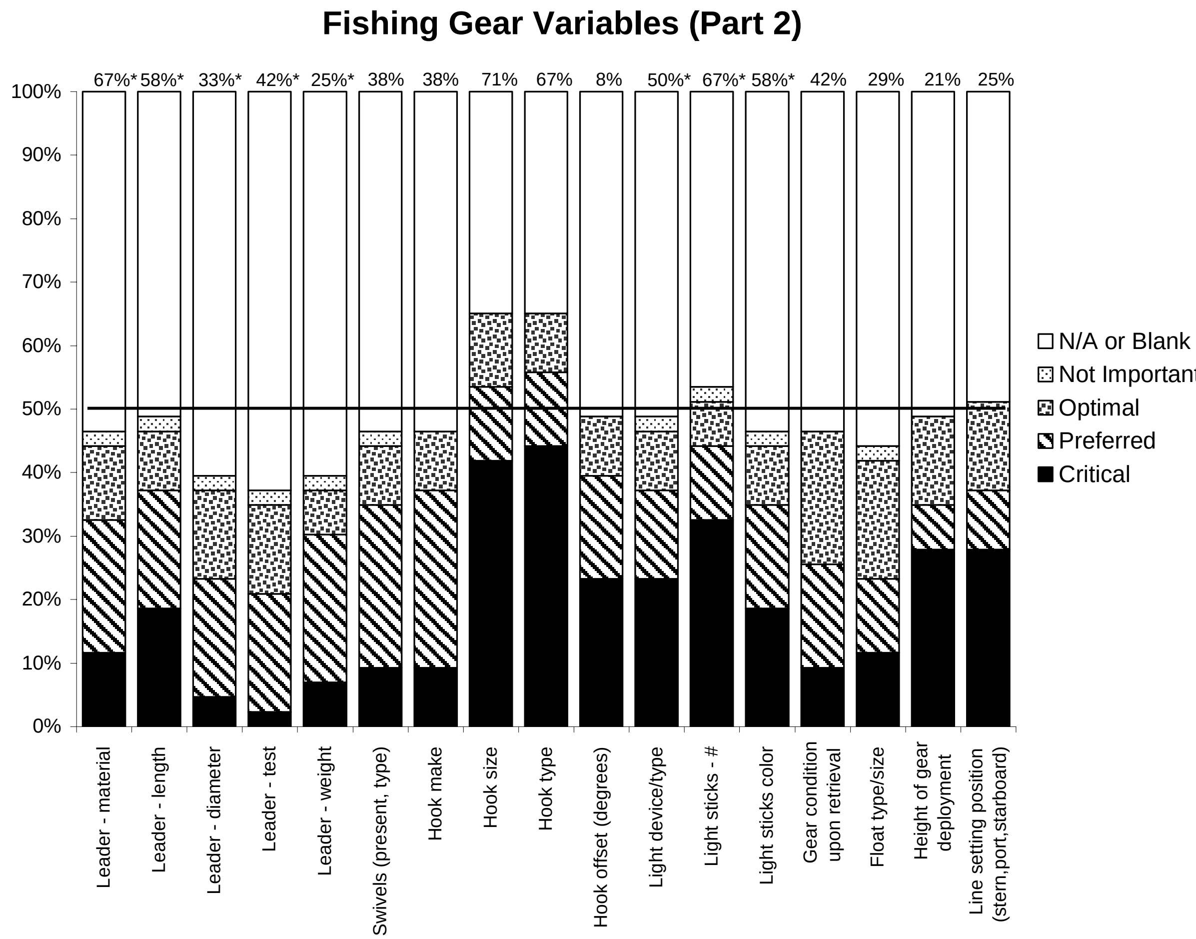

Figure 11: Ranking by data user respondents (n=-43) of the relative importance of some of the fishing gear variables included in the survey (see also Figure 10). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables. Those marked with * represent only respondents from pelagic fisheries (n=12), as these variables are generally not collected for demersal longline fisheries.

Catch Information

Catch information is data collected on the catch, number and weight of species sampled, and observed effort (Figure 12). Variables include actual or estimated total catch, catch weight by species, catch number by species, and the number of hooks sub-sampled upon both deployment and retrieval. The total catch estimate is the total estimated catch per set (weight or number), including target and bycatch species. Fifty-eight percent of data user respondents ranked this variable as critical or preferred, and 88% of observer program respondents indicated they collect this information (Figure 12). Less than half of those programs reported this variable as easy to collect, with approximately 65% of programs stating that this information was moderately easy to obtain.

Catch weight by species is the weight of a sub-sample of a specific species of fish. This variable was ranked as critical or preferred by 53% of data user respondents (Figure 12). Seventy-five percent of all observer program respondents (and 92% of demersal fishery programs) indicated they collect this information, with approximately 70% of those programs ranking this variable as moderately easy to collect. Catch number is a direct count of each species in the sub-sample. This variable was ranked as critical or preferred by 53% of respondents and reported to be collected by 38% of observer program respondents (and 50% of pelagic fishery programs).

The number of hooks sub-sampled by observers, during both *deployment* and *retrieval* of the gear, was considered a critical variable by 49% of the data user respondents and preferred by 7% and 5% of data users, respectively. Eight percent of observer program respondents indicated they record the number of hooks sub-sampled during *deployment,* and 54% of programs reported they record the number of hooks sub-sampled during gear *retrieval*. This information was ranked as easy to moderately easy for most programs to collect. The inclusion of these variables in the survey was intended to address situations when not every hook was monitored during gear deployment and retrieval, but it did not specifically ask whether observers routinely sub-sample the gear (as opposed to observing 100% of the hooks) (Figure 12).

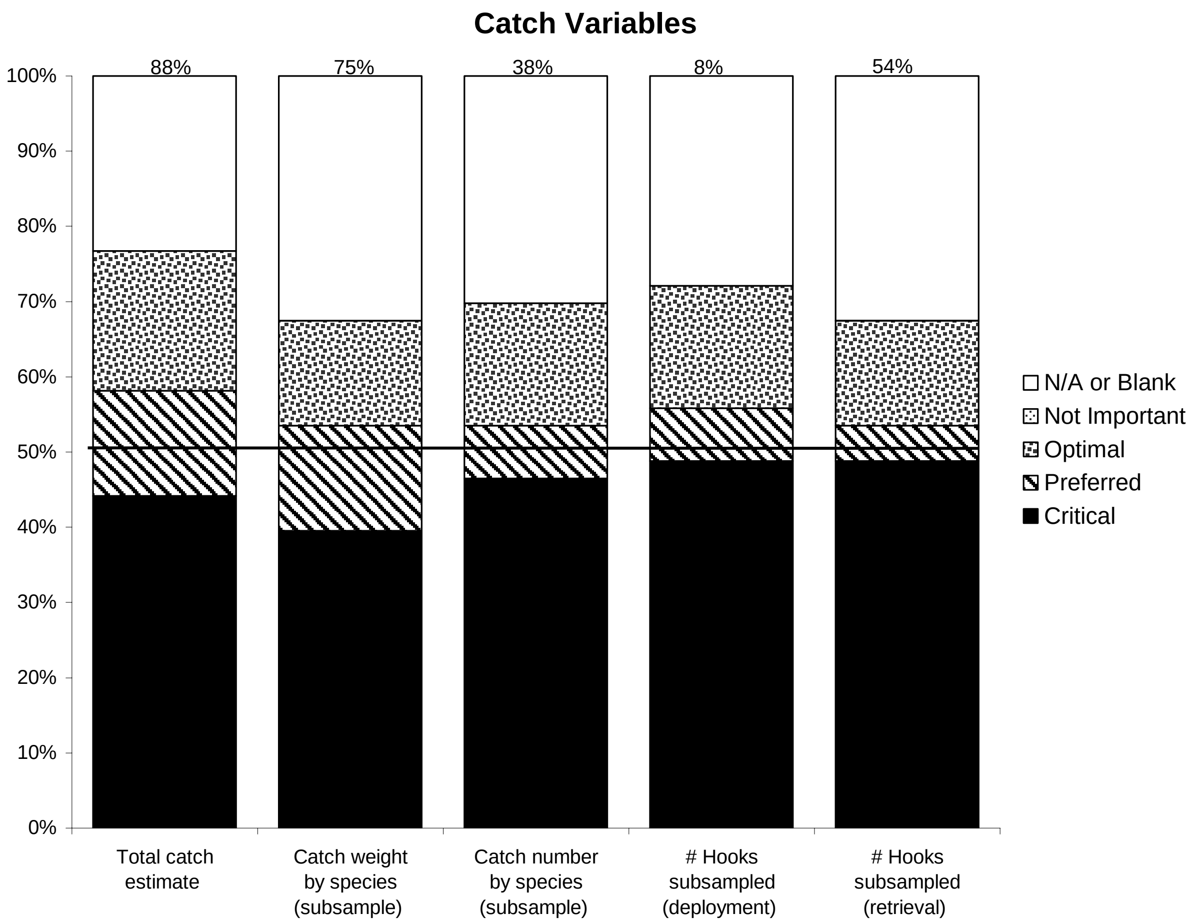

Figure 12: Ranking by data user respondents (n=43) of the relative importance of catch variables included in the survey. The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables.

<u>Mitigation Methods and Deterrent Devices</u>

Bycatch reduction methods and deterrent devices are those methods or devices used to reduce or deter the incidental catch of non-target species. The survey included references to some commonly used methods and devices, but did not specify which bycatch species the mitigation methods or deterrent device was targeting. Variables included in this portion of the survey also included questions pertaining to possible depredation on fish catches by marine mammals. In addition to asking general questions regarding whether deterrent devices were used and how well they performed, survey respondents were asked to rank the importance of collecting information on the use of 13 specific bycatch reduction methods or deterrent devices: towed buoys, streamer/tori lines, line shooters, setting gear below surface, weights on gear (groundline and branchline), water shooter/spray, deflating swim bladder of bait, blue-dyed bait, discharging offal strategically, deploying hooks outside the wake of the vessel, night setting, and the use of acoustic alarms (Figures 13 and 14).

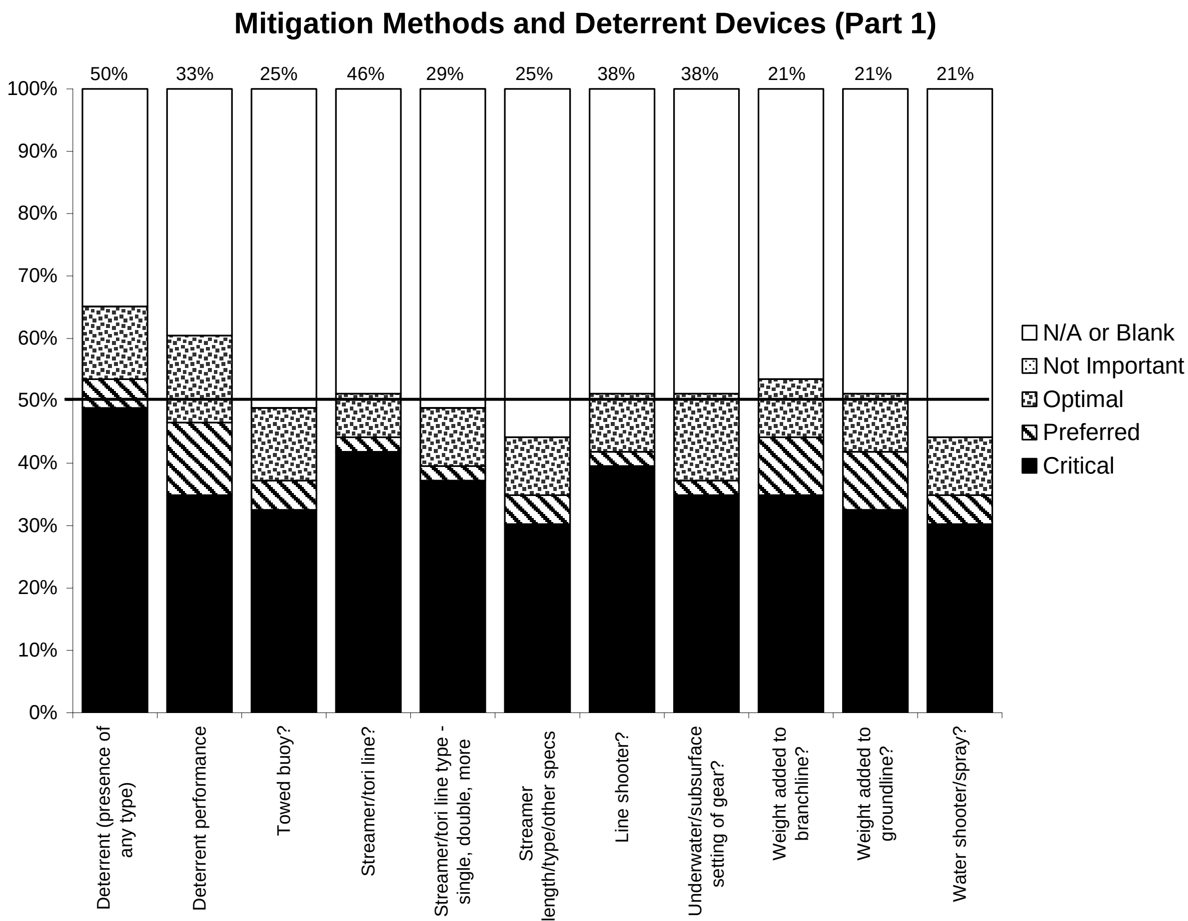

Figure 13: Ranking by data user respondents (n=43) of the relative importance of some incidental catch deterrent methods or devices included in the survey (see also Figure 14). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables.

The presence or absence of a mitigation device or technique was ranked as critical or preferred by 58% of data user respondents and reported to be collected by 40% of observer program respondents. The majority of those programs ranked the presence or absence of mitigation devices or techniques as easily ascertained information (Figure 13). None of the other variables included in this section of the survey had a combined critical and preferred ranking of >50% and results were similar for all measures included in the survey. Several programs noted that even if the use of deterrents is not formally monitored by observers, observers may record this information on haul log forms, logbooks, or vessels surveys. Another issue raised was whether the methods or devices referred to in the survey might be used for purposes other than bycatch reduction.

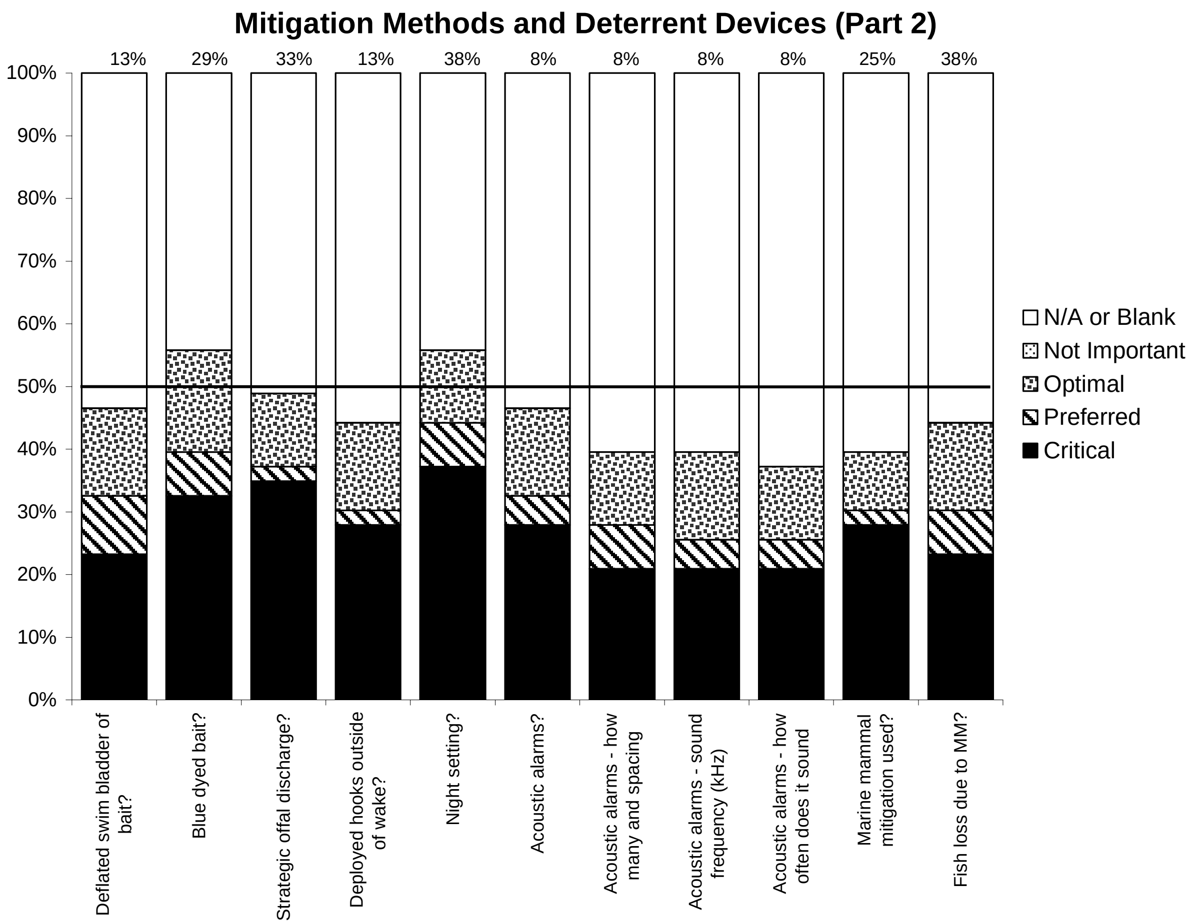

Figure 14: Ranking by data user respondents (n=43) of the relative importance of some incidental catch deterrent methods or devices included in the survey (see also Figure 13). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables.

Sea Turtles

Sea turtle variables included data on sightings and interactions (Figures 15 and 16). Sighting variables were species, number, and behavior. Interaction variables were: whether the turtle interacted with the gear; the location and water temperature where the sea turtle was captured; species of turtle taken (by number and weight); where the turtle was taken on gear and the distance to light devices or other gear parameters; how the turtle was caught on the gear (hooked/entangled/both); how the hook was removed; amount of gear left on the turtle upon release; viability of turtle; location upon release (Figure 15); whether an ID form was filled out and/or pictures were taken; whether the turtle was scanned for pit or external tags; various body size measurements; presence of lesions/injuries; sex (if possible); and color of the turtle (Figure 16). Only responses from the 20 data users that work with sea turtles were included in analyses, and only 22 of the 24 observer programs were included in calculations of % of program respondents that reported they collect each variable (fisheries observed by CCAMLR and the

North Pacific Groundfish Observer Program do not operate in areas where sea turtles are distributed).

Sea turtle sighting information (species involved, number, and behavior) was ranked as critical or preferred by 65% of data users, and 59% of observer program respondents reported they collect this information (Figure 15).

Interaction information specific to whether or not an interaction occurred between sea turtles and the vessel or gear was ranked as critical or preferred by 65% of data users and reported to be collected by 50% of observer program respondents (Figure 15). Several variables related to actual interactions were of high priority to data users. The number of turtles taken by species was ranked as critical by 70% of data users and reported to be collected by 91% of observer program respondents. The majority of those programs ranked catch number by species as an easy variable to collect. Where the sea turtle was taken on the line (e.g., hook #) was ranked as critical or preferred by 65% of data users and reported to be collected by 23% of observer program respondents. The temperature of the water upon capture was ranked as critical or preferred by 50% of data users and reported to be collected by 9% of program respondents. The proximity to the closest light device was ranked as critical or preferred by 50% of data users and reported to be collected by 18% of observer program respondents. Whether there was a light stick on the branchline/gangion and the color of the light stick was ranked as critical or preferred by 55% of data users and reported to be collected by 14% of observer program respondents (Figure 15).

The type of interaction and the outcome of the interaction were of high priority to data users. Sixty-five percent of data users ranked whether the animal was hooked/entangled/both as critical, and 55% of observer program respondents stated they collect this information (Figure 15). Where the turtle was hooked or entangled was ranked as critical or preferred by 60% of data users and reported to be collected by 32% of observer program respondents. How the hook was removed was ranked as critical by 55% of data users and reported to be collected by 36% of observer program respondents. How much gear was left on the animal upon release and the viability of the turtle upon release were ranked as critical or preferred by 60% of data users and reported to be collected by 55% of observer program respondents. More than half of observer program respondents regarded viability as moderate to difficult to collect. Capture position (latitude/longitude) was ranked as critical by 65% of data users and reported to be collected by 64% of program respondents. Release position (latitude/longitude) was ranked as critical by 50% of data users and reported to be collected by 18% of program respondents (Figure 15).

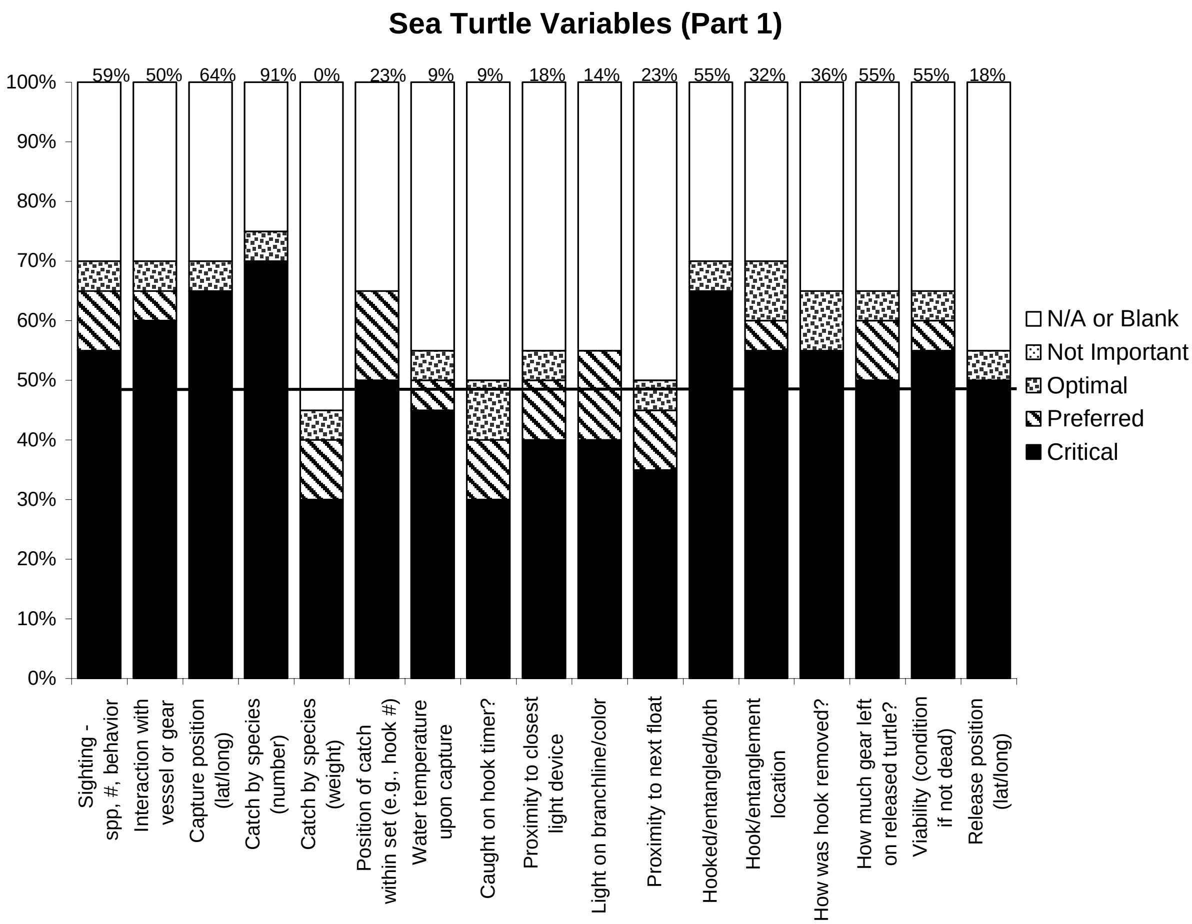

Figure 15: Ranking by only those data user respondents that use sea turtle data (n=20) of the relative importance of collecting the variables pertaining to sea turtle incidental catch included in the survey (see also Figure 16). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=22) that currently collect each of the variables.

Obtaining information to confirm species identification was a high priority for data users. Having observers complete turtle identification forms, take photographs, or both was considered critical or preferred by 65% of respondents, and 59% of the program respondents reported they collect this information (Figure 16). Over 55% of those programs ranked these variables as easy to collect. Some program respondents suggested that three or more photographs be taken of each turtle, including a dorsal, ventral and frontal view. Whether there were any external tags on the animal was ranked as critical or preferred by 55% of data users and reported to be collected by 64% of program respondents (Figure 16).

Certain variables related to the life history of sea turtles were of priority to data users respondents. Curved carapace length was ranked as critical or preferred by 55% of data users and reported to be collected by 41% of observer program respondents (Figure 16). Collection of skin biopsies from live sea turtles was ranked as critical or preferred by 60% of data users and reported to be collected by 27% of observer program respondents. Sex (as determined from blood samples) was ranked as critical or preferred by 55% of data users and reported to be collected by 14% of program respondents. Over 90% of the programs that report collecting this variable refer to it as moderate to difficult to collect. It should be noted that U.S. observer programs are prohibited from collecting blood from sea turtles due to Endangered Species Act permitting and training issues.

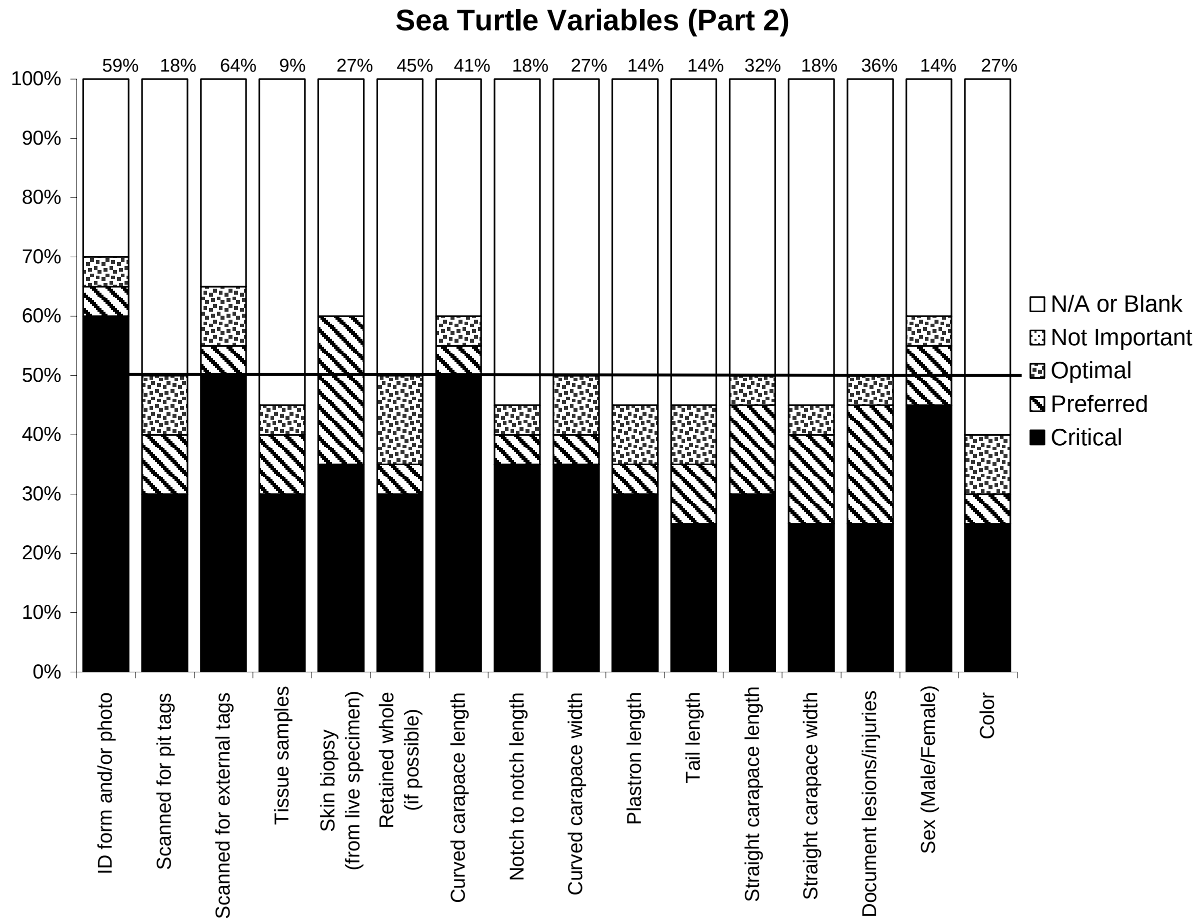

Figure 16: Ranking by only those data user respondents that use sea turtle data (n=20) of the relative importance of collecting the variables pertaining to sea turtle incidental catch included in the survey (see also Figure 15). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=22) that currently collect each of the variables.

Marine Mammals

There were 29 variables in the survey related to data on marine mammals sighted or incidentally caught (Figures 17 and 18). These variables included sighting information (species, number, and behavior), as well as oceanographic conditions associated with sightings, such as sea surface temperature (SST), Beaufort sea state, and weather (Figure 17). Variables also included: whether there was an interaction with gear; species of marine mammal taken (by number and weight); position of catch on gear (i.e., hook number); viability of the marine mammal upon release;

whether an identification form was filled out and/or photograph was taken; whether tissues samples and biopsies were collected, whether the animal was collected in whole or in part; sex (Figure 17), if female, whether she was lactating, had a fetus, and its length; and whether a canine tooth was collected for pinnipeds, body temperature, blubber thickness (Figure 18). Not included in the survey was the location of the capture (latitude/longitude), but this information can be derived with some accuracy by knowing the location of the set, the position of the catch on the gear, and the hauling direction. Only responses from the 21 data users that work with marine mammals were included in analyses; all 24 observer program responses were included.

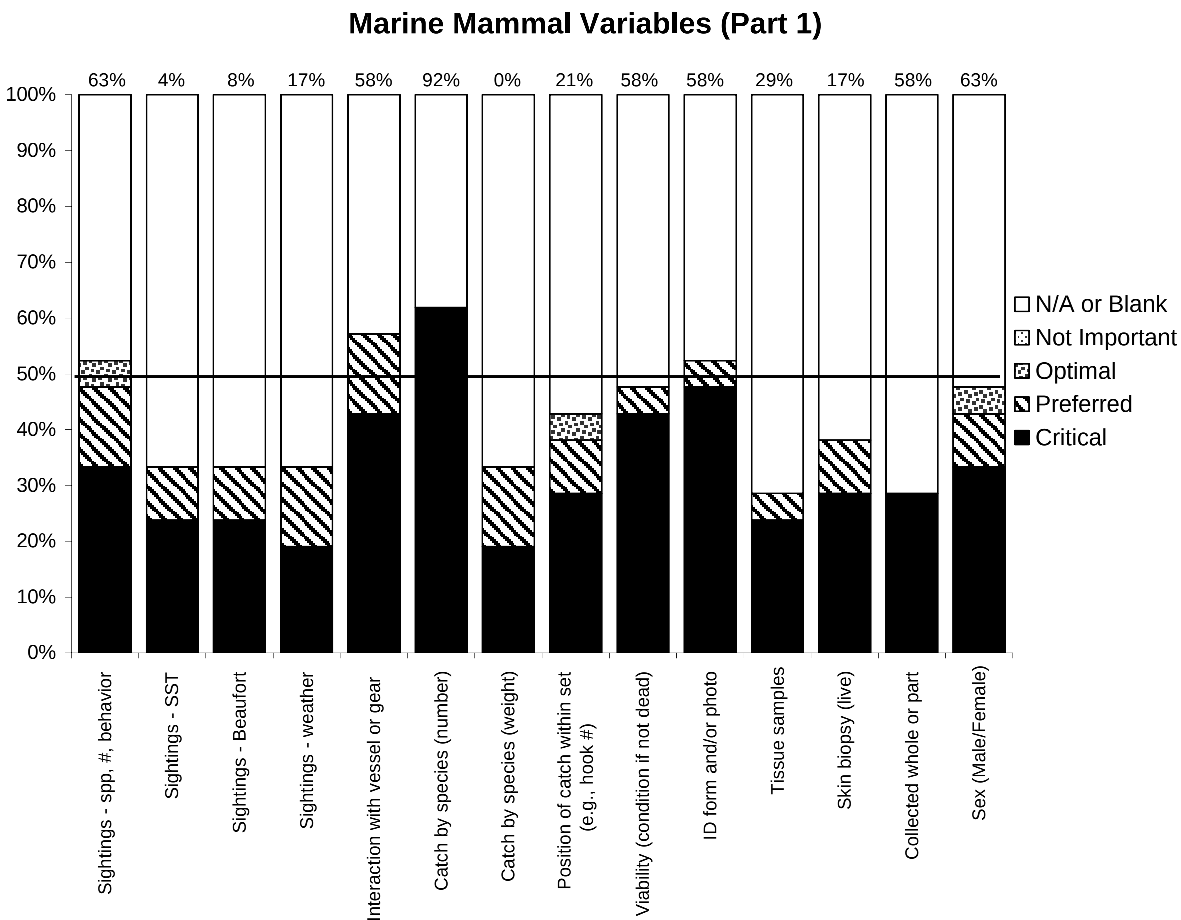

Figure 17: Ranking by only those data user respondents that use marine mammal data (n=21) of the relative importance of collecting the variables pertaining to marine mammal incidental catch included in the survey (see also Figure 18). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of the observer program respondents (n=24) that currently collect each of the variables.

Only a handful of variables were of high priority to data users, as evidenced by having 50% or more of data users ranking them as critical or preferred. Whether there was an interaction with the vessel or gear was ranked as critical or preferred by 57% of data users and reported to be collected by 58% of observer program respondents (Figure 17). The number of marine mammals caught by species was ranked as critical by 62% of data users and reported to be collected by 92% of observer program respondents. Over 60% of observer program respondents considered this information easy to collect. Species identification forms and/or photographs were ranked as critical or preferred by 52% of data users and reported to be collected by 58% of observer program respondents. Half of those programs felt the collection of this information was easily accomplished. Total length of the animal was ranked as critical or preferred by 52% of data users, and 46% of observer program respondents indicated they collect this information (Figure 18).

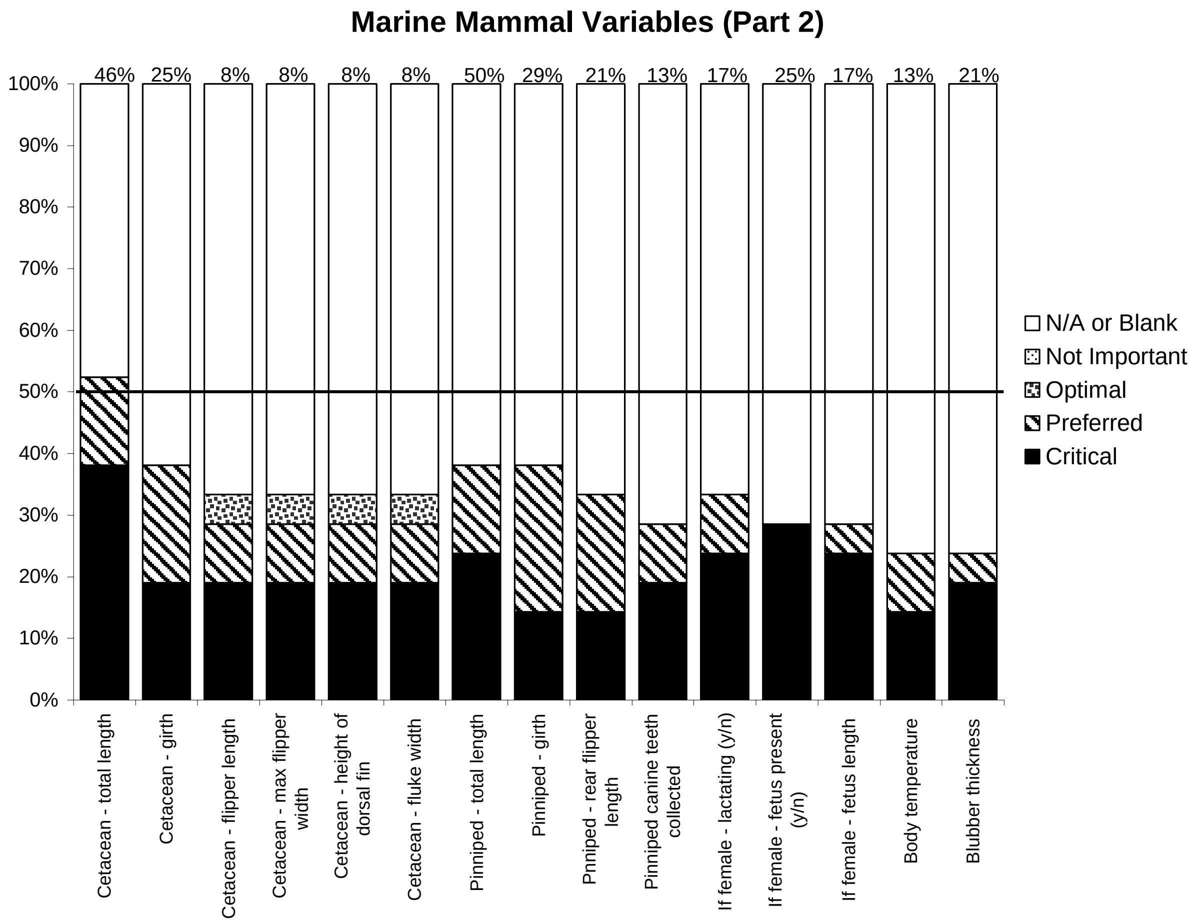

Figure 18: Ranking by only those data user respondents that use marine mammal data (n=21) of the relative importance of collecting the variables pertaining to marine mammal incidental catch included in the survey (see also Figure 17). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables.

Seabirds

Seabird variables included sightings and interaction data (Figures 19 and 20). Sighting variables included species, number, and behavior. Interaction variables included: whether there was an interaction with gear during deployment and retrieval; abundance of seabirds during deployment; interaction rates during deployment; species of seabird taken (by number and weight); position of catch on gear (i.e., hook number); proximity to light device; proximity to float (Figure 19), proximity to added weight; location of hook on body; viability of the seabird upon release (if alive), whether an identification form was filled out and/or photograph was taken; whether tissues samples were collected; the presence of a band or other tagging device; whether the carcass was collected; and sex, age (e.g., juvenile, subadult, adult), and molt condition (Figure 20). Not included in the survey was the location of the capture (latitude/longitude), but this information can be derived with some accuracy by knowing the location of the set, the position of the catch on the gear, and the hauling direction. Only responses from the 26 data users that work with seabirds were included in analyses. All 24 observer program responses were included.

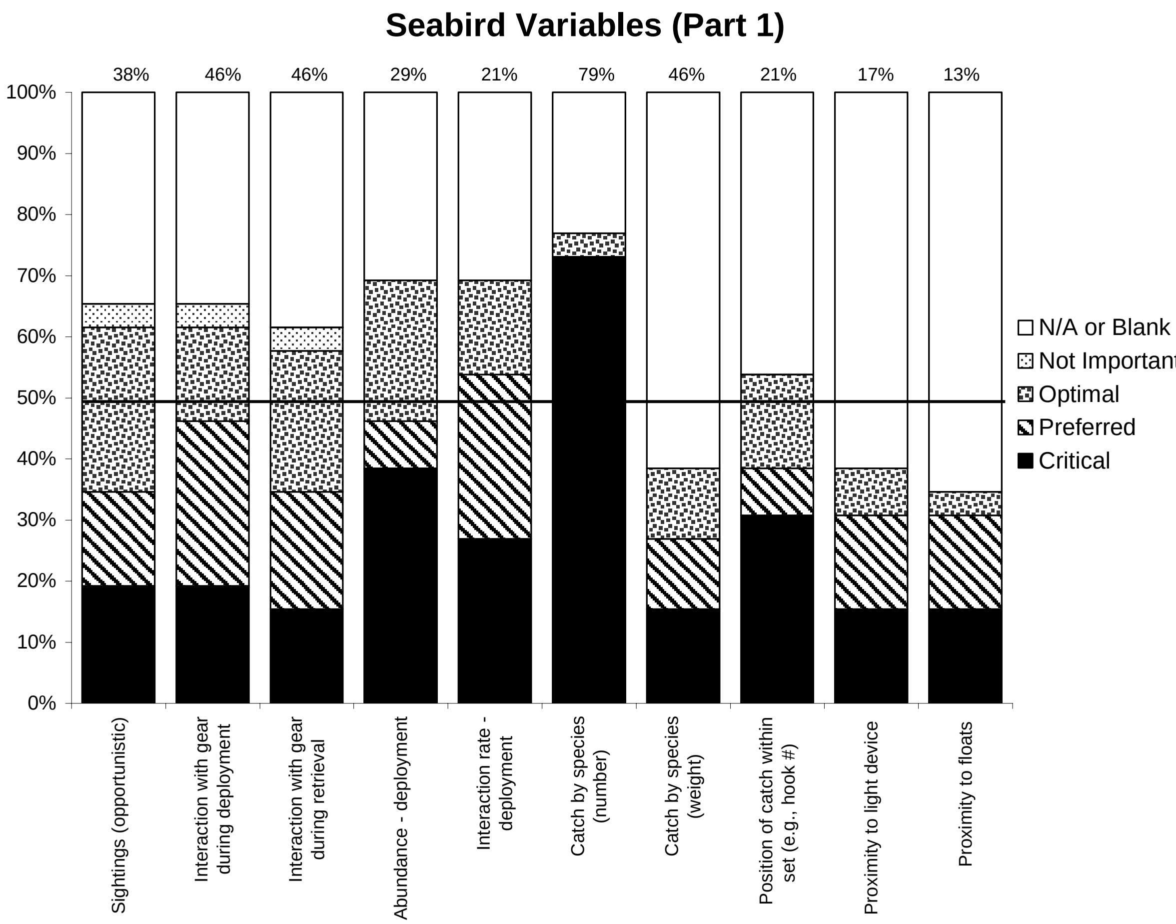

Figure 19: Ranking by only those data user respondents that use seabird data (n=26) of the relative importance of variables related to incidental catch of seabirds included in the survey (see also Figure 20). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables.

Interaction rate during deployment was ranked as critical or preferred by 54% of data users and reported to be collected by 21% of observer program respondents (Figure 19). The number of seabirds caught by species was ranked as critical 73% of data user respondents and reported to be collected by 79% of observer program respondents. Over 70% of those programs responded this was easy information to obtain. One issue raised by data users was whether or not a distinction is made between those birds caught during gear deployment, and those caught during gear retrieval.

The location of the hook on the animal was ranked as critical or preferred by 54% of data users and reported to be collected by 46% of program respondents (Figure 20). The viability of the animal if released alive was ranked as critical or preferred by 50% of data user respondents and reported to be collected by 54% of observer program respondents. Of those programs, over half considered this variable as easy to collect. The use of a species identification form and/or the taking of photographs were ranked as critical or preferred by 58% of data user respondents and reported to be collected by 63% of the observer program respondents. Half of those programs indicated these variables were easy to collect, and the other half indicated they were moderate to difficult to collect.

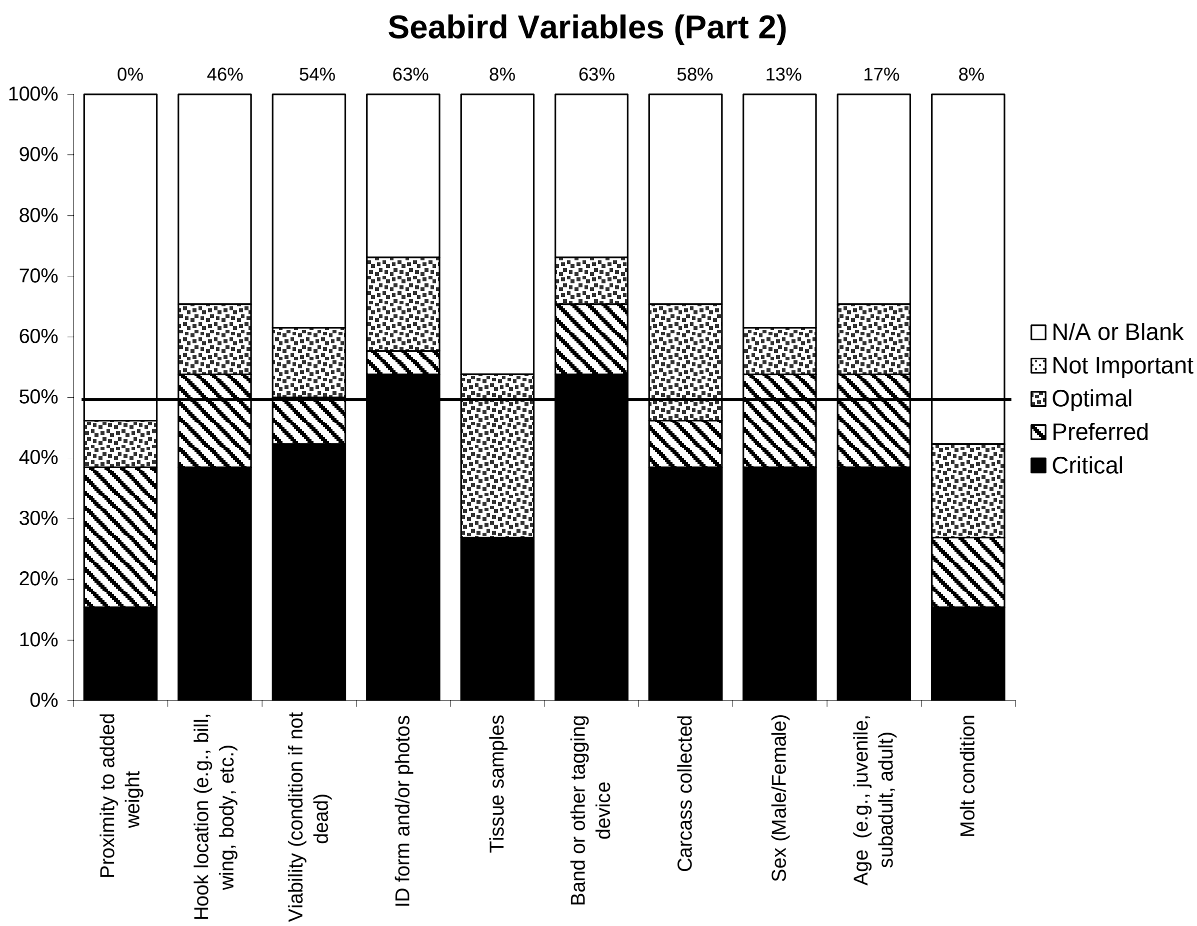

Figure 20: Ranking by only those data user respondents that use seabird data (n=26) of the relative importance of variables related to incidental catch of seabirds included in the survey (see also Figure 19). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables.

Whether there was a tag or band on the animal was ranked as critical or preferred by 65% of data users and reported to be collected by 63% of program respondents. Gender and age were both ranked as critical or preferred by 54% of data users, and 13% and 17%, respectively, of observer program respondents reported they collect these variables. The programs ranked gender as moderate to difficult to collect. This variable is most often derived from carcasses sent to seabird experts. Age in seabirds is categorized as juvenile, sub-adult, or adult. This is most often determined by examining the plumage in order to estimate the current stage of a bird's life cycle. Observers are often supplied with field guides that include different stages of plumage in certain species, but again this may be difficult to assess except by seabird experts.

Elasmobranchs – Sharks, Skates, and Rays

There were 13 variables included in the survey related to the incidental capture of sharks, skates and rays (Figure 21). Variables included identification to species, sex, total length, fork length (sharks only), distance from the 1st to the 2nd dorsal fin (D1 to D2; sharks only), clasper length (sharks only), disc width (skates and rays only), disposition, and whether a tag was present (sharks only). Only responses from the 15 data users that work with these animals were included in analyses. All 24 observer program responses were included.

For sharks, data users ranked identification to species, sex, fork length, disposition upon release, and whether a tag was present as critical or preferred. Identifying the animal to species was ranked as critical by 73% of data user respondents, and this information was reported to be collected by 100% of observer program respondents (Figure 21). Approximately 30% of these programs considered this variable easy to collect, the other respondents ranked it moderately easy to determine. Usually observers are equipped, by the observer program, with a field guide to assist with the identification of species. Sex determination was ranked as critical or preferred by 67% of data user respondents and reported to be collected by 63% of observer program respondents. Ninety percent of those programs considered sex easy to determine. Fork length was ranked as critical or preferred by 53% of data user respondents and reported to be collected by 67% of observer program respondents. Disposition was ranked as critical or preferred by 53% of data user respondents and reported to be collected by 50% of observer program respondents. The presence of a tag was ranked as critical or preferred by 60% of data user respondents and reported to be collected by 75% of observer program respondents. Over 60% of those programs responded that the presence of a tag was easily recorded, while the remaining respondents ranked this variable as moderately easy to collect.

For skates and rays, critical or preferred variables included identification to species, sex, total length, and disposition upon release. In general, less information is collected from skates and rays than from sharks. Identification to species was ranked as critical or preferred by 73% of data user respondents and reported to be collected by 79% of observer program respondents (Figure 21). Sex was ranked as critical or preferred by 60% of data user respondents and reported to be collected by 50% of observer program respondents. Total length was ranked as critical or preferred by 53% of data user respondents and reported to be collected by 38% of observer program respondents. Disposition upon release was ranked as critical or preferred by 53% of data user respondents and reported to be collected by 50% of observer program respondents.

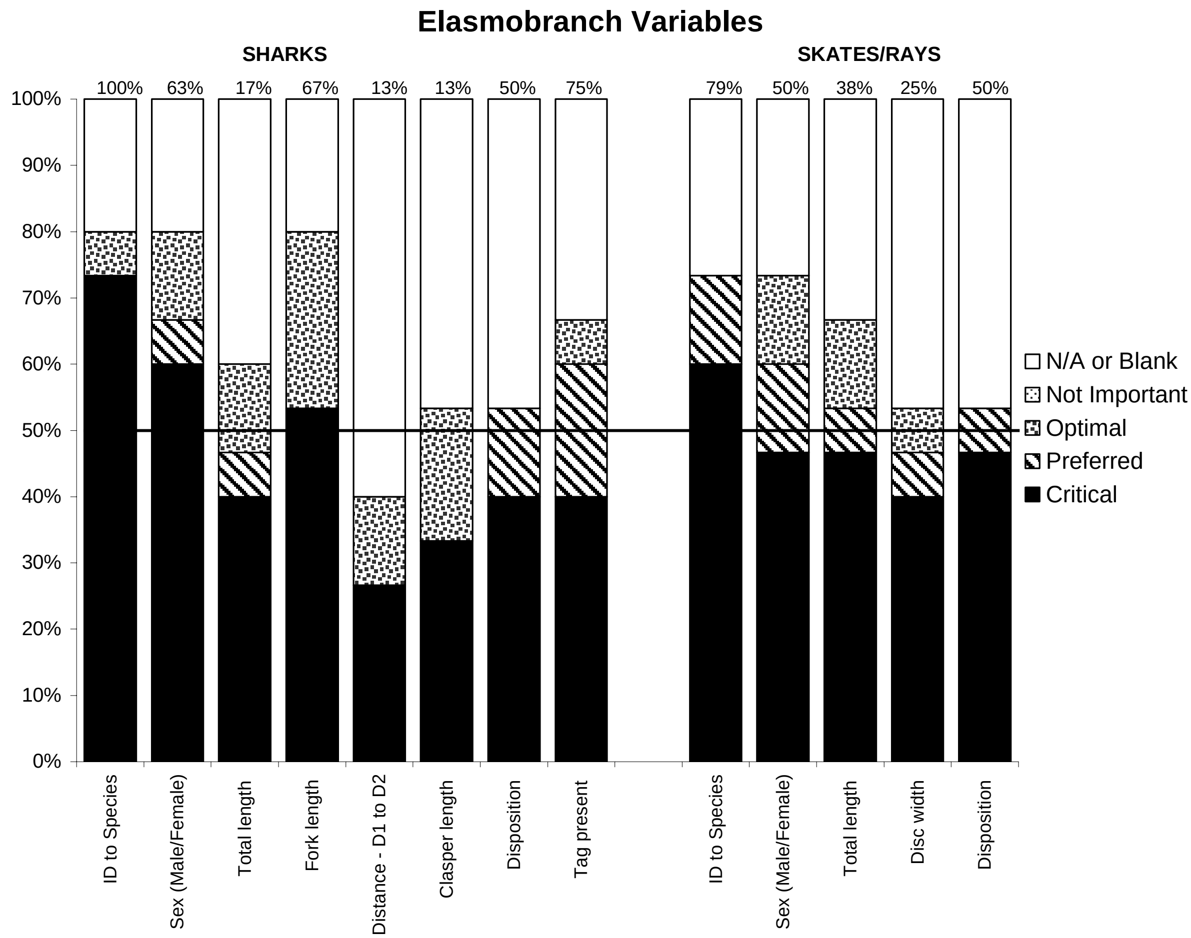

Figure 21: Ranking by only those data user respondents that use data on elasmobranchs (n=15) of the relative importance of variables related to incidental catch of elasmobranchs included in the survey. The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents (n=24) that currently collect each of the variables.

Billfish

There were 16 variables included in the survey related to the incidental catch of billfish (Figures 22 and 23), and 4 additional variables relating to incidental catch of swordfish (Figure 23). Variables included: the disposition of the fish when caught; was it retained in whole or in part; was it damaged and, if so, what type of damage; were tags present; were tags attached to the billfish upon released; were biological samples collected; were ripe running eggs collected; was sex determined; was a photograph taken to document species identification or damage; and were various measurements made (eye to fork length, cleithrum to keel, half girth, lower jaw to for length, pectoral to fork length, and other measurements). Of these variables, several were considered a high priority for data collection, including: sex, whether a tag was present, and whether a photograph was taken (Figure 22), and the lower jaw to fork length (Figure 23).

For swordfish, collection of the anal fin ray was considered a high priority (Figure 23). Only responses from the 9 data users that work with these animals were included in analyses, and only responses provided by programs observing pelagic fisheries were include (n=12). These variables were not discussed in any detail at the workshop due to time constraints, but are included here for reference purposes.

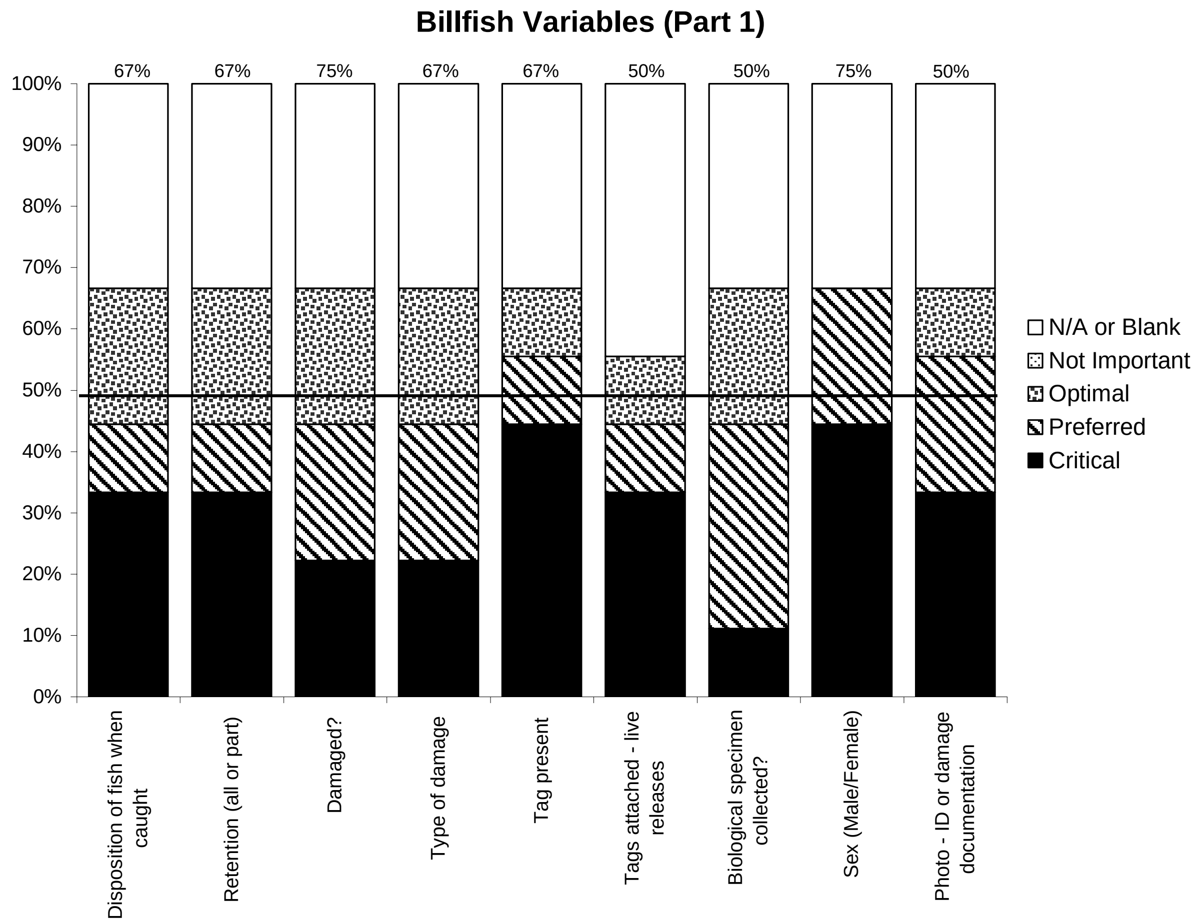

Figure 22: Ranking by only those data user respondents that use data on billfish (n=9) of the relative importance of collecting the variables pertaining to incidental catch of billfish included in the survey (see also Figure 23). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents from pelagic fisheries only (n=12) that currently collect each of the variables.

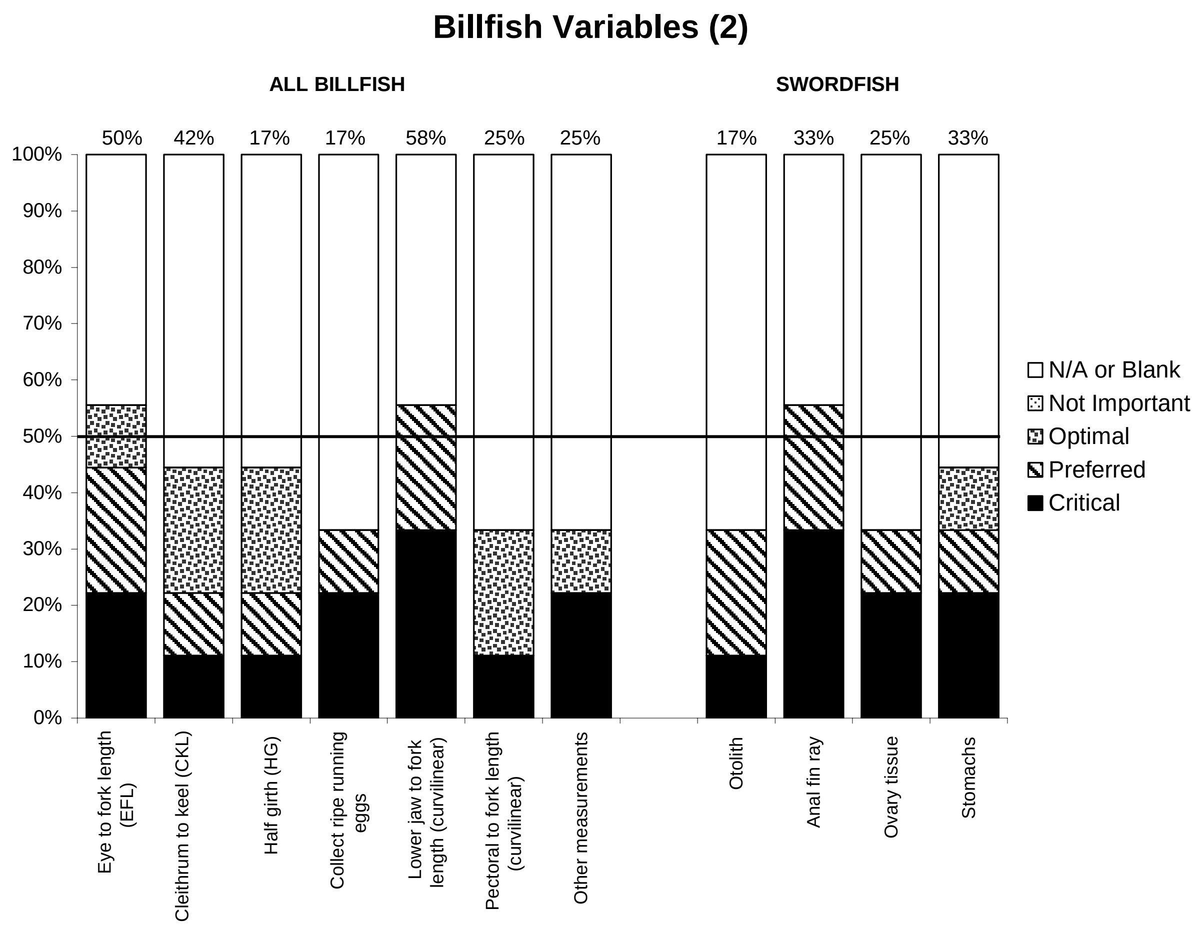

Figure 23: Ranking by only those data user respondents that use data on billfish (n=9) of the relative importance of collecting the variables pertaining to incidental catch of billfish (and specifically swordfish) included in the survey (see also Figure 22). The 50% line is provided as a reference point to indicate whether a majority of data users ranked each variable as a high priority for data collection. Along the top is the % of observer program respondents from pelagic fisheries only (n=12) that currently collect each of the variables.

WORKSHOP DISCUSSIONS

I. General Discussion on the Need to Develop Best Practices for Observer Data Collections

Workshop participants were asked to consider the following issues: (a) what variables should be included in best practices for longline monitoring programs; (b) were variables missed in the pre-workshop questionnaire that are currently being collected or that should be collected; (c) what methodologies are used to collect these variables (i.e., do the variables mean the same thing in different programs), and do these methodologies need to be more consistent throughout the various programs worldwide; (d) can some variables be derived rather than collected, thereby lessening the workload for observers; and (e) what gear and equipment does an observer need to collect the information. Participants discussed which variables to include in best practices, but in the broader context of program priorities and core responsibilities.

The purpose of the workshop was to focus on data collection for the purpose of facilitating research and analysis to reduce bycatch. Yet many of the programs represented in the pre-workshop survey were originally developed for sustainable fisheries purposes. In only a few cases, observer programs were set up specifically to collect information on bycatch. The pre-workshop survey did not distinguish between "core" data elements developed for specific purposes (fisheries, bycatch), versus those data elements that might be collected in a research situation. Some participants felt the real value of observer data is the consistent collection of core data elements over the long-term. Others felt that these institutionalized, long-standing programs lack the flexibility to incorporate data collection for emerging research questions. A challenge is to adapt existing observer programs for other data uses. Data elements that meet both fisheries and bycatch objectives must be identified, and additional data collection must not conflict with observers' core responsibilities. The ideal would be for observer programs worldwide to meet these multiple objectives.

Several participants highlighted their programs' initiatives to meet multiple objectives. In New Zealand, there is one central agency providing the majority of government-funded observer services, and two major departments within that agency that require different types of information. The Department of Conservation addresses marine mammal and seabird bycatch, and the Ministry of Fisheries ensures the sustainability of fisheries. In some cases, gathering data for one purpose conflicts with data collection for the other. The Ministry of Fisheries has undergone a comprehensive review to make sure that the observer program policies support the linking of these two disparate requirements, and that the data are standardized and can be used globally as well as locally. In addition, the integrity of some of the data collected by the fishing industry has been questioned. The development of data collection standards has allowed enhanced sharing of data between departments and the industry.

The Forum Fisheries Agency (FFA) reported that all 13 observer programs in the central Western Pacific collect data for research and fisheries sustainability, but they are also responsible for collecting compliance data. Therefore, certain data fields, such as the vessel owner's name, may not be important to data users working with bycatch but may be very important to other user groups for compliance purposes.

A Canada Department of Fisheries and Oceans (DFO) participant from the east coast reported that most of their data (95%) is gathered for scientific purposes, but the program falls within the enforcement division (Conservation and Protection). When a violation occurs, the observer's primary task becomes the investigation and documentation of the possible violation. Data collection by the observer is then focused on the violation and other data collections become secondary.

A CCAMLR participant indicated that their data scheme breaks the observer program into three categories: bycatch, stock assessment, and factual information that can be used for compliance purposes. For exploratory fisheries where information on both bycatch and stock assessment are needed, CCAMLR assigns two observers to provide greater coverage of all different aspects of data collection. CCAMLR has a core set of data for all three categories. In addition, member nations may add to data collection requirements (e.g., tissue collection for genetics). A problem arises when observers become overloaded with data collection requirements for both CCAMLR and their own nation. The CCAMLR participant noted that any additional work assigned to observers is reviewed on an ongoing basis. Based on these reviews, CCAMLR adjusts observer priorities and actually removes data elements that are no longer needed. A review process should be an essential part of all observer programs.

An Argentina (INIDEP) participant indicated their program provides stock assessments to the application authority and aso provides researchers working in the INIDEP institute with data to support research on different species and projects. Observer programs are designed to provide data for these INIDEP researchers. For example, since 2000, INIDEP researchers developed a protocol for data collection for the Patagonian toothfish. The observers employ the protocol for Patagonian toothfish while working on different species on the same trip and vessel. INIDEP is planning a new system for observers to make observations for a complete dataset that will allow data users to collect only the data that they need. They hope to have this in place by 2006.

Despite the diversity in observer program objectives, best practices can be developed and incorporated into programs throughout the world. As a first step, minimum data elements to be collected in every program should be identified. These minimum data elements should allow for the development of a baseline assessment of bycatch, especially for fisheries that currently lack observer coverage. Collection of data that helps to determine the cause and effect of bycatch should be the second step. Variables collected need to focus on what is being caught and why in order to mitigate the interactions. However, because so many variables are collected, there may be a masking of what factors are ultimately responsible for causing bycatch. Managers need to fine-tune which variables should be collected to determine why bycatch is occurring, and use this information to develop measures to reduce bycatch. One commenter felt that "cause and effect" would best be determined in a research environment, due to the number of variables that might need to be collected to determine the cause of bycatch of a particular species.

A U.S. participant noted the Atlantic pelagic longline observer program has been collecting sea turtle bycatch data for about 4 years, and the program worked closely with sea turtle researchers to determine what data needed to be collected. However, this collaboration had not yet occurred with the data users for the collection of marine mammal and seabird data elements. Researchers and observer programs need to initiate a dialogue to determine what information is needed and what data can feasibly be collected. Another commenter noted that observer programs may need to take the initiative to determine what changes are needed. Observer programs could suggest a framework for collection of bycatch data and have the data users review and provide input on the framework.

Protocols exist for some programs to survey their data users. This feedback may be straightforward when a program knows who its data users are; however, when a researcher who is not that program's "first" customer is tapping observer program data, then the identification of these data gaps may be an important tool. An observer program may not be able to answer a question that has yet to be asked, yet it can fully document the purpose and associated parameters for which the data are collected. The difficulties with designing programs for data users are that users may not have developed their questions yet, they may be looking at data retrospectively, and/or they may be trying to use data for a purpose it was not designed to meet. Difficulties can be minimized if observer programs develop good metadata and make that available to all data users.

Because observers are limited in what they can collect, observers should have a clear sense of program priorities and what can be collected as time permits. Prioritizing data collection is critical. How data gaps are addressed must take into account the current workload of observers. Some of the data gaps may be easily addressed, others would entail a huge addition to an observer's workload. The health and safety of the observer is paramount and should also be considered when establishing data collection priorities and workload requirements.

Clear directives regarding priorities for data collection are needed from the agencies requiring the information. When an observer is confronted with two or three tasks, he/she needs to know which task to work on first. New Zealand has an observer forum that includes Ministry of Fisheries observer program staff, compliance staff, and industry representatives. The forum works closely with the observer programs to work through conflicting priorities. They also have a research coordinating committee that coordinates with the observer programs to establish upcoming priorities. Forward planning allows observer programs to more efficiently meet the needs of the various entities requesting the data to be collected. Finally, there has to be the feedback from these entities in order for observer programs to evolve.

A participant from the Pacific Islands Observer Program (PIOP) agreed that a common problem occurs when programs add variables but are reluctant to remove variables. The fallback is "it must be there for a reason." A periodic assessment would be beneficial to determine what data variables are still relevant and which variables can be eliminated. Observer programs and their data users should maintain a dialogue to ensure that data collected are valid and reliable.

Many participants were concerned about how best to align data collection priorities across regional, national, and international observer programs. Many observer programs were designed to meet regional or fishery-specific data needs, and broader national or international data needs for bycatch research may not be understood or deemed a high enough priority. For example, seabird bycatch has been identified as a global priority by the FAO and many RFMOs. Yet, the NPGOP collects seabird bycatch information based on regional needs. The regional information may not 'feed' into the global effort to assess seabird bycatch. Priorities identified on a regional, national, and international level will provide observers with clear directives about what they should do on any given day on any given set.

International priorities for collecting bycatch data take time to filter down to a regional observer program. For example, CCAMLR has been proactive in collecting seabird data and requiring mitigation measures. CCAMLR requires observer coverage for participating countries as a condition of the vessel's permit. When these same vessels fish in their country's Economic Exclusive Zone, CCAMLR data may not be collected, and seabird mitigation measures may not be required. Efforts to standardize data collection and mitigation measures at the international level are needed. CCAMLR adopted a resolution to invite other RFMOs to work cooperatively to exchange information on common bycatch concerns. ICCAT has seabird and sea turtle resolutions but these have not been fully evaluated for effectiveness. Bycatch species of concern are highly migratory and cross national boundaries where they may interact with other RFMO fisheries. Countries within larger regions need to standardize bycatch data collection. Only then can impacts to species be accurately assessed.

Observer programs are also at various stages of development. Establishing data standards may result in some resistance as it would require programs to change their data forms and databases to accommodate additional variables. Thus, collecting certain data may need to be voluntary. Each program may want to conduct a periodic review to determine how best to incorporate the collection of standard data elements.

Communication between observer programs is essential to developing best practices, given similarities across programs. It is important not to reinvent the wheel regarding issues that have been dealt with in another fishery. In the Pacific, FFA monitors what happens in other programs, particularly the U.S. and Africa. This allows them to anticipate and proactively solve problems that may have come up in other countries. FFA convenes a meeting of all their programs every two years to decide what data the observers will collect in the coming years. They discuss emerging issues that may require additional data elements or increased observer coverage. FFA has collected data on dolphins, turtles, shark finning, and gear technology for several years. FFA believes these data will be useful because of the international interest in bycatch and the overlap between their fisheries and bycatch species of concern.

A PIOP participant noted minor, conflicting gear definitions at the regional and international level. Conflicting definitions may pertain to the gear or how the data are collected or both. Clear-cut definitions are needed for every data element being collected, and these definitions should be established for each data element. Information on standards for defining gear and variables can be shared in forums such as this workshop, or through electronic postings and virtual discussion groups.

For fisheries that are experiencing declines in effort, such as is the case for New Zealand fisheries, program managers need to assess observer coverage levels to maximize the amount of information collected. Managers need to be proactive and adapt data collection priorities to ensure critical issues facing declining fisheries are assessed.

To conclude, in order to implement best practices for data collections in longline fisheries, programs must prioritize their bycatch issues. Observer programs and data users need to communicate on what data should be collected. Observer programs need to communicate with each other on a regional, national, and international level. The survey conducted for this workshop was a start. Data elements recommended as a result of this workshop should be reviewed by data users to determine if these variables are the correct fields to collect and observer programs to determine whether these variables are feasible to collect. Programs also need to communicate with fishermen regarding the data that are being collected, especially when fishermen are paying for the program. Finally, programs should periodically assess their core data needs, and ensure that these needs are met. A data element that is core to one program may not apply universally. Periodic assessments will ensure unnecessary data elements are eliminated and new elements are valid. These program assessments should include discussions with data users who work on bycatch issues. Additional data elements must be feasible to collect. There is no international body to make specific recommendations regarding data collection for all bycatch species. However, this workshop lays out those variables considered by data users as having a high priority for data collection. Each program must decide how best to accommodate these priorities.

II. Discussion of Which Variables Should be Included as Best Practices

To determine what data should be collected across bycatch species, the recommendations from the data users were reviewed, and key data variables were identified. The collective experience and expertise of the participants at the workshop was then used to rank the variables for each species. Although the recommendations are in their infancy, there are similarities to recommendations from other workshops where specifics have been identified. Some of the data elements may be useful to address bycatch issues across species, whereas some may be more specific to certain species.

Most data users that conduct analyses on bycatch of protected species indicated they use the data primarily to assess total bycatch and secondarily to characterize the factors that influence bycatch (i.e., cause and effect).

There was not time for a separate discussion of data needs for sharks, skates, and billfish, but it was noted that the same critical variables noted below to be collected for marine mammals, seabirds, and sea turtles should also be collected for these species.

Spatial and Temporal Variables

Where and when the gear are deployed and retrieved (day and time) were identified as critical data variables. Precision may be critical if assessing correlations between bycatch and a particular habitat. On the other hand, confidentiality of fishing location data may conflict with precision. Precision of location should be to the tenth of a minute at a minimum. The source of this information can either be the ship's GPS or a hand-held GPS brought on board by the observer. One participant stated that their program provides observers with hand-held GPS units to ground-truth the ship's GPS. Some programs use the information recorded by the vessel captain or crew regarding location of gear deployment and retrieval, especially when the observer is working at some distance from the vessel's GPS.

Another variable that is important to data users, especially for marine mammals and sea turtles, is the location of the actual incidental take (this variable was included in the section of the survey that pertains to each species of bycatch). For pelagic gear, the position of the incidental take may not accurately represent where the take occurred because the gear drifts. An approximate location of the incidental take can be derived based on where the take occurred on the gear (e.g., which hook). The timing of the take may be more difficult unless a hook timer is used.

Physical and Environmental Variables

Participants noted that fishing depth (at beginning and ending of set), bottom depth (at beginning and ending of set) and sea surface temperature are physical and environmental variables that should be included in best practices. For demersal gear, only the beginning and ending bottom depth is needed, because bottom depth is the same as fishing depth. However, one participant countered that bottom depth does not necessarily equal fishing depth. For example, the Spanish type demersal gear consists of an extra floatline, which causes the hooks to fish some distance off the ocean bottom. In these cases, the program records the distance of the hooks off the bottom of the ocean. Measurement of other variables, such as hook depth range, would probably require additional instruments.

How fishing depth is defined may vary between programs. For instance, some observer programs derive fishing depth from the sum of other gear measurements. In the Atlantic pelagic longline fishery, the observers calculate fishing depth based on the sum of the floatline/dropline length plus the branchline/gangion length. Their calculations are double-checked by the program to ensure accuracy. Programs need to have clear cut definitions of how fishing depth is derived, so that data users understand what the variable represents. An average fishing depth, rather than depths taken at the beginning and ending of the set, may be more useful for bottoms of varying depth. Data users indicated they prefer observers to record bottom depth at the start and end of the set, so that multiple recordings would not have to be made. If an average is used, the number of data points (more than 2) should be based on the length of the line.

Sea surface temperature is critical, and most programs collect it. Wind speed was not considered as critical by the majority of survey respondents due to uncertainty about collection methods (i.e., instrumentation) and collection time (set, haul, or time of bycatch). Wind speed affects Beaufort sea state, which may not have a direct impact on bycatch, but it does affect the observer's ability to make accurate species identifications of marine mammals and turtles at sea, and may also impact the crew's ability to land target catch. Recognizing that some variables can be derived from other variables, there should be further discussion as to what variables need to be recorded and which can be derived. Moon phase is another example of a variable that does not need to be collected as it can be derived from date.

Vessel and Fishing Variables

Of the variables included for review, nine variables were considered critical: unique vessel ID, vessel length (how length is determined also needs to be clearly defined), observer ID, target species, bait species, bait type and condition (including live vs. dead, fresh vs. frozen, and other similar bait characteristics), direction of haulback (which allows the program to derive soak time per hook), and whether an auto-baiter is used (Y/N), and if used, the efficiency of the baiter (determined by observing some or all of the hooks, or using the industry-accepted efficiency). Also, if weights are used, the weight of the weights is considered critical. Number of hooks deployed was also considered critical, although it is unclear how this variable is collected. For example, the INIDEP program observers must observe all data recorded and no data may be taken from the vessel captain. Other programs sub-sample the gear or derive this number from counting the hooks between floats and the number of floats.

Target species needs to be defined in terms of how it is derived. In the Atlantic pelagic longline fishery, the target species historically was tuna or swordfish, but is now reported as more of a “mixed” fishery. Does this reflect an actual change in target species or is it an artifact of how this variable is derived? Again it is important to fully document and define how variables are collected over time. This helps in quality control of the data.

Gear Variables

The gear variables that are important to be collected fall under the broad category of “cause and effect.” Important variables depend on required regulation and mitigation measures that vary between fisheries and bycatch species of concern. Thus, participants could not recommend any one critical data element that should be collected in every fishery. Instead, participants recommended that the best practices should include standard definitions for each of the gear variables. They also recommended that a network consisting of observer programs and data users be established to ensure information is exchanged on data collection and research efforts. Such a network will facilitate sound decisions regarding what data each program should collect.

Details on how to measure specific gear parameters (e.g., line diameter or strength) were not discussed, because many of these variables depend on the bycatch species of concern. Specific gear parameters may also not be available or are difficult to measure. For fishing hooks, the size of the hook and gap between the point and shank affect bycatch. Yet, some manufacturers do not include hook size and gap. Line diameter or strength is not easily measured, and observers must rely on what the fishermen tell them. In those cases, observers may identify these variables as “reported” rather than “observed” (i.e., the observer did not measure it themselves or compare it to some standard). For example, when the observer records that 60 miles of line were fished, this may not be exactly how much line was fished, but it does represent how much line the fisherman thought was fished. The use of ‘reported,’ ‘observed,’ or ‘estimated’ better reflects how the data were collected and clarifies for data users which variables are independently collected.

Catch Variables

All 5 of the catch variables were considered critical for data collection: estimate of total catch, catch weight by species, catch number by species, and the number of hooks sub-sampled during both deployment and retrieval. Number of hooks observed is used with number of bycaught animals taken by species to determine bycatch rate. Only hooks directly observed should be recorded when calculating bycatch rates. Each program should have clear definitions of effort (total and observed), since the total number of hooks deployed and observed is critical. Determining total effort fishery-wide was recognized as important but was beyond the scope of the workshop.

Mitigation Measures and Deterrent Devices

Collection of variables to assess the effectiveness of the mitigation measures is prone to subjectivity. Observers need clear definitions and performance criteria about these mitigation measures. In many fisheries, it is not one single measure used to deter bycatch, so all of the measures that are being used need to be recorded. Catch Per Unit Effort (CPUE) data on the target catch for sets with and without mitigation measures need to be collected and analyzed for possible impacts on the fishery. CPUE is generally (but not always) collected as part of the observer's duties. Programs should have clear data forms as to the type of information observers are required to collect. The workshop pre-survey included specific variables related to certain mitigation measures. For those fisheries that use these and/or other mitigation measures, this level of detail in data collection is appropriate along with clear definitions for what the mitigations measures are and how they were used.

Species-Based Variables

For all species, observers must identify whether the disposition of the animal (i.e., dead or released alive). If alive, the condition of the animal upon release, or "viability" of the animal, is a critical data element. However, differences exist in how 'viability' is defined. Workshop attendees were asked how this is addressed in training, and whether viability can be assessed by observers. For seabirds, most animals caught are dead, so viability is more relevant to bycatch of marine mammals and sea turtles. To assess how serious an injury is, data users need fairly specific information, not just 'dead' or 'released, condition unknown.' In the CCAMLR program, bycatch of seabirds and marine mammals are classified as either 'released alive,' 'dead,' or 'injured.' CCAMLR currently considers all animals released as "injured" or "dead" to be dead, which negates the need to further define "injured." In the WCGOP, a concern is that without criteria for assessing viability, certain end users of the data may not understand what is meant by the various designations, leading to misinterpretation. In the North Pacific, observers are provided a dichotomous key for making objective assessments of viability for halibut. This approach may be helpful for other bycatch species, especially protected species. In the U.S., NOAA Fisheries Service developed criteria for determining the viability of sea turtles caught in pelagic longline fisheries. The probability that the turtle will not survive the interaction is based on observable parameters, such as whether the hook was swallowed and or visible in the esophagus. The observer records what they see on the catch form and the responsibility for determining viability lies with the analyst reviewing the data. However, care should be taken in the extrapolation of viability data, as the viability of an animal released alive when an observer is on board a vessel may be different than the viability of an animal released alive when there is no observer onboard. In the U.S., for example, fishermen are provided training on safe handling and release of sea turtles, but there may still be differences in the handling of sea turtles when observers are not onboard a vessel.

Participants suggested that determining how to assess viability should be done in a separate forum, on a species-specific basis. The determination of viability needs to take into account what kind of data can be objectively collected by observers and what type of data are appropriate to collect. The later must be based on input from biologists, veterinarians, and other species experts. Programs should identify what species to assess and what observable parameters should be collected. Viability may be considered on a gear basis, as some gear are more likely to result in mortalities or certain types of injuries, depending on how the animal interacts with the gear. Gear left on the animal upon release is also important to collect. The amount and type of gear left on the animal can help make determinations regarding the seriousness of the injury. Handling of the animal as it is brought to the vessel is also important, but clear methods for data collection must be identified to reduce subjectivity.

Species identification and number of each species taken was identified as a universal need to assess bycatch. Accurate species identification depends on sufficient observer training, ability and capacity to take good photographs, and appropriate collection of samples or whole carcasses. For seabirds, retention of the entire carcass may be needed for positive species identification. Emphasis on species identification may need to be on species that are endangered or otherwise of high priority. Also of importance is the nature of the interaction, i.e., whether the animal was hooked, entangled, or collided with the gear.

Sightings information around gear is helpful but not critical (number of animals, species, and when sighted with respect to deployment, soaking, or retrieval of the gear). The relationship between sightings and interactions may be useful in predicting interaction rates for unobserved sets. A question was asked as to whether sightings information should be collected for every set, or only when there is an interaction with the gear. In 2004, the Hawaii-based longline fishery, sightings information was indicated as a low priority and collected opportunistically. An exception to this was for short-tailed albatross – all sightings of this endangered bird were recorded for every set, and a separate sightings form has been developed for this purpose. The systematic sampling approach provides a unit of effort associated with sightings. Participants disagreed about the overall usefulness of opportunistic sightings (i.e., not according to a systematic sampling scheme), but agreed that all protected species interactions should be recorded.

Life history and demographic data (age, sex, and morphological measurements) are important if collected from animals that are brought on board the vessel. This information helps provide a better understanding of how protected species populations are being affected by bycatch. Although these data may not be a high priority for all programs, it makes sense that if a protected species is brought on board dead, the observer should attempt to collect as much information as possible from this animal. However, collection of certain data may require special permits to collect it, especially for endangered species (e.g., blood is needed to sex sea turtles). Because this data may be difficult or time-consuming to collect, programs should know where this information is going and who will be using it. Programs may train some of their observers to collect this information as a sub-sample or only as part of a dedicated research effort.

Visible tags on the bycaught animal should be recorded, and tags should be applied to live animals prior to release. The former is a higher priority than the latter.

Spatial and temporal information associated with the capture and release of any protected species is important, with the caveats noted above regarding uncertainties of take location (in pelagic fisheries) or time (in both demersal and pelagic fisheries). Also noted above was the need to collect information on number of hooks actually observed to determine bycatch rates per unit effort.

Biopsy samples are important to collect from marine mammals to identify individuals from a specific breeding population. Depredation variables are also important including species of fish damaged, description of type of damage, photographs of damaged fish (photographs are helpful to determine whether depredation was caused by marine mammals or other species (i.e., sharks)), and number of fish damaged.

In summary, for species variables, species identification and number of animals captured are critical variables. If the animal is released alive, the condition of the animal upon release is also critical for determining the extent of the injury. However, more work needs to be done to ensure that observers are collecting data to determine viability in an objective manner. Sightings data are preferable but not necessarily critical, as are demographic data (age, sex) and presence of tags.

III. Dissemination and Communication of Results of Workshop

The workshop conveners indicated that the results of this workshop would be prepared as a report and circulated back to the workshop attendees and survey respondents for comment. User feedback on this report would be helpful. The report should be accessible on the web through a posting on the NOAA Fisheries Service website and/or the IFOC website, with links to these postings included on other observer program websites.

It was suggested that as part of the final report, an assessment be made to determine who might already be following these best practices. This assessment was incorporated in the display of the survey results illustrated in Figures 3-23 and is summarized in the next section.

The establishment of a longline fishery listserv was suggested, although attendees were not sure whether enough postings would be made. Instead, participants may want to add postings to a larger listserv or to listservs that are more specific to certain species.

It was also suggested that RFMOs receive copies of the report on behalf of the workshop attendees, and that each program take these recommendations back to their respective programs for consideration and implementation as appropriate.

It was suggested that a separate workshop be devoted to other fishery gear types, such as purse seine, trawl, and gillnet. Best practices for each gear type should be compiled and brought together at some point, as best practices for data collections may be different for different gear types. The International Fisheries Forum was mentioned as another possible venue (besides the International Fisheries Observer Conference) for developing these best practices for other gear types. The FAO Technical Consultation for Sea Turtles is on all fisheries and gear types and may be an appropriate venue for providing a broader focus (but just for sea turtles). Participants recommended that a working group or forum with representatives from each program be established to develop best practices, preferably sanctioned or supported by some international body, such as FAO. An international forum would be able to look across species as well as across gear types.

RECOMMENDATIONS FOR BEST PRACTICES

Based on the responses provided by data users in the pre-workshop survey and discussions by workshop participants, a list of variables was compiled that represent “best practices” that should be included in the collection of longline data by fisheries observers (Table 3). The workshop participants generally agreed with the list of variables identified as **critical** or **preferred** by data users in the pre-workshop survey, but in some cases other variables were added to the list based on further discussions at the workshop.

Table 3: Best Practices--Recommended minimum variables to be collected in all longline fisheries.

Gear Type Fished	Category	Variables
All	Temporal	Date gear was deployed Start time of gear deployment End time of gear deployment Date gear was retrieved Start time of gear retrieval End time of gear retrieval
Pelagic	Spatial	Latitude at beginning of gear deployment Longitude at beginning of gear deployment Latitude at end of gear deployment Longitude at end of gear deployment Latitude at beginning of gear retrieval Longitude at beginning of gear retrieval Latitude at end of gear retrieval Longitude at end of gear retrieval
Demersal[a]		Latitude at beginning of either gear deployment or retrieval Longitude at beginning of either gear deployment or retrieval Latitude at end of either gear deployment or retrieval Longitude at end of either gear deployment or retrieval
Pelagic	Physical and Environmental	Sea surface temperature Depth fished at beginning of gear deployment [b] Depth fished at end of gear deployment [b] Depth of bottom at beginning of gear deployment Depth of bottom at end of gear deployment
Demersal		Sea surface temperature Depth fished at beginning of gear deployment[b,c] Depth fished at end of gear deployment[b,c] Depth of bottom at beginning of gear deployment Depth of bottom at end of gear deployment
All	Vessel and Fishing	Unique vessel identifier Unique observer identifier Vessel length Total number of hooks deployed Direction of haulback Target species[d] Bait species Bait condition (live/fresh/frozen/thawed, whole/cut) Autobaiter used? (if used, also record bait efficiency) Weight of added weight (if used) Direction of gear retrieval

Gear Type Fished	Category	Variables
All	Gear[e]	Groundline/mainline length[f] Branchline/gangion length Distance between branchlines Hook size[g] Hook type
All	Catch	Total catch, actual or estimated (number and/or weight) Catch by species (number and/or weight) Observed effort (total number of hooks observed during retrieval)
All	Mitigation Measure/ Deterrent Device	Presence of any type of deterrent used or required to be used, and how it was used
All	Bycatch	Species identification Number of each species captured Type of interaction (hooking/entanglement) Disposition (dead/alive) Description of condition/viability of the animal upon release (if released alive)

[a] Demersal gear fished on the bottom is stationary, thus collecting data on either where gear is deployed or retrieved is sufficient.
[b] In some observer programs, fishing depth is derived from the sum of the floatline/dropline length and the branchline/gangion length.
[c] For demersal gear, depth fished should also be collected it if is different than bottom depth.
[d] Target species may be derived in some programs from the catch composition.
[e] Although $\geq$50% data users responding to the pre-workshop survey identified these 5 gear variables as critical or preferred, workshop attendees were reluctant to identify specific gear variables for inclusion as best practices, instead noting these will vary by fishery depending on bycatch species and regulatory measures in place. Emphasis was instead placed on standardized definitions of terms and data collection methods.
[f] Groundline/mainline length is rarely an exact measurement, due to the length of the line. Instead it is either derived (by multiplying distance between floats by number of floats), estimated by the observer, or reported by the vessel.
[g] Hook size is often reported by the vessel or provided by the manufacturer rather than measured by the observer.

Optimal data specific to bycatch species was identified by data users in the pre-workshop survey and workshop participants. They recommended the following variables and material be collected when possible:

- Collection of whole carcasses (seabirds) or parts/biopsies (sea turtles and marine mammals)
- Photographs and species identification forms
- Age (as derived from collection of teeth or other samples)
- Sex (observed, or blood sample/biopsy dart if cannot be observed)
- Size of animal (type of measurements vary by species, and may be limited to an estimate of total length if animal is not boarded)
- Time and location of capture of bycatch species within the set (although there may be constraints on the precision of these variables)
- Systematic sightings of protected species around gear during gear deployment/retrieval
- Tags (presence/absence, attached prior to release)
- Evidence of depredation on catch (by marine mammals or other species), including species of fish damaged, description of type of damage, photographs of damaged fish, and number of fish damaged.

Data variables considered **not important** for data collection were not discussed in detail at the workshop, as there were very few responses in this category. The lack of responses indicating a particular variable was not important made interpretation of the survey results difficult and subject to potential bias.

When incorporating these best practices into observer data collections, workshop participants recommended that each program should:

- Establish a process for periodically reviewing and prioritizing data needs, in coordination with data users. Priorities may be set according to fishery-specific data needs, but should incorporate broader priorities where possible.
- Clearly communicate data collection priorities to all stakeholders.
- Establish and disseminate metadata for observer databases that describe each variable collected, how it is collected and when data collection methods change, why it is collected (long-term operational vs. short-term research project), and the level of precision of measurements.
- Identify which variables are or can be derived from other variables; consider eliminating collection of variables that can be derived from other variables.
- Ensure the use of standard and objective definitions and data collection methodologies.
- Clarify when data are “reported” (by the vessel or some other entity) as opposed to “measured independently” (by the observer).
- Strive to meet data collection needs while keeping observer health and safety a priority.
- Keep informed regarding current bycatch reduction research and emerging data needs to support research.

Workshop conveners and participants believe that the workshop was a success, but was only a first step toward implementing best practices in observer programs globally. Workshop participants recommended that next steps should include:

- Dissemination of the results of this workshop to all observer programs and data users, and to RFMOs.
- A follow-up assessment of how well recommended variables are being incorporated into observer program data collections, including those programs that may not have been represented in the initial survey or at the workshop, as well as programs that are involved in bycatch reduction research.
- The establishment of a longline working group, or use of new or existing listservs, as a vehicle for sharing information and further developing best practices in sampling design, data collection methodologies, and observer training.
- Development of best practices for observer data collection to facilitate research and analysis to reduce bycatch of protected species for other gear types (such as purse seine, trawl, and gillnet).

In conclusion, workshop participants recognized that decisions regarding the incorporation of these or other best practices would necessarily be made at the program level, but that these decisions should be informed by consideration of data needs to facilitate analysis and research on protected species bycatch on a global scale.

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Appendix B: Workshop Agenda

8:30 AM Introduction of Workshop Participants

8:45 – 9:00 Overview of Workshop Objectives and Approach (presentation)

- Objectives of Workshop
- Impetus for Workshop (list of workshops that recommended a need for standardized data collection protocols)
- Pre-Workshop Survey (why was a survey used?)
- Focus on informal discussion and consensus on recommendations
- Workshop Constraints (what we can't cover in a day)

9:00 – 9:30 Species-Specific Overviews – sea turtles, seabirds, marine mammals (presentations)

- Summary of problem
- Analyses to date
- Management measures in place
- Summary of stumbling blocks and data gaps identified at previous workshops

9:30 – 10:30 Pre-Workshop Survey (presentation)

- Survey instrument and methodology
- Observer programs that responded to survey
- Data Users that responded to survey
- Representativeness of survey responses (i.e., what programs/key data users may have been missed?)

Results of Survey (presentation, handouts, and discussion)

- Commonalities in data collections vs. data user priorities
- Where are the data gaps between what is being collected and what is a high priority variable for data users?
- Prioritizing what data users consider to be data gaps? (e.g., 30% of users consider X to be a data gap vs. 70%)
- Identify variables that have different meanings to different users/programs (definition of terms)
- Identify variables that may be collected differently (methodologies)
- Identify variables that could be derived from other variables and therefore omitted from data forms
- Identify variables missing from survey that data users noted as important

10:30 – 11:00 Morning Tea

11:00 – 12:30 Putting It All Together (discussion)

- Are programs collecting what data users need?
- Data gaps to address critical, enhancing, and optimal data collection requirements

12:30 – 1:30 LUNCH

1:30 – 3:30 Putting It All Together - continued (discussion)
- Best practices in data collection methodologies (how data are collected, standardized approaches?)
- Prioritizing data collections (observers are only human)
- Training resources (species ID guides, anemometers, thermometers, etc.)
- Statistical and sampling design considerations (i.e., systematic approach to sea bird or cetacean observations during setting/haulback)
- Changes in data forms and databases
- Timeliness (how quickly can changes be made?)
- Feedback process for data users and program managers

3:30 – 4:00 Afternoon Tea

4:00 – 4:30 Next Steps (discussion)
- Implementing best practices
- Reporting out to other workshop participants and RFMOs not represented at workshop
- Ongoing sharing of information, stumbling blocks, resources available

4:30 Adjourn

Appendix C: Summary of Responses - Rankings of Variables by Data Users, and Number of Observer Programs that Collect Each Variable

Temporal Variables (Data user n=43; Obs. Prog. n=24)

	Data User Responses					Observer Programs Collecting
	Critical	Preferred	Optimal	Not Important	N/A or Blank	
Gear deployment – date	29	2	5	1	6	24
Gear deployment - start time	22	6	7	2	6	24
Gear deployment - end time	21	7	7	2	6	22
Gear retrieval – date	25	5	6	1	6	24
Gear retrieval - start time	17	7	9	2	8	22
Gear retrieval - end time	16	6	11	2	8	24
Time of capture (bycatch species of interest)	12	8	12	3	8	9
Time zone	13	5	6	8	11	11
Time-of-day (e.g., dawn, day, dusk, night)	14	7	8	5	9	3

Spatial Variables (Data user n=43; Obs. Prog. n=24; *Obs. Prog. - pelagic only, n=12)

	Data User Responses					Observer Programs Collecting
	Critical	Preferred	Optimal	Not Important	N/A or Blank	
Latitude - start gear deploy (set)	27	4	4	1	7	24
Longitude - start gear deploy (set)	26	4	5	1	7	24
Latitude - end gear deploy (set)	21	5	9	1	7	23
Longitude - end gear deploy (set)	21	5	8	1	8	23
Latitude - start gear retrieval (haul)	21	8	4	2	8	12*
Longitude - start gear retrieval (haul)	20	8	5	2	8	12*
Latitude - end gear retrieval (haul)	17	8	7	2	9	12*
Longitude - end gear retrieval (haul)	18	7	6	2	10	12*
Area (categorical management area)	8	9	4	8	14	14

Physical and Environmental Variables (Data user n=43; Obs. Prog. n=24)

	Data User Responses					Observer Programs Collecting
	Critical	Preferred	Optimal	Not Important	N/A or Blank	
Bottom depth - start gear deploy	11	8	8	6	10	14
Bottom depth - end gear deploy	9	7	11	6	10	12
Bottom depth - average	5	9	7	7	15	1
Fishing depth - start gear deploy	9	9	6	8	11	12
Fishing depth - end gear deploy	7	9	6	7	14	8
Fishing depth - average	6	11	2	8	16	6

	Data User Responses					
	Critical	Preferred	Optimal	Not Important	N/A or Blank	Observer Programs Collecting
Depth range of hooks	9	8	8	7	11	9
Depth - maximum hook depth	8	9	5	7	14	6
Sea surface temperature (SST)	11	11	8	4	9	16
Sea level pressure (SLP)	5	7	8	8	15	6
Swell height/seas	8	6	9	6	14	3
Swell direction	7	6	9	6	15	4
Wind speed	13	7	6	7	10	8
Wind direction relative to gear deploy	8	8	7	7	13	3
Wind direction - compass	8	7	8	8	12	8
Beaufort sea state	10	8	6	5	14	8
Cloud cover	5	10	10	6	12	9
Visibility	6	7	7	9	14	3
Moon brightness/ visibility	11	7	6	7	12	1
Moon phase	12	5	6	7	13	3
Weather	9	10	5	7	12	8

Vessel and Fishing Variables (Data user n=43; Obs. Prog. n=24; *Obs. Prog. for pelagic only, n=12; **Obs. Prog. for demersal only, n=12)

	Data User Responses					
	Critical	Preferred	Optimal	Not Important	N/A or Blank	Observer Programs Collecting
Unique Vessel identifier	21	3	4	4	11	24
Vessel length	13	10	6	2	12	18
Engine (sound profile)	5	5	7	9	17	3
Captain name (or unique identifier)	11	7	4	6	15	18
Captain's experience (with vessel & gear type)	5	9	6	5	18	5
Owner	6	3	6	9	19	14
Observer unique identifier	20	10	1	2	10	21
Target species/Fishery	25	6	3	2	7	3
Other vessels in area by gear type?	3	7	10	9	14	4
Bait spp. (e.g., mackerel, squid)	22	2	8	3	8	11
Bait type (live/whole/cut)	18	7	6	4	8	5
Bait temperature (fresh/frozen/thawed)	15	6	10	3	9	10
Bait method (auto/manual)	16	7	6	4	10	4
Bait size	9	7	12	4	11	7
Bait ratio (if multiple species)	8	8	5	7	15	9
Bait efficiency	7	3	10	5	18	5
Setting pattern	7	6	8	5	17	4
Setting into propeller up- or down-wash	7	4	9	6	17	3
Setting speed	10	5	8	6	14	13
Line shooter speed	7	7	6	6	17	6
Bait throwing machine	7	5	5	9	17	8

	Data User Responses					Observer Programs Collecting
	Critical	Preferred	Optimal	Not Important	N/A or Blank	
Offal discharge - gear deploy (y/n)	14	4	5	6	14	5
Offal discharge – gear retrieve (y/n)	13	5	6	6	13	8
Size of offal discharge (big/little chunks)	8	5	9	8	13	2
Offal dumping position	11	4	6	9	13	5
# Hooks deployed	30	0	5	1	7	12
# Hooks retrieved	23	3	6	2	9	17
# floats/1000 hooks (or length)	15	6	6	4	12	7*
# weights/1000 hooks (or length)	14	7	5	4	13	3**
Distance between line weights	17	6	6	3	11	4**
Weight of line weight	13	6	6	5	13	4**
Groundline sink rate	10	5	6	8	14	4

<u>Fishing Gear Variables (Data user n=43; Obs. Prog. n=24; *Obs. Prog. for pelagic only, n=12)</u>

	Data User Responses					Observer Programs Collecting
	Critical	Preferred	Optimal	Not Important	N/A or Blank	
Anchor weight	4	5	5	11	18	3
Groundline - material	9	11	4	3	16	14
Groundline - # strands	4	11	6	5	17	9
Groundline - length	13	9	4	2	15	9
Groundline - diameter	6	11	5	3	18	13
Groundline – test (breaking strength)	4	8	6	6	19	5
Groundline – color	4	8	6	6	19	9
Floatline/dropline - material	2	9	6	8	18	5*
Floatline/dropline - length	9	6	4	6	18	8*
Floatline/dropline - diameter	2	8	5	9	19	3*
Floatline/dropline - distance between	7	8	4	6	18	5*
Branchline/gangion - material	5	12	6	3	17	12
Branchline/gangion – length	12	8	5	2	16	15
Branchline/gangion - diameter	3	10	6	7	17	7
Branchline/gangion - color	4	10	5	5	19	6
Branchline/gangion – test	1	9	5	9	19	5
Branchline/gangion - distance between	16	5	4	4	14	12
Leader - material	5	9	5	5	19	8*
Leader - length	8	8	4	5	18	7*
Leader - diameter	2	8	6	8	19	4*
Leader - test	1	8	6	8	20	5*
Leader - weight	3	10	3	7	20	3*
Swivels (present, type)	4	11	4	4	20	9
Hook make	4	12	4	7	16	9
Hook size	18	5	5	3	12	17
Hook type	19	5	4	3	12	16

	Data User Responses					
	Critical	Preferred	Optimal	Not Important	N/A or Blank	Observer Programs Collecting
Hook offset (degrees)	10	7	4	6	16	2
Light device/type	10	6	4	7	16	6*
Light sticks - #	14	5	3	6	15	8*
Light sticks color	8	7	4	7	17	7*
Gear condition upon retrieval	4	7	9	5	18	10
Float type/size	5	5	8	5	20	7
Height of gear deployment	12	3	6	8	14	5
Line setting position (stern,port,starboard)	12	4	6	6	15	6

Catch Variables (Data user n=43; Obs. Prog. n=24)

	Data User Responses					
	Critical	Preferred	Optimal	Not Important	N/A or Blank	Observer Programs Collecting
Total catch estimate	19	6	8	2	8	21
Catch weight by species (subsample)	17	6	6	3	11	18
Catch number by species (subsample)	20	3	7	3	10	9
#Hooks subsampled (deployment)	21	3	7	3	9	2
#Hooks subsampled (retrieval)	21	2	6	3	11	13

Mitigation Methods and Deterrent Devices (Data user n=43; Obs. Prog. n=24)

	Data User Responses					
	Critical	Preferred	Optimal	Not Important	N/A or Blank	Observer Programs Collecting
Deterrent (presence of any type)	21	2	5	6	9	12
Deterrent performance (are they deployed correctly/effectively?)	15	5	6	4	13	8
Towed Buoy?	14	2	5	6	16	6
Streamer/tori Line?	18	1	3	6	15	11
Streamer/tori line type - single, double, more	16	1	4	7	15	7
Streamer length/type/other specs	13	2	4	8	16	6
Line Shooter?	17	1	4	5	16	9
Underwater/subsurface setting of gear?	15	1	6	5	16	9
Weight added to branchline/gangion?	15	4	4	4	16	5
Weight added to groundline/mainline/hookline?	14	4	4	5	16	5
Water shooter/spray?	13	2	4	7	17	5
Deflated swim bladder of bait?	10	4	6	7	16	3
Blue dyed bait?	14	3	7	4	15	7
Strategic offal discharge?	15	1	5	7	15	8

	Data User Responses					
	Critical	Preferred	Optimal	Not Important	N/A or Blank	Observer Programs Collecting
Deployed hooks outside of wake?	12	1	6	7	17	3
Night setting?	16	3	5	6	13	9
Acoustic alarms?	12	2	6	8	15	2
Acoustic alarms - how many and spacing	9	3	5	9	17	2
Acoustic alarms – sound frequency (kHz)	9	2	6	9	17	2
Acoustic alarms - how often does it sound	9	2	5	9	18	2
Marine mammal mitigation used?	12	1	4	10	16	6
Fish loss due to MM?	10	3	6	8	16	9

Sea Turtle Variables (Data user n=20; Obs. Prog. n=22 (excluded high latitude programs))

	Data User Responses					
	Critical	Preferred	Optimal	Not Important	N/A or Blank	Observer Programs Collecting
Sighting - spp, #, behavior	11	2	1	1	5	13
Interaction with vessel or gear	12	1	1	1	5	11
Capture position (latitude/longitude)	13	0	1	2	4	14
Catch by species (number)	14	0	1	1	4	20
Catch by species (weight)	6	2	1	4	7	0
Position within set (e.g., hook #)	10	3	0	1	6	5
Water temperature upon capture	9	1	1	2	7	2
Caught on hook timer?	6	2	2	2	8	2
Proximity to closest light device	8	2	1	2	7	4
Light stick on branchline/ light color	8	3	0	2	7	3
Proximity to next float	7	2	1	2	8	5
Hooked/entangled/both	13	0	1	1	5	12
Hook/entanglement location	11	1	2	1	5	7
How was hook removed?	11	0	2	2	5	8
How much gear left on released turtle?	10	2	1	1	6	12
Viability (condition if not dead)	11	1	1	2	5	12
Release position (latitude/longitude)	10	0	1	2	7	4
Identification form and/or photograph	12	1	1	1	5	13
Scanned for pit tags	6	2	2	3	7	4
Scanned for external tags	10	1	2	1	6	14
Tissue samples	6	2	1	4	7	2
Skin biopsy (from live specimen)	7	5	0	2	6	6
Retained whole (if possible)	6	1	3	3	7	10
Curved carapace length(notch to tip)	10	1	1	2	6	9
Notch to notch length	7	1	1	4	7	4

	Data User Responses					Observer
	Critical	Preferred	Optimal	Not Important	N/A or Blank	Programs Collecting
Curved carapace width	7	1	2	3	7	6
Plastron length	6	1	2	3	8	3
Tail length	5	2	2	4	7	3
Straight carapace length (notch to tip)	6	3	1	3	7	7
Straight carapace width	5	3	1	3	8	4
Document lesions/injuries	5	4	1	2	8	8
Sex (male/female)	9	2	1	2	6	3
Color	5	1	2	5	7	6

<u>**Marine Mammal Variables (Data user n=21; Obs. Prog. n=24)**</u>

	Data User Responses					Observer
	Critical	Preferred	Optimal	Not Important	N/A or Blank	Programs Collecting
Sightings - spp, #, behavior	7	3	1	0	10	15
Sightings - SST	5	2	0	1	13	1
Sightings – Beaufort	5	2	0	2	12	2
Sightings - weather	4	3	0	1	13	4
Interaction with vessel or gear	9	3	0	0	9	14
Catch by species (number)	13	0	0	0	8	22
Catch by species (weight)	4	3	0	3	11	0
Position of catch within set (e.g., hook #)	6	2	1	0	12	5
Viability (condition if not dead)	9	1	0	0	11	14
Identification form and/or photograph	10	1	0	0	10	14
Tissue samples (e.g., liver, kidney, heart, etc.)	5	1	0	3	12	7
Skin biopsy (live)	6	2	0	2	11	4
Collected whole or part	6	0	0	3	12	14
Sex (Male/Female)	7	2	1	0	11	15
Cetacean - total length (tip of jaw to notch of tail fluke)	8	3	0	0	10	11
Cetacean - girth (leading edge of dorsal fin/ axilla)	4	4	0	0	13	6
Cetacean - flipper length	4	2	1	1	13	2
Cetacean - max flipper width	4	2	1	1	13	2
Cetacean - height of dorsal fin	4	2	1	1	13	2
Cetacean - fluke width	4	2	1	1	13	2
Pinniped - total length (tip of snout to tip of tail)	5	3	0	0	13	12
Pinniped - girth (axilla)	3	5	0	0	13	7
Pnniped - rear flipper length	3	4	0	1	13	5
Pinniped canine teeth collected	4	2	0	2	13	3
If female - lactating (y/n)	5	2	0	1	13	4
If female - fetus present (y/n)	6	0	0	2	13	6
If female - fetus length	5	1	0	2	13	4

	Data User Responses					
	Critical	Preferred	Optimal	Not Important	N/A or Blank	Observer Programs Collecting
Body temperature	3	2	0	3	13	3
Blubber thickness	4	1	0	3	13	5

Seabird Variables (Data user n=26; Obs. Prog. n=24)

	Data User Responses					
	Critical	Preferred	Optimal	Not Important	N/A or Blank	Observer Programs Collecting
Sightings (opportunistic)	1	4	4	2	15	9
Interaction with gear during deployment	2	5	2	1	16	11
Interaction with gear during retrieval	2	2	4	1	17	11
Abundance - deployment	4	1	6	2	13	7
Interaction rate - deployment	2	6	2	1	15	5
Catch by species (number)	11	1	1	0	13	19
Catch by species (weight)	2	2	0	5	17	11
Position of catch within set (e.g., hook #)	4	2	3	1	16	5
Proximity to light device	2	3	0	4	17	4
Proximity to floats	2	3	0	3	18	3
Proximity to added weight	2	4	1	2	17	0
Hook location (e.g., bill, wing, body)	5	5	1	1	14	11
Viability (condition if not dead)	7	3	1	1	14	13
Identification form and/or photographs	8	1	2	0	15	15
Tissue samples	3	1	5	1	16	2
Band or other tagging device	8	2	1	1	14	15
Carcass collected	5	1	4	1	15	14
Sex (Male/Female)	5	3	2	0	16	3
Age (e.g., juvenile, subadult, adult)	5	3	2	0	16	4
Molt condition	1	3	2	2	18	2

Elasmobranch Variables (Data user n=15; Obs. Prog. n=24)

	Data User Responses					
	Critical	Preferred	Optimal	Not Important	N/A or Blank	Observer Programs Collecting
SHARKS						
ID to Species	11	0	1	0	3	24
Sex (Male/Female)	9	1	2	0	3	15
Total length	6	1	2	1	5	4
Fork length	8	0	4	0	3	16
Distance – D1 to D2	4	0	2	2	7	3
Clasper length	5	0	3	2	5	3
Disposition	6	2	0	0	7	12
Tag present	6	3	1	0	5	18
SKATES/RAYS						
ID to species	9	2	0	1	3	19

	Data User Responses					Observer
	Critical	Preferred	Optimal	Not Important	N/A or Blank	Programs Collecting
Sex (Male/Female)	7	2	2	0	4	12
Total length	7	1	2	1	4	9
Disc width	6	1	1	1	6	6
Disposition	7	1	0	1	6	12

Billfish Variables (Data user n=9; Obs. Prog. n=12 (Pelagic only))

	Data User Responses					Observer
	Critical	Preferred	Optimal	Not Important	N/A or Blank	Programs Collecting
ALL BILLFISH						
Disposition of fish when caught	3	1	2	0	3	8
Retention (all or part)	3	1	2	0	3	8
Damaged?	2	2	2	0	3	9
Type of damage	2	2	2	0	3	8
Tag present	4	1	1	0	3	8
Tags attached – live releases	3	1	1	0	4	6
Biological specimen collected?	1	3	2	0	3	6
Sex (Male/Female)	4	2	0	0	3	9
Photograph identification or damage documentation	3	2	1	0	3	6
Eye to fork length (EFL)	2	2	1	0	4	6
Cleithrum to keel (CKL)	1	1	2	1	4	5
Half girth (HG)	1	1	2	1	4	2
Collect ripe running eggs	2	1	0	2	4	2
Lower jaw to fork length (curvilinear)	3	2	0	0	4	7
Pectoral to fork length (curvilinear)	1	0	2	2	4	3
Other measurements	2	0	1	2	4	3
SWORDFISH						
Otolith	1	2	0	2	4	2
Anal fin ray	3	2	0	0	4	4
Ovary tissue	2	1	0	2	4	3
Stomachs	2	1	1	2	3	4

Appendix D: Summary of Responses - Observer Program Responses Regarding Feasibility of Collecting Data Variables

Temporal Variables (n=22)

	Easy	Moderate	Difficult	Impossible	Blank
Gear deployment – date	19	2	0	0	1
Gear deployment - start time	19	2	0	0	1
Gear deployment - end time	18	3	0	0	1
Gear retrieval – date	21	0	0	0	1
Gear retrieval - start time	21	0	0	0	1
Gear retrieval - end time	20	1	0	0	1
Time of capture (bycatch species of interest)	5	4	0	0	13
Time zone	10	0	0	0	12
Time-of-day (e.g., dawn, day, dusk, night)	4	0	0	0	18

Spatial Variables (n=22)

	Easy	Moderate	Difficult	Impossible	Blank
Latitude - start gear deploy (set)	19	0	0	0	3
Longitude - start gear deploy (set)	19	0	0	0	3
Latitude - end gear deploy (set)	16	1	0	0	5
Longitude - end gear deploy (set)	16	1	0	0	5
Latitude - start gear retrieval (haul)	17	0	0	0	5
Longitude - start gear retrieval (haul)	17	0	0	0	5
Latitude - end gear retrieval (haul)	14	1	0	0	7
Longitude - end gear retrieval (haul)	14	1	0	0	7
Area (categorical management area)	15	0	0	0	7

Physical and Environmental Variables (n=22)

	Easy	Moderate	Difficult	Impossible	Blank
Bottom depth - start gear deploy	4	6	3	0	9
Bottom depth - end gear deploy	6	4	3	0	9
Bottom depth - average	4	1	2	0	15
Fishing depth - start gear deploy	4	7	3	0	8
Fishing depth - end gear deploy	1	6	3	0	12
Fishing depth - average	7	0	2	0	13
Depth range of hooks	1	4	4	0	13
Depth - maximum hook depth	2	3	3	0	14
Sea surface temperature (SST)	9	7	2	0	4

	Easy	Moderate	Difficult	Impossible	Blank
Sea level pressure (SLP)	6	0	2	0	14
Swell height/seas	5	3	2	0	12
Swell direction	1	3	2	0	16
Wind speed	8	5	2	0	7
Wind direction relative to gear deploy	3	2	2	0	15
Wind direction - compass	7	5	2	0	8
Beaufort sea state	3	5	2	0	12
Cloud cover	8	0	2	0	12
Visibility	3	0	2	0	17
Moon brightness/ visibility	1	0	2	0	19
Moon phase	4	0	2	0	16
Weather	4	3	2	0	13

Vessel and Fishing Variables (n=22)

	Easy	Moderate	Difficult	Impossible	Blank
Unique Vessel identifier	20	0	0	0	2
Vessel length	18	1	0	0	3
Engine (sound profile)	2	1	0	0	19
Captain name (or unique identifier)	14	1	2	0	5
Captain's experience (with vessel & gear type)	3	1	2	0	16
Owner	10	5	2	0	5
Observer unique identifier	18	0	2	0	2
Target species/Fishery	20	1	0	0	1
Other vessels in area by gear type?	3	3	2	0	14
Bait spp. (e.g., mackerel, squid)	16	3	2	0	1
Bait type (live/whole/cut)	8	0	2	0	12
Bait temperature (fresh/frozen/thawed)	7	1	2	0	12
Bait method (auto/manual)	10	0	2	0	10
Bait size	4	3	2	0	13
Bait ratio (if multiple species)	3	5	2	0	12
Bait efficiency	4	0	2	0	16
Setting pattern	4	0	2	0	16
Setting into propeller up- or down-wash	3	0	2	0	17
Setting speed	9	1	2	0	10
Line shooter speed	2	3	3	0	14
Bait throwing machine	8	0	2	0	12
Offal discharge – gear deploy (y/n)	5	0	2	0	15
Offal discharge – gear retrieve (y/n)	6	2	2	0	12
Size of offal discharge (big/little chunks)	3	0	2	0	17
Offal dumping position	5	0	2	0	15
# Hooks deployed	10	9	2	0	1
# Hooks retrieved	6	8	0	0	8

	Easy	Moderate	Difficult	Impossible	Blank
# floats/1000 hooks (or length)	10	3	2	0	7
# weights/1000 hooks (or length)	5	0	2	0	15
Distance between line weights	3	2	2	0	15
Weight of line weight	5	0	2	0	15
Groundline sink rate	0	0	5	0	17

Gear Variables (n=22; *Pelagic only n=12)

	Easy	Moderate	Difficult	Impossible	Blank
Anchor weight	0	1	2	0	19
Groundline - material	9	2	2	0	9
Groundline - # strands	7	0	2	0	13
Groundline - length	7	6	2	2	5
Groundline - diameter	9	1	2	0	10
Groundline – breaking strength	2	0	4	0	16
Groundline – color	8	0	2	0	12
Floatline/dropline - material *	4	1	1	0	6
Floatline/dropline - length *	6	1	1	0	4
Floatline/dropline - diameter *	3	1	1	0	7
Floatline/dropline - distance between *	3	2	1	0	6
Branchline/gangion - material	7	0	2	0	13
Branchline/gangion – length	6	3	2	0	11
Branchline/gangion - diameter	4	1	2	0	15
Branchline/gangion - color	3	0	2	0	17
Branchline/gangion – test	1	2	3	0	16
Branchline/gangion - distance between	5	4	2	0	11
Leader - material *	7	0	1	0	4
Leader - length *	6	1	1	0	4
Leader - diameter *	4	0	1	0	7
Leader - test *	2	2	2	0	6
Leader - weight *	3	1	1	0	7
Swivels (present, type)	8	0	2	0	12
Hook make	4	1	4	0	13
Hook size	14	1	2	0	5
Hook type	11	3	2	0	6
Hook offset (degrees)	2	1	2	0	17
Light device/type *	6	1	1	0	4
Light sticks - # *	7	1	1	0	3
Light sticks color *	7	0	1	0	4
Gear condition upon retrieval	3	3	0	0	16
Float type/size	5	0	2	0	15
Height of gear deployment	4	0	2	0	16
Line setting position (stern,port,starboard)	3	2	2	0	15

Catch Variables (n=22)

	Easy	Moderate	Difficult	Impossible	Blank
Total catch estimate	6	10	0	0	6
Catch weight by species (subsample)	5	8	1	0	8
Catch number by species (subsample)	6	10	0	0	6
#Hooks subsampled (deployment)	6	2	0	0	14
#Hooks subsampled (retrieval)	5	5	0	0	12

Mitigation Methods and Deterrent Devices (n=22)

	Easy	Moderate	Difficult	Impossible	Blank
Deterrent (presence of any type)	11	0	2	0	9
Deterrent performance (are they deployed correctly/effectively?)	6	3	2	0	11
Towed Buoy?	6	0	2	0	14
Streamer/tori Line?	11	0	2	0	9
Streamer/tori line - single, double, more	6	0	2	0	14
Streamer length/type/other specs	6	0	2	0	14
Line Shooter?	9	0	2	0	11
Underwater/subsurface setting	8	1	2	0	11
Weight added to branchline/gangion?	6	0	2	0	14
Weight added to groundline/mainline/hookline?	5	0	2	0	15
Water shooter/spray?	6	0	2	0	14
Deflated swim bladder of bait?	3	1	2	0	16
Blue dyed bait?	8	0	2	0	12
Strategic offal discharge	7	1	2	0	12
Deployed hooks outside of wake?	4	0	2	0	16
Night setting?	8	1	2	0	11
Acoustic alarms?	2	1	2	0	17
Acoustic alarms - how many and spacing	2	0	2	0	18
Acoustic alarms – sound frequency (kHz)	2	0	2	0	18
Acoustic alarms - how often does it sound	2	0	2	0	18
Marine mammal mitigation used?	4	0	2	0	16
Fish loss due to MM?	3	0	2	2	15

Sea Turtle Variables (n=22)

	Easy	Moderate	Difficult	Impossible	Blank
Sighting - spp, #, behavior	8	1	0	0	13
Interaction with vessel or gear	10	1	0	0	11
Capture position (latitude/longitude)	11	1	0	0	10
Catch by species (number)	12	2	0	0	8
Catch by species (weight)	4	1	0	2	15
Position of catch within set (e.g., hook #)	4	1	2	0	15
Water temperature upon capture	2	1	2	0	17
Caught on hook timer?	2	1	0	0	19
Proximity to closest light device	3	2	0	0	17
Light on branchline/color	2	4	0	0	16
Proximity to next float	4	2	1	0	15
Hooked/entangled/both	8	7	0	0	7
Hook/entanglement location	9	3	1	0	9
How was hook removed?	7	3	1	0	11
How much gear left on released turtle?	6	9	0	0	7
Viability (condition if not dead)	5	6	1	0	10
Release position (latitude/longitude)	7	1	0	0	14
Identification form and/or photograph	7	5	1	0	9
Scanned for pit tags	0	2	3	0	17
Scanned for external tags	3	4	1	0	14
Tissue samples	2	1	0	2	17
Skin biopsy (from live specimen)	0	3	2	2	15
Retained whole (if possible)	3	4	1	2	12
Curved carapace length(notch to tip)	4	4	2	0	12
Notch to notch length	2	2	2	0	16
Curved carapace width	2	3	2	0	15
Plastron length	2	2	2	0	16
Tail length	2	2	2	0	16
Straight carapace length(notch to tip)	2	3	2	0	15
Straight carapace width	2	3	2	0	15
Document lesions/injuries	3	5	0	0	14
Sex (Male/Female)	1	3	2	0	16
Color	4	2	0	0	16

Marine Mammal Variables (n=22)

	Easy	Moderate	Difficult	Impossible	Blank
Sightings - spp, #, behavior	7	8	0	0	7
Sightings - SST	2	0	0	0	20
Sightings – Beaufort	2	2	2	0	16
Sightings - weather	2	0	2	0	18

	Easy	Moderate	Difficult	Impossible	Blank
Interaction with vessel or gear	9	5	0	0	6
Catch by species (number)	11	6	0	0	5
Catch by species (weight)	0	2	3	0	17
Position of catch within set (e.g., hook #)	4	1	2	0	15
Viability (condition if not dead)	0	2	0	0	20
Identification form and/or photograph	5	5	0	0	12
Tissue samples (e.g., liver, kidney, heart, etc.)	0	4	2	0	16
Skin biopsy (live)	4	4	3	0	11
Collected whole or part	1	3	2	0	16
Sex (Male/Female)	1	5	0	0	16
Cetacean - total length (tip of jaw to notch of tail fluke)	4	1	5	0	12
Cetacean - girth (leading edge of dorsal fin/ axilla)	4	1	2	0	15
Cetacean - flipper length	2	0	2	0	18
Cetacean - max flipper width	1	0	2	0	19
Cetacean - height of dorsal fin	1	0	2	0	19
Cetacean - fluke width	1	0	2	0	19
Pinniped - total length (tip of snout to tip of tail)	4	7	0	1	10
Pinniped - girth (axilla)	4	4	0	0	14
Pnniped - rear flipper length	2	3	0	0	17
Pinniped canine teeth collected	1	12	0	0	9
If female - lactating (y/n)	2	3	2	0	15
If female - fetus present (y/n)	2	3	2	0	15
If female - fetus length	1	1	2	0	18
Body temperature	0	3	2	0	17
Blubber thickness	3	5	2	2	10

Seabird Variables (n=22)

	Easy	Moderate	Difficult	Impossible	Blank
Sightings (opportunistic)	4	1	4	0	13
Interaction with gear during deployment	5	2	3	0	12
Interaction with gear during retrieval	7	5	2	0	8
Abundance - deployment	4	2	2	0	14
Interaction rate - deployment	3	2	2	0	15
Catch by species (number)	13	3	2	0	4
Catch by species (weight)	4	2	0	0	16
Position within set (e.g., hook #)	4	0	3	0	15
Proximity to light device	2	1	2	0	17
Proximity to floats	2	1	2	0	17
Proximity to added weight	2	0	2	0	18

	Easy	Moderate	Difficult	Impossible	Blank
Hook location (e.g., bill, wing, body)	8	3	2	0	9
Viability (condition if not dead)	7	3	2	0	10
Identification form and/or photographs	8	5	3	0	6
Tissue samples	2	2	2	0	16
Band or other tagging device	9	3	0	0	10
Carcass collected	6	2	0	0	14
Sex (Male/Female)	0	2	3	0	17
Age (e.g., juvenile, subadult, adult)	0	3	3	0	16
Molt condition	0	2	2	0	18

Elasmobranch Variables (n=22)

	Easy	Moderate	Difficult	Impossible	Blank
SHARKS					
ID to Species	7	10	1	0	4
Sex (Male/Female)	9	1	0	0	12
Total length	10	7	0	0	5
Fork length	7	3	1	0	11
Distance – D1 to D2	5	2	0	0	15
Clasper length	3	3	0	0	16
Disposition	7	1	0	0	14
Tag present	13	5	0	0	4
SKATES/RAYS					
ID to species	2	9	2	0	9
Sex (Male/Female)	5	3	0	0	14
Total length	4	1	0	0	17
Disc width	1	4	1	0	16
Disposition	6	2	0	0	14

Billfish Variables (Pelagic only n=12)

	Easy	Moderate	Difficult	Impossible	Blank
ALL BILLFISH					
Disposition of fish when caught	5	1	0	0	6
Retention (all or part)	7	0	1	0	4
Damaged?	7	2	0	0	3
Type of damage	6	3	0	0	3
Tag present	6	2	0	0	4
Tags attached - live releases	1	3	3	0	5
Biological specimen collected?	2	4	1	0	5
Sex (Male/Female)	3	3	1	0	5
Photograph identification or damage documentation	2	3	1	0	6
Eye to fork length (EFL)	4	3	1	0	4
Cleithrum to keel (CKL)	3	1	1	0	7
Half girth (HG)	2	1	1	0	8
Collect ripe running eggs	1	2	1	0	8

	Easy	Moderate	Difficult	Impossible	Blank
Lower jaw to fork length (curvilinear)	3	2	2	0	5
Pectoral to fork length (curvilinear)	1	1	1	0	9
Other measurements	2	1	0	0	9
SWORDFISH					
Otolith	0	1	2	0	9
Anal fin ray	3	1	1	0	7
Ovary tissue	1	3	1	0	7
Stomachs	1	3	1	0	7

Appendix E: Resources Used in Developing Survey

Observer Manuals (M) /Training Materials (T) available online:

United States

- Northeast Fisheries Observer Program – (M)
  http://www.nefsc.noaa.gov/femad/fishsamp/fsb/

- North Pacific Groundfish Observer Program – (M)
  http://www.afsc.noaa.gov/refm/observers/default.htm

- West Coast Groundfish Observer Program – (M)
  http://www.nwfsc.noaa.gov/research/divisions/fram/Observer/

- Southeast Fisheries Science Center Pelagic Observer Program – (M / T)
  - General: http://www.sefsc.noaa.gov/pop.jsp
  - Sea Turtles/observers: http://www.sefsc.noaa.gov/seaturtlefisheriesobservers.jsp
  - Sea Turtles/general: http://www.sefsc.noaa.gov/seaturtlesprogram.jsp

- Commercial Shark Fisheries Observer Program – (M / T)
  http://www.flmnh.ufl.edu/fish/sharks/csop/csop2.htm

CCAMLR – (M) http://www.ccamlr.org

IATTC (M, Spanish) – http://www.ecopacifico.org

Appendix F: List of Definitions

Fishing terminology differs among gear types and geographic regions. To maintain consistency within this report, primary terms are listed in **bold** font below; lesser-used terms are in *italics*; other synonymous terms are included for cross-reference.

Autobaiter: A device used to bait hooks automatically.

Branchline: A line connecting a hook to the mainline. These vary in length and may include one or multiple swivels. For pelagic gear, branchlines are frequently made of nylon monofilament and are attached to a mainline by a snap. These are also called gangions, ganlines, or snoods. Fishermen may sometimes refer to these as leaders but see alternate definition for leader.

Demersal longline: Longline gear that is fished on bottom (also known as bottom longline, tub trawl).

Depredation: The removal of hooked fish or bait from longlines by cetaceans.

Disposition: Whether the animal was kept on board the vessel or released, either live or dead.

Dropline: See floatline.

Floatline: A line that connects the floats on the water's surface to the mainline. This may also be called the dropline.

Gangion: See branchline.

Gangline: See branchline.

Groundline: See mainline.

Handline: A weight, leader, and at least one hook that may be baited and attached to a line. Handlines are not always held during fishing (e.g., rod and reel).

Hook and line: Type of fishing gear using hooks to capture fish and may include rod and reel, troll, tended and longline.

Hookline: See mainline.

Hook spacing: Distance between neighboring hooks measured between attachment points of two neighboring branchlines on the stretched mainline.

Leader: A relatively short section of monofilament or steel wire placed between a swivel and the hook. It reduces bite-offs, makes hook replacement easier, and helps to maintain branchline length. Leader lengths may or may not be included in branchline measurements, depending on the program.

Longline: A mainline ("the string") with spaced branchlines attached and baited hooks on the free end. The mainline is divided into sections of hook and float arrangements which are distinguished by a high flyer, radio beacon, or beeper buoy. This may include multiple "tubs" of gear tied together (see Figure 9).

Magazine: See section.

Mainline: The length of line to which all of the hooks are attached. This line is the "backbone" of the gear and is also known as the hookline or groundline.

Offset: Degrees that the hook point is offset from the shank.

Pelagic longline: Generally, 700-900 pound test monofilament nylon mainline ("string") supported in the water column by floats ("floatlines"), and having attached branchlines with baited hooks on the free end.

Radar deflectors: Also called high flyers, devices used to detect location of gear using radar.

Radio beacons: Also called radio or beeper buoys.

Section: Unit of longline gear. For pelagic longline, each portion of the entire longline string beginning with a high flyer, radio beacon, or beeper buoy and ending with the next high flyer, radio beacon, or beeper buoy. Sections will generally have repeating configurations throughout the entire string. Also known as a skate, tub, or magazine.

Set: The entire length of mainline from the first hook to the last hook, also referred to as a "string" of gear.

Skate: See section.

Snood: See branchline.

Spanish gear: Longline gear in which the main line is kept at a specific depth by the joint action of the weights and floats. Hanging from the main line are branch lines which are tied with their respective hooks.

Troll line: One or more lines with hooks and bait or lures attached that are towed behind a moving boat.

Tub: See section.