Report of the U.S. Longline Bycatch Reduction Assessment and Planning Workshop

Seattle, Washington, USA
18-20 September 2007

Conveners:
Office of Protected Resources
National Marine Fisheries Service
Silver Spring, MD 20910

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

NOAA Technical Memorandum NMFS-OPR-41
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EXECUTIVE SUMMARY

On September 18-20, 2007, NOAA's National Marine Fisheries Service (NMFS), Office of Protected Resources, convened the U.S. Longline Bycatch Reduction Assessment and Planning Workshop (Workshop) in Seattle, Washington.

The purpose of the Workshop was to review and assess the results of all U.S. longline bycatch reduction efforts to date, including the available information on the effects of circle hooks on bycatch species and target catch, and to use this information to (1) identify best gear and fishing practices and (2) develop an action plan to direct NMFS' domestic and international marine turtle longline bycatch reduction efforts. The workshop focused primarily on marine turtle bycatch, while also considering bycatch of other species, including billfish, marine mammals, seabirds, and sharks. Twenty-six invited participants with expertise relevant to the issue of longline fishery bycatch participated in the Workshop. The majority of participants were NMFS staff; the remaining participants represented other federal agencies and intergovernmental and non-governmental organizations.

During the workshop, federal participants identified best gear and fishing practices (see Appendix A) for each of five major categories of fisheries: swordfish (classic, shallow), bigeye (classic, deep), other pelagics (tunas, sharks, combination), mahi-mahi (artisanal), and demersal. Best gear and fishing practices were identified for the following categories: hook type/size, bait, gear configuration, light sources, set/haul time, fishing depth, and turtle avoidance tactics. For hook type, participants recommended circle hooks as a best gear type for all of the fishery categories, although recommended hook size varied for the different fisheries. For bait, participants recommended whole finfish, as large as practical, with the bait covering the point of the hook for all of the fishery categories. For gear configuration, light sources, set/haul time, fishing depth, and turtle avoidance tactics, best practice recommendations varied by fishery category. In some cases, there was insufficient information to make a recommendation.

Drawing on discussions of best gear and fishing practices, global implementation and the implications of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA), and research needs and priorities, federal participants also developed a concise near-term (1-3 years) action plan (see Appendix B) for guiding NMFS' domestic and international efforts to implement best practices for reducing marine turtle bycatch in longline fisheries. Participants recommended one or more actions and an estimated timeline to complete the action for each of six identified focus areas. The six focus areas addressed:

- Reducing domestic bycatch by modifying gear and fishing practices;
- Reducing international bycatch by working within regional fishery management organizations, bilateral agreements, international turtle agreements, and international provisions in the Magnuson-Stevens Fishery Conservation and Management Act;
- Refining safe handling and release practices;
- Continuing gear research both domestically and internationally;
- Increasing capacity building and outreach; and
- Enhancing information dissemination and packaging.

The workshop consisted of two sessions: an open session (Days 1-2), and a federal closed session (Day 3). The primary purpose of the open session was to inform Day-3 federal discussions on best gear and fishing practices and an action plan. The workshop also included a mix of plenary presentations and discussions and breakout session discussions. Key experts presented updates on bycatch in longline fisheries for different taxonomic groups, including marine turtles, billfish, marine mammals, and seabirds. Participants also participated in extended breakout sessions to discuss and evaluate current longline bycatch reduction efforts. Here, participants exchanged information and views on: recent efforts to reduce hooking (e.g., through the use of different hook designs, bait types, and light sources); recent efforts to reduce entanglement and the role played by hook design, gangion design, and use of leaded swivels; the effectiveness of current safe handling and release practices; and key issues affecting current experimental data and estimation methods.

PART I. WORKSHOP BACKGROUND AND INTRODUCTION

The NMFS U.S. Longline Bycatch Reduction Assessment and Planning Workshop took place on September 18-20, 2007 in Seattle, Washington.

Workshop Purpose

The purpose of the Workshop was to review and assess the results of all U.S. longline bycatch reduction efforts to date, including the available information on the effects of circle hooks on bycatch species and target catch, and to use this information to (1) identify best gear and fishing practices and (2) develop an action plan to direct NMFS' domestic and international marine turtle longline bycatch reduction efforts. The Workshop focused primarily on marine turtle bycatch while also considering bycatch of other species, including billfish, marine mammals, seabirds, and sharks.

The Workshop outcomes described below are intended to serve as guidance and recommendations for the agency.

Workshop Organization

The Workshop was organized into two parts, as follows:

- *Days 1-2* of the Workshop were open to invited federal and non-federal participants as well as public observers. The format included a mix of plenary presentations and discussions and breakout session activities. The primary purpose of this open session was to inform agency-only discussions on Day 3. In particular, Days 1-2 were designed to provide background and context to Workshop participants on the topics of longline bycatch reduction efforts for various taxonomic groups. Other topics discussed included research needs and global implementation of bycatch reduction.

- *Day 3* was a closed planning session in which only federal government officials participated. The primary purpose of the federal closed session was to develop Workshop recommendations on (1) best gear and fishing practices, and (2) an action plan for directing NMFS' future domestic and international marine turtle longline bycatch reduction efforts. These topics are discussed in sections below.

The agenda for the Workshop is provided in Appendix C.

Discussions during Days 1-2 of the Workshop focused on the exchange of facts and information. The aim was to seek the ideas, views, and recommendations of individual Workshop participants; it was not to seek consensus advice on future federal government policies or actions from participants as a group. The information gathered during Days 1-2 was to inform the Federal planning session on Day 3.

Participants, Roles, and Ground Rules

Twenty-six invited participants with expertise relevant to the issue of longline fishery bycatch participated in the Workshop. Participants were recruited based upon their expertise in longline fishery bycatch of marine turtles, billfish, marine mammals, seabirds, and/or sharks. See appendix B for a list of participants.

The majority of participants were NMFS staff, including individuals from Regional Offices and Science Centers as well as the Offices of Protected Resources, Sustainable Fisheries, and International Affairs. The other federal agency represented was the U.S. Department of State. Non-federal participants included representatives from intergovernmental and non-governmental organizations. One member of the public, representing a conservation organization, attended the workshop as an observer.

NMFS Assistant Administrator Bill Hogarth participated and offered welcoming remarks.

CONCUR, Inc—an environmental mediation firm specializing in marine and water resources issues—facilitated the Workshop.

The primary role of invited participants was to provide expert input for NMFS' consideration. In this role, participants were asked to share pertinent information, ask clarifying questions, and express professional views in both plenary and breakout sessions. Observers were invited to view and track the deliberations on Days 1-2 but not participate in the discussions.

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

Workshop Preparations

Workshop preparations were guided by a steering committee consisting of both agency staff and non-agency participants. Steering committee members included: Chris Boggs, Alan Bolten Kristy Long, Pat Moran, Cheryl Ryder, Barbara Schroeder, Kim Rivera, Yonat Swimmer, and John Watson. The steering committee worked with the CONCUR facilitation team in the preparation of the Workshop.

To help establish the context for the Workshop, Workshop conveners produced a Workshop reader synthesizing relevant information on longline bycatch reduction activities. This internal document, intended for Workshop participants only, represented the latest information on longline bycatch reduction efforts and research. The compiled reader included background information on the following topics:

- Description of longline fishing gear
- Overview of artisanal fisheries

- Summary of marine turtle longline bycatch mitigation research (including research from the Pacific and Azores)
- Summary of recent technical workshops on sea turtle bycatch reduction efforts and experiments
- Summary of longline bycatch reduction activities from nations and regions
- Summary of international tools and measures for reducing longline bycatch of marine turtles
- Comparison of longline bycatch reduction outreach materials
- Summary of bycatch reduction research for billfish, marine mammals, seabirds, and sharks
- List of select longline bycatch reduction publications

Workshop Facilitators

Scott McCreary and Eric Poncelet of CONCUR, Inc. served as the facilitators for the Workshop. CONCUR also worked closely with the Steering Committee in preparation of the Workshop. Additionally, CONCUR drafted a Workshop summary, which served as the basis for this Technical Memorandum.

Workshop Logo

Christofer Boggs of the NMFS Pacific Islands Fisheries Science Center graciously created the artistic logo for the Workshop.

PART II. SUMMARY OF WORKSHOP DISCUSSION AND OUTCOMES

Open Session (Days 1-2)

The public portion of the workshop was organized into 4 sections:

1) Overview of bycatch reduction by species groups
2) Breakout session discussion and evaluation of current bycatch reduction efforts
3) Plenary presentations and discussions on global implementation of bycatch reduction
4) Plenary discussion and initial prioritization of research needs

Key outcomes of each of these sections are summarized below.

Section 1: Overview of Bycatch Reduction by Species Groups

To set the context for the Workshop, key experts presented overviews on the bycatch species and bycatch reduction efforts in longline fisheries for several different taxonomic groups. The purpose of this discussion was to inform and update Workshop participants with regard to the latest in research and bycatch reduction efforts for the suite of taxonomic groups impacted by longline fisheries. Presentations included the following:

Summary of Pelagic Longline Bycatch Mitigation Research Results
John Watson, NMFS Southeast Fisheries Science Center

Pelagic longline fishers and scientists in several countries have been developing, testing, and implementing fishing techniques and gear modifications to improve the selectivity and sustainability of pelagic longline fisheries and increase post-release survival of bycaught animals. This approach is an alternative to other management strategies that reduce available fishing grounds, such as time-area closures, which have historically predominated U.S. bycatch reduction measures, but which have been only rarely adopted by regional fisheries management organizations (RFMOs).

Over the past decade, national governments, RFMOs, and longline industries have developed and tested numerous seabird mitigation methods in longline fisheries. Several methods nearly eliminate bird captures when correctly employed (Brothers et al. 1999). Methods that not only have the capacity to minimize bird capture, but are also practical and provide crew with incentives to employ them consistently and effectively, hold promise for minimizing seabird bycatch to negligible levels (Gilman, 2001). The methods include bird-scaring flag lines that stream behind the vessel ("tori lines"), line shooters, side setting, and weighted lines to rapidly sink the baits below the range of birds, and dyed bait to reduce visibility during deployment. Gilman and Moth-Poulsen, 2007, reviewed measures taken by intergovernmental organizations (IGOs) to address sea turtles and seabird interactions in marine capture fisheries. Several IGOs have begun to examine seabird or sea turtle interactions, several have adopted voluntary measures to address problematic interactions, and five RFMOs have legally binding measures

requiring the employment of seabird avoidance methods in pelagic and demersal longline fisheries. Currently, there are no legally binding measures in place by an IGO to manage sea turtle-fishery interactions.

In 1999, Hoey and Moore produced a comprehensive report on U.S. longline fishing gear operational characteristics. They concluded that geographic area, month, and time of set, gear soak time, surface temperature, fishing depth, bait size, bait type, baiting technique, hook size and hook type can have significant effects on the selectivity of pelagic longline gear. Beginning in 2000, several researchers began investigating mitigation measures designed to reduce bycatch in pelagic longline gear with emphasis on sea turtle bycatch. This research has resulted in the development of bycatch reduction strategies which include: safe handling and release gear and protocols, the use of circle hooks in place of traditional J-style hooks, the use of fish bait rather than squid and gear restrictions such as branch line lengths, limits on the length of mainline, and the use of non-stainless steel corrodible hooks. Much of this research has concentrated on the impact of changes in hook designs and bait type on bycatch and target species. In addition to hook and bait studies, research has been conducted on initiatives to reduce effort in shallow depths while refocusing effort in cooler strata associated with frontal systems or by fishing greater depths to reduce bycatch. One such technique has recently been developed to reduce shallow bycatch species and selectively target bigeye tuna by setting the gear to ensure all hooks are below 100m depth (Beverly, 2004). Other mitigation techniques being investigated include moving away from an immediate fishing area once an interaction has occurred and fostering vessel communications within the commercial fleet to avoid areas of high interaction.

In 2007, the ICCAT sub-committee on ecosystems reviewed existing data on the effects of circle hooks and bait type on target and bycatch species compared to traditional J and tuna hooks in pelagic longline fisheries. The data reviewed included studies conducted in the Azores, U.S. Atlantic, Gulf of Mexico, and Pacific longline fisheries, Canadian North Atlantic, Eastern Pacific coastal longline fisheries, Japanese far seas fishery, Japanese Western North Pacific fishery, Korean Eastern Pacific fishery, Spanish Indian Ocean fishery, and Italian Mediterranean fishery. The results of this review indicated that the reported effect of circle hooks on target and bycatch species was dependent on the size of circle hooks relative to the size of traditional J and tuna hooks to which they were compared and, in some cases, was dependent on the bait type used in various fisheries.

The available data include two published results of research and many research reports including preliminary reports on ongoing research. There are several caveats that should be considered when reviewing the available data:

- The effect of circle hooks varies with hook size and shape and the size and shape of the hook to which it is being compared, and generalizations of the effect of circle hooks can be misleading and should be avoided.
- Bait type and size can significantly alter the effect of circle hooks.
- We must be very careful to draw conclusions from any study that does not include a complete description of the hooks and the bait type and size used in the study.
- More rigorous studies are needed for some applications to determine the best circle hook size and shape and the bait type and size needed to achieve the desired result.

Below is a summary of the effect of circle hooks and bait types by species on target and bycatch species.

Swordfish

Catch rates with circle hooks was dependent on bait type (U.S. North Atlantic and Eastern Pacific, Azores, Spanish Indian Ocean, Japan Far Seas Fishery).

- 18/0 circle hook with *squid bait* compared to 9/0 J hooks with squid bait reduced swordfish catch between 21% and 33%.
- 18/0 circle hook with *large mackerel bait* compared to 9/0 J hooks with squid bait increased swordfish catch between 5% and 30%.
- 16/0 circle hook with *squid bait* reduced swordfish catch 31%.
- 3.8 sun circle hook compared to 3.8 sun tuna hook: there was no substantial difference in swordfish catch rates.

Bigeye Tuna

Catch rates with circle hooks was dependent on bait type (U.S. North Atlantic and Eastern Pacific, Eastern Pacific Coastal, Japan Far Seas, Spanish Indian Ocean)

- 18/0 circle hook with *squid bait* compared to 9/0 J hooks with squid bait increased bigeye tuna catch between 24% and 35%.
- 18/0 circle hook with *large mackerel bait* compared to J hooks with squid bait decreased bigeye tuna catch between 50% and 83%.
- 18/0 circle hook with *small mackerel bait* compared to 16 (?) J hook increased bigeye tuna catch 30%.
- 3.8 sun circle hook compared to 3.8 sun J hook: there was no substantial difference in bigeye tuna catch.

Yellowfin Tuna

Catch rates with circle hooks was dependent on hook size (U.S. North Atlantic and Gulf of Mexico, Spanish Indian Ocean).

- 18/0 circle hook with *small fish bait* compared to 16/0 circle hook with small fish bait reduced yellowfin tuna catch by 26%
- 18/0 circle hook with *squid bait* compared to 16 (?) J hook increased yellowfin tuna catch 6%
- 18/0 circle hook with *small mackerel bait* compared to 16 (?) J hook increased yellowfin tuna catch 46%
- 16/0 circle hook with *mixed bait* compared to J hooks increased yellowfin tuna catch by 2.5 times

Albacore Tuna

Catch rates with circle hooks was dependent on bait type (U.S. North Atlantic, Spanish Indian Ocean).

- 18/0 circle hook with *squid bait* compared to 9/0 J hook with squid bait increased albacore tuna catch between 33% and 64%.
- 18/0 circle hook with *large mackerel bait* compared to 9/0 J hook with squid bait reduced albacore tuna catch 85%.
- 18/0 circle hook with *squid bait* compared to 16 (?) J hook increased albacore tuna catch 16%.
- 18/0 circle hook with *small mackerel bait* compared to 16 (?) J hook increased albacore tuna catch 56%.

Mahi-mahi

Large circle hooks consistently reduced catch of Mahi-mahi (U.S. North Atlantic and Eastern Pacific).

- 18/0 circle hook with *squid bait* compared to 9/0 J hooks with squid bait decreased Mahi-mahi catch between 61% and 80%.
- 18/0 circle hook with *large mackerel bait* compared to 9/0 J hooks with squid bait reduced Mahi-mahi catch between 34% and 85%.

All Tuna Species Combined

Studies that combined data for all tunas indicate that circle hook performance is dependent on hook size (U.S. Eastern Pacific, Eastern Pacific Coastal, Japan Far Seas, Korean Eastern Pacific).

- 18/0 circle hook with *large mackerel bait* compared to J hooks reduced all tunas combined by 50%.
- 16/0 circle hook with *mixed bait* compared to tuna and J hooks had similar catch rates for all tuna combined.
- 18/0 circle hook with *mixed bait* compared to 4.0 tuna hook reduced all tuna combined by 35%.
- 15/0 circle hook with *mixed bait* compared to 4.0 tuna hook reduced all tuna combined by 2%.

Sharks

Circle hook effect on shark catches was dependent on hook size and bait type (U.S. North Atlantic and Eastern Pacific, Japan Western North Pacific, Korean Eastern Pacific).

- 18/0 circle hook with *squid bait* compared to 9/0 J hook increased blue shark catch rate by 9%.
- 18/0 circle hook with *large mackerel bait* compared to 9/0 J hook decreased blue shark catch by 30%.

- 18/0 circle hook with *large mackerel bait* decreased all sharks combined 34%.
- 4.3 sun and 5.2 sun circle hooks with *squid bait* compared to 3.8 sun tuna hooks; there was no significant difference for blue shark catch.
- 18/0 circle hooks with *mixed baits* compared to 4.0 tuna hooks reduced combined shark catch 57%.
- 15/0 circle hooks with *mixed baits* compared to 4.0 tuna hooks reduced combined shark catch 52%.

Billfish

Circle hooks reduced billfish catch rates (Korean Eastern Pacific).

- 18/0 circle hooks with *mixed baits* compared to 4.0 tuna hooks reduced billfish catch 17%.
- 15/0 circle hooks with *mixed baits* compared to 4.0 tuna hooks reduced billfish catch 40%.

Seabirds

Observer data from the U.S. North Atlantic indicates six times lower seabird CPUE with circle hooks compared to J hooks.

Loggerhead Sea Turtles

Circle hook effect was dependent on circle hook size and bait type (U.S. North Atlantic and Eastern Pacific, Canadian North Atlantic, Azores, Eastern Pacific Coastal, Japan Far Seas, Korean Eastern Pacific, Italian Mediterranean).

- 18/0 circle hook with *squid bait* compared to 9/0 J hook reduced loggerhead sea turtle catch between 77% and 85%.
- 18/0 circle hook with *large mackerel bait* compared to 9/0 J hook reduced loggerhead sea turtle catch between 88% and 90%.
- 18/0 circle hook with *squid bait* compared to 3.6mm tuna hook reduced loggerhead sea turtle catch 74%.
- 16/0 circle hook with *squid bait* compared to 3.6mm tuna hook reduced loggerhead sea turtle catch 58%.
- 16/0 circle hook with *mixed bait* compared to small (< 9/0) J hooks reduced hard shell sea turtle catch (loggerhead and olive ridley) between 40% and 60%.
- 3.8 sun circle hook compared to 3.8 sun J hook not effective in reducing loggerhead turtle CPUE.
- 4.3 sun and 5.2 sun circle hooks compared to 3.8 sun J hooks had potential to reduce hooking rates of loggerhead turtles.
- 16/0 circle hook compared to J hook with same gape was effective in reducing loggerhead catch.
- 16/0 circle hook compared to 4/0 J hook reduced loggerhead catch.

- Squid Versus Fish Bait – 95.5% of hardshell turtles captured on sets using squid bait (Canada). Loggerhead turtle catch rate for squid was substantially higher than that for mackerel.

Leatherback Sea Turtles

Large circle hooks and large mackerel bait effective in reducing leatherback catch (most leatherback interactions are entanglement) (U.S. North Atlantic and Eastern Pacific and Canadian North Atlantic).

- 18/0 circle hook with squid bait compared to 9/0 J hook reduced leatherback turtle catch between 50% and 75%.
- 18/0 circle hook with large mackerel bait compared to 9/0 J hook reduced leatherback catch between 63% and 83%.
- 16/0 circle hook compared with 9/0 J hook; leatherback turtle captures increased when J hooks were used.

Hook Effects and Implications for Post-Release Mortality

A much higher percentage of all bycatch species are hooked in the mouth with circle hooks than with J hooks, which more often are deeply swallowed (U.S. North Atlantic and Eastern Pacific, Azores, Eastern Pacific Coastal, Japan Far Seas).

- For J hooks between 60% and 68.8% of loggerhead turtles caught swallowed the hooks compared to between 13% and 27.3% for circle hooks.
- The 3.8, 4.3, and 5.2 sun circle hook reduced the proportion of turtles hooked in the throat and increased the proportion hooked in the mouth compared to the 3.8 sun tuna hook.
- A significantly higher proportion of white marlin and blue marlin were released alive from circle hooks compared to J hooks.
- Juvenile bluefin tuna release mortality was 4% for circle hooks compared to 28% for J hooks.

Summary of research findings:

1. Circle hooks reduce the proportion of hooks that are swallowed by bycatch and target species compared to “J” hooks.
2. Fish bait reduces the catch rate for sea turtles compared to squid bait.
3. Reduction in bycatch species catch rates with circle hooks is dependent on the size of circle hooks relative to the “J” hooks to which they are compared and, in some cases, is bait dependent.
4. The effect of circle hooks on target species is dependent on circle hook size and bait type and size.
5. Research results must include hook specifications and bait type and size.
6. There is a need to standardize hook measurement techniques and terminology.

Recommendations:

1. Switch to fish bait from squid bait.
2. Use 18/0 or 5.2 sun circle hooks in swordfish and bigeye tuna fisheries.
3. Conduct additional research to determine most effective circle hooks size for other tuna and Mahi-mahi fisheries.

NMFS National Seabird Program: Seabird Bycatch Reduction Efforts
Kim Rivera, NMFS Alaska Fisheries Science Center

Increased concerns have arisen about the incidental capture of non-target species in various fisheries throughout the world. Incidental capture can be economically wasteful, it impacts living marine resources, and the accidental killing of non-harvested animals may be aesthetically averse. Incidental catch of non-target marine species such as marine mammals, sea turtles, and seabirds has generated growing concern over the long-term ecological effects of such bycatch in longline and other fisheries conducted in many areas of the world's oceans.

In response to these concerns, the United Nations' Food and Agriculture Organization (FAO) called for an expert consultation on the issue of global seabird bycatch in longline fisheries. As a result of the consultation, the FAO adopted an International Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries (IPOA-S) in 1999. The IPOA-S applies to "States" (hereafter Countries) in whose waters longline fishing is being conducted by their own or foreign vessels, and to Countries that conduct longline fishing on the high seas and in the exclusive economic zones (EEZs) of other Countries. The IPOA-S is a voluntary measure that calls on Countries to: (1) assess the degree of seabird bycatch in their longline fisheries; (2) develop individual national plans of action (NPOA-Seabirds) to reduce seabird bycatch in longline fisheries that have a seabird bycatch problem; and (3) develop a course of future research and action to reduce seabird bycatch. The NPOA-Seabirds is to be implemented consistent with the FAO Code of Conduct for Responsible Fisheries and all applicable rules of international law, and in conjunction with relevant international organizations.

The FAO's Committee on Fisheries (COFI) focused considerable attention at its 27th Meeting (COFI-27, March 2007) on the IPOAs for seabirds and sharks and the sea turtle guidelines. Several Members advised COFI on their progress to develop or implement their NPOA-Seabirds. Many Members were of the view that FAO, in collaboration with BirdLife International, should seek to strengthen the implementation of the IPOA-Seabirds by developing best practice technical guidelines to support the elaboration of NPOA-Seabirds. It was agreed that FAO should, in cooperation with relevant bodies, develop best practice guidelines to assist countries and Regional Fishery Management Organizations (RFMOs) in implementation of the IPOA–Seabirds and that the best practice guidelines should be extended to other relevant fishing gears. Many Members expressed the view that the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), the Agreement on the Conservation of Albatrosses and Petrels (ACAP) and BirdLife International were the most relevant bodies in that context. It is likely that an FAO expert consultation will be held in 2008 to develop these best practice guidelines.

The United States developed its NPOA-Seabirds in 2001. Development of the NPOA was a collaborative effort between the NOAA's National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (FWS) and the Department of State (DOS), carried out in large part by the Interagency Seabird Working Group (ISWG) consisting of representatives from those three agencies. This partnership approach recognizes the individual agency management authorities covering seabird interactions with longline fisheries. Also in 2001, NMFS appointed its National Seabird Coordinator to head up its NPOA implementation initiatives. This work requires maintenance of a national perspective through coordinated regional activities.

NMFS manages U.S. fisheries under the authority of the Magnuson-Stevens Fishery Conservation and Management Act and the High Seas Fishing Compliance Act. FWS manages birds predominately under the authority of the Endangered Species Act and the Migratory Bird Treaty Act. In addition, DOS has the lead role in international negotiations on fisheries conservation and management issues that should help promote IPOA implementation by encouraging other nations to develop NPOAs. Given each agency's responsibilities, the NPOA-Seabirds was developed collaboratively by NMFS and FWS. This collaborative effort has increased communication between seabird specialists and fishery managers in FWS and NMFS. Maintaining this cooperation is a high priority for both agencies.

NMFS' role in reducing seabird bycatch in fisheries is guided by the following:

- ✓ Magnuson-Stevens Fishery Conservation & Management Act (as reauthorized in 2006)
- ✓ Endangered Species Act
- ✓ United States' National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries (NPOA-Seabirds)
- ✓ NMFS National Bycatch Strategy and National Bycatch Report
- ✓ Executive Order (EO) 13186 "Responsibilities of Federal Agencies to Protect Migratory Birds"

New language in the Magnuson-Stevens Act requires the Secretary, within 1 year, to establish regional bycatch reduction programs to develop technological devices designed to minimize bycatch and seabird interactions in Federally-managed fisheries. The language further authorizes the Secretary to coordinate with Interior to undertake projects to improve information and technology to reduce seabird bycatch, including outreach to industry on new technologies and methods, mitigation projects, and actions at international fishery organizations. The Act further directs us to transmit an annual report to Congressional committees describing the funding provided to implement this section, development in gear technology achieved under this section, and improvements and reduction in bycatch and seabird interactions associated with implementing this section, as well as proposals to address remaining bycatch or seabird interaction problems.

NMFS has been implementing the NPOA-Seabirds since 2001 and numerous activities have been undertaken such as: seabird avoidance regulations (NMFS Regions in Alaska, Pacific Islands, and the Southwest), Fishery Management Plan (FMP) development addressing seabird mitigation (West Coast Highly Migratory Species FMP), cooperative mitigation research with the longline industry (Alaska, Hawaii), observer training, education and outreach materials for fishermen and the public (NMFS Regions or Science Centers in Alaska, Pacific Islands,

Southwest, Northwest, Northeast, and Southeast), and international efforts at numerous regional fishery management organizations that have jurisdiction for management of fisheries on the high seas, bilateral government fishery meetings, fishers forum, fisheries observer conferences, albatross and seabird conferences, and ACAP.

NMFS pursues effective and practicable solutions for seabird bycatch reduction in its fisheries through collaborations with fishing industry groups, gear technologists, scientists, seabird biologists, and environmental conservation groups. These collaborative approaches have resulted in successful outcomes as seen by seabird bycatch reductions in Alaska and Hawaii longline fisheries. Since paired streamer lines with performance standards were implemented by the Alaska demersal longline fleet beginning in 2002, total seabird mortality and seabird bycatch rates are down by 69% and 79% respectively, while fishing effort increased. Results from a cooperative research study in Hawaii showed that side-setting was the most effective method at reducing seabird captures in both tuna and swordfish pelagic longline gear, resulting in seabird capture rates of 0.002 and 0.01 captures/1000 hooks, respectively. In 2006, the estimated albatross interactions with the Hawaiian longline fleet were less than 100 birds (73 black-footed albatross *Phoebastria nigripes*, 15 Laysan albatross *P. immutabilis*). This compares to bycatch in 2000 when over 2,300 albatross were estimated taken (1,339 black-footed albatross, 1,094 Laysan albatross). This order of magnitude reduction likely occurred as a result of required mitigation measures and a modified swordfish fishery.

NMFS' action on seabird bycatch reduction in longline fisheries has focused on Pacific fisheries, where seabird species that more commonly interact with longline gear occur (e.g., albatross). Observer data from the Atlantic pelagic longline fishery has also been analyzed and relatively few seabirds are taken. Only 113 seabirds were estimated to be taken from 1992 to 2004 and greater shearwaters (*Puffinus gravis*) accounted for the majority of the take. Preliminary results from this data analysis suggest that sets using circle hooks may catch fewer birds than those sets using J hooks. The study sample size is small though and requires further study to determine if hook type impacts the number of birds hooked. This type of study and information is critical and could lend additional justification for the use of circle hooks to reduce impacts on non-target species.

International efforts are also critical to stem any fishery impacts on seabird species that have broad global distributions. Efforts have included support of binding seabird avoidance measures at RFMOs and participating as an observer at the meetings of ACAP. ACAP's involvement at RFMOs has increased and its Seabird Bycatch Working Group has developed a mitigation research plan that identifies top priorities for research to address mitigation in pelagic longline fisheries that is most likely to be both effective at reducing bycatch and practicable for fishermen to use. Identified high priorities include: streamer lines, bait setting capsule, side-setting, weighted branchlines, bait pod/smart hook, and circle hooks.

Summary:

- ✓ Seabird bycatch in US domestic longline fisheries off Alaska and Hawaii has been reduced through collaborative and cooperative approaches with industry, scientists, and environmental conservation groups;
- ✓ Seabird bycatch reduction solutions are science-based and focus on methods and gear that are practicable for use by fishermen and may be fishery-specific;

- ✓ This model for seabird bycatch reduction efforts in US fisheries can be applied to international fisheries;
- ✓ Methods used for the bycatch reduction of turtles (i.e., circle hooks) may also reduce bycatch of seabirds;
- ✓ Research testing the efficacy of circle hooks on non-seabird species must also measure whether bycatch of seabirds is reduced;
- ✓ Development of bycatch reduction methods for one taxa must consider potential impacts on other taxa; and
- ✓ Continued research on effective mitigation methods for seabird bycatch reduction is needed and has been prioritized.

Marine Mammals
Lance Garrison, NMFS Southeast Fisheries Science Center

Interactions between longline fishing gear and marine mammals is a global problem. The primary factor driving these interactions appears to be "depredation" or the removal of catch and bait from longline fishing gear by marine mammals. This behavior results in two important management concerns. First, depredation by marine mammals results in a direct economic loss to fishermen. In many cases, marine mammals can remove significant amounts of commercially valuable catch from the longline. Second, marine mammals often are either hooked or become entangled in fishing gear resulting in serious injury or mortality. While the overall rate of such interactions is relatively low, the large amount of longline fishing effort may result in high total estimated mortality and represents a conservation concern. Thus, identifying mechanisms to reduce the rate of depredation on longline fishing gear, and thereby reduce the likelihood of incidental bycatch or mortality of marine mammals, is both a significant management and conservation issue.

Interactions with marine mammals have been observed in both pelagic and bottom longline fisheries throughout the world's oceans. For example, in the Southern Ocean surrounding Antarctica, interactions between bottom longlines in the Patagonian toothfish (*Dissostichus eleginoides*) fishery from both Orca whales (*Orcinus orca*) and Sperm whales (*Physeter macrocephalus*) were common, but variable, with up to 70% of observed trips including some degree of interaction with these two species (Kock *et al.*, 2006). For both mammal species, observer reports in this region indicate that they may remove up to 80% of the catch from the line leaving only toothfish jaws or lips behind in trips where the mammals are present.

Similarly, depredation on demersal longlines by sperm whales has been documented in the Alaskan sablefish (*Anoplopoma fimbria*) fishery. These interactions have been studied through the "SEASWAP" program, which is a consortium of academic scientists, fishermen, and government scientists. In this fishery, a longer season with lower overall effort appears to have increased the opportunity for sperm whales to interact with fishing gear, and reports of depredation have increased rapidly in recent years. In an evaluation of 39 sets, sperm whale depredation was seen on 71% of sets when whales were present, and there was a significant loss of catch when whales were present. Sperm whales are frequently observed "waiting" near flag buoys for the gear to be hauled back and may be attracted to the acoustic signatures of the vessels during hauls (Jan Straley, University of Alaska, pers. comm.; reviewed in Donoghue *et*

al., 2003). The SEASWAP program is continuing to investigate these interactions and the behavior of whales around fishing gear to identify potential mitigation approaches.

Marine mammal interactions with pelagic longlines in tropical to temperate waters throughout the world's oceans are also relatively common (reviewed in Donoghue *et al.*, 2003). For the most part, these interactions are documented with smaller toothed whales described as "blackfish" such as Orca whales, false killer whales (*Pseudorca crassidens*), melon-headed whales (*Peponocephala electra*), pygmy killer whales (*Feresa attenuata*), or longfin or shortfin pilot whales (*Globicephala sp.*). For most of the international fleets, there is relatively little systematic observer coverage, and thus both the rates of interactions and the identification of species are uncertain. However, reports from fishermen indicate both that depredation is common and that cetaceans may be incidentally hooked or entangled in lines. Interviews with fishermen in the Taiwanese distant water longline fleet indicated that fishermen attempted to deter depredation by harpooning cetaceans or other forms of harassment, but that these efforts have limited effectiveness (reviewed in Donoghue *et al*., 2003).

In U.S. waters, marine mammal interactions and incidental bycatch have been observed in the Hawaiian pelagic longline fishery with false killer whales and Risso's dolphins (*Grampus griseus*) and in the East Coast pelagic longline fishery primarily with unidentified pilot whales and Risso's dolphins (*Grampus griseus*). In the Hawaiian fisheries, there were a total of 84 documented cetacean takes from 1994-2006. The primary species interacting with this gear were false killer whales and Risso's dolphins. For the most part, these interactions involved hooking in the mouth, and the animals were considered seriously injured (K. Forney, Southwest Fisheries Science Center, pers. comm.; Carretta *et al.*, 2006). In 2004, regulations were implemented to mandate the use of larger, 18/0 circle hooks. Preliminary analyses suggest a reduction in the overall rate of marine mammal interactions with longline gear associated with this change. However, analysis of these data is ongoing (K. Forney, Southwest Fisheries Science Center, pers. comm.).

The east coast pelagic longline fishery has been the subject of a recent take reduction team mandated under the Marine Mammal Protection Act (MMPA) due to concerns over incidental serious injury and mortality of pilot whales in longline fishing operations in the mid-Atlantic Bight. The team met between June 2005 and April 2006 to evaluate patterns of incidental bycatch and develop approaches to reduce interactions. As with other pelagic longline fisheries, depredation, by pilot whales in particular, is a significant issue for fishermen, resulting in economic losses. Pilot whale bycatch in pelagic longline gear is concentrated primarily along the shelf-break between Cape Hatteras, North Carolina and New Jersey. Seasonally, the bycatch rates peaked during September through November as effort intensifies. The shelf break is particularly important since both longline effort and pilot whale spatial distribution is strongly correlated to this feature. This reflects oceanographic features that result in high densities of fish and squids, which in turn concentrates the large pelagic fish that are the target of the fishery along with marine mammals (Garrison, 2007).

Approximately 50% of the pilot whales observed caught on pelagic fishing gear are entangled in the mainline or other portions of the gear while the remaining half are hooked in the mouth. In the case of animals that are entangled, but not hooked, fishermen generally work to free the animal and most are released without entangling gear. In the case of mouth-hooked animals, the gear is often cut or breaks and the animal is released with both a hook in the mouth and significant amounts of trailing monofilament line (Garrison, 2007). Under NMFS guidelines (Angliss and DeMaster, 1998), these animals are considered to be seriously injured and likely to die, and hence are counted against the potential biological removal (PBR) benchmark as mandated by the MMPA. The total estimated

serious injury and mortality of pilot whales in the east coast longline fishery averaged 132 animals per year from 1999-2003. This accounts for 63% of the commercial fishery related mortality and serious injury of pilot whales on the east coast (Waring *et al.*, 2006).

Analyses conducted in support of the Pelagic Longline Take Reduction Team were used to identify environmental factors and fishing practices that were correlated with pilot whale and Risso's dolphin bycatch. This analysis indicated that the probability of catching a marine mammal increased with increasing water temperature, decreasing distance from the shelf break, the presence of damage to swordfish catch, and the length of the mainline set (Garrison, 2007). The correlations with environmental features are consistent with the proposed mechanism of physical oceanographic features concentrating the prey of both large pelagic fish and marine mammals along the shelf break. In addition, the correlation with swordfish damage indicates the importance of depredation as a process related to incidental bycatch and serious injury. The observer data also indicate that bycatch of marine mammals was significantly reduced in sets with mainlines less than 20 nautical miles in length. It is hypothesized that shorter sets may be less attractive to marine mammals, are less detectable to marine mammals, and/or have shorter haulback times resulting in reduced opportunities for depredation, entanglements, and hooking (Garrison, 2007). This potential mitigation measure is currently being considered by NMFS within the framework of the developing Pelagic Longline Take Reduction Plan.

The analyses described above encompass observer data collected from 1992-2004, and thus do not include data since the implementation of regulations mandating the use of circle hooks in the east coast longline fishery in late 2004. Thus, there is a possibility that these regulations to reduce turtle bycatch have implications for marine mammal bycatch. A thorough analysis of the available observer data did not suggest any correlation between hook size or type and marine mammal bycatch (Garrison, 2007). Further, the total estimated bycatch of pilot whales has been increasing in the pelagic longline fishery during the last five years while overall effort has been declining. Interestingly, the bycatch of Risso's dolphins has been declining and was zero in 2006 (Fairfield-Walsh and Garrison, 2007). After the implementation of the circle hook regulations, both bycatch rates and total estimated bycatch for pilot whales were slightly higher than those prior to the regulations (Fairfield-Walsh and Garrison, 2007). Thus, while the limited data available do not indicate that the recent regulations have significantly increased marine mammal bycatch, there is also no indication that they have significantly decreased bycatch.

The strategies to reduce marine mammal bycatch are generally linked to the depredation issue. Mitigation strategies focus on reducing both the "attractiveness" and "predictability" of the fishing gear. For example, fishermen in Alaska have attempted to stop hauling while whales are in the area and wait to resume the haul until the animals have left. Some studies have also suggested that setting "dummy" surface buoys with no attached longlines may distract whales. Other suggested strategies include avoiding marine mammal "hotspots" if possible, moving and fishing in a different area if depredation is occurring, setting strings with no hooks on them in between regular sets, and working to reduce the amount of noise radiated into the water column during haulback (reviewed in Donoghue *et al.*, 2003). For the Atlantic take reduction plan, a proposed reduction in mainline length to less than 20 nautical miles is predicted to reduce marine mammal bycatch by between 30-45% depending upon how fishermen compensate for the resulting reduction in effort (L. Garrison, unpublished analysis). Other research areas include improving methods to detect marine mammals near fishing gear using passive acoustic detection methods and improving the capability of fishermen to safely remove gear from marine mammals. It is likely that some combination of these methods will be required to reduce both economic losses due to depredation and the impacts of longline fishing on marine mammal populations.

Billfish Longline Bycatch Reduction: A Summary of Hook Performance Research

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Introduction

The billfishes (Family Istiophoridae) are apex predators that support recreational fisheries valued in the billions of dollars in subtropical and tropical pelagic waters. Despite their ecological and economic importance, little is known about their basic biology and ecology, especially their growth, reproduction and movement within a dynamic oceanic habitat. Most billfish research to date has focused on issues of stock structure, population abundance and fishing mortality as part of stock assessments. There is general consensus that the principal source of mortality on adult istiophorid billfishes is pelagic longline fisheries (Cramer 2004). For the most part, billfish are caught incidentally as bycatch in fleets primarily targeting tunas (Scombridae) and swordfish (*Xiphias gladius*). Therefore, understanding billfish bycatch in longline fisheries is key to reducing uncertainties in stock assessments, implementing appropriate management measures and developing new techniques to reduce incidental billfish capture, injury, and mortality.

Empirical studies on the istiophirids (marlins, sailfish and swordfish) that have potential relevance to billfish bycatch reduction are relatively new, few and based primarily on research conducted in the northwestern Atlantic and/or the Caribbean Sea. Consequently, the focal species in this small body of literature are: blue marlin (*Makaira nigricans*), white marlin (*Tetrapterus albicans*) and sailfish (*Istiophorus platypterus*). Comparatively less data have been collected on Pacific sailfish and striped marlin (*Tetrapterus audax*). As is the case with virtually all aspects of spearfish ecology and population dynamics, there is virtually no information relevant to addressing bycatch reduction for the spearfishes (e.g., *Tetrapterus pfluegeri, T. georgii, T. belone, T. angustirostris*) in any of the world's oceans.

Hook Studies

Nine empirical studies have compared the relative "performance" of circle hooks with respect to billfish catch, injury and/or mortality. Approximately half of these studies examined circle hook performance in recreational fisheries specifically targeting billfish (Prince et al. 2002; Domeier et al. 2003; Horodysky and Graves 2004; Prince et al. 2007), while the others were based on commercial longline fisheries where tuna and/or swordfish were targeted (Falterman and Graves 2002; Kerstetter and Graves 2006a; Kerstetter and Graves 2006b; Kerstetter et al. 2006; Diaz 2007; Rice et al. in prep.). Most information pertains to sailfish and white marlin and to a lesser extent blue marlin and striped marlin. As noted above, no quantitative hook evaluations relevant to spearfishes have been conducted. Numbers of individuals (interactions) per billfish species have ranged from 4 to 766. The most common hook evaluations relevant to billfish compare the performances of 0-degree offset circle hooks and 10-degree offset J hooks. Four studies directly compare the performance of circle hooks with different degrees of offset (Prince et al. 2002; Domeier et al. 2003; Prince et al. 2007; Rice et al. in prep.). In addition, samples sizes, hook sizes, other hook specifications, baits, baiting and fishing methods have not been uniform among studies.

Recreational Fishing: Catch rates

In a Pacific recreational trolling fishery for sailfish and blue marlin, Prince et al. (2002) found no catch rate differences between 5-degree offset circle hooks and 0-degree offset "J" hooks. Similarly, they detected no catch rate differences between 0-, 5- and 15-degree offset circle hooks in an Atlantic recreational fishery for sailfish. Examining a recreational fishery for striped

marlin in eastern Pacific waters, Domeier et al. (2003) found almost identical catch rates for a J hook (10-degree offset) as compared to two circle hooks (with 0-degree and 10-degree offset). In a recent study on an Atlantic sailfish recreational fishery, Prince et al. (2007) evaluated changes with drop-back time in the performance of two types of circle hook (both with 0-degree offset) and one J hook (5-degree offset). At the greatest drop back interval (i.e., > 15 seconds) differences between circle and J-hooks were not significant.

Longline Fishing: Catch Rates

Working on a longline fishing vessel primarily in northwestern Atlantic waters, Kerstetter and Graves (2006a) compared the performance of circle hooks and "J" hooks with 0-degree and 10-degree offset, respectively. They did not report significant catch rate differences for the sailfish or white marlin that were caught on the two hook types. Diaz (2007) compared circle and "J" hook catch rates in a commercial longline fishery in a Gulf of Mexico fishery targeting yellowfin tuna. He detected no significant catch rate differences for blue marlin or white marlin caught on 0-degree offset circle hooks and 10-degree offset "J" hooks. Rice et al. (in prep) compared blue marlin, white marlin and sailfish catch rates between two circle hook types deployed on commercial longlines. They found a significantly higher catch rate for sailfish on 10-degree offset circle hooks than for 0-degree offset circle hooks; corresponding results for blue marlin and white marlin were not statistically significant.

Recreational Fishing Injury/Bleeding

Prince et al. 2002 found significantly more sailfish were "deep-hooked" with 0-degree offset "J" hooks (46%) than with 5-degree offset circle hooks (2%) in the Pacific recreational trolling fishery. In the same fishery, incidence and severity of bleeding was significantly higher for sailfish caught with the 0-degree offset "J" hooks than the circle hook. In their comparison of 0-, 5- and 15-degree offset circle hooks in an Atlantic recreational trolling fishery for sailfish, Prince et al. (2002) found deep-hooking and bleeding both increased with increasing offset. Domeier et al. (2003) reported similar results in their comparison of circle (0- and 10-degree offset) versus J hooks in a Pacific recreational striped marlin fishery. Significantly more deep-hooking and bleeding was associated with fish caught on J hooks. Focusing on a recreational white marlin fishery in Western Atlantic waters, Horodysky and Graves (2006) recorded hook location on individuals that were subsequently released bearing pop-up satellite tags. They observed a tendency for more deep-hooking for white marlin with the 10-degree offset "J" hooks, but this difference was not statistically significant. Kerstetter and Graves (2006a) also examined hooking location and post-release mortality for white marlin using pop-up satellite tags, but with a focus on longline-caught individuals. Again, hook location differences were minor between 0-degree offset circle hooks and 15-degree offset J hooks were minor. In the Prince et al. (2007) study, which compared circle hooks (0-degree offset) and J hooks (5-degree offset) in a recreational Atlantic sailfish fishery, incidence of bleeding was significantly higher in fish caught on J hooks than circle hooks.

Longline Fishing: Injury/Bleeding

Kerstetter et al. (2006) tested for hook location differences in sailfish caught in the Brazilian longline fishery. They found a significantly higher likelihood of deep-hooking with 10-degree offset "J" hooks versus 0-degree offset circle hooks. In the Kerstetter and Graves (2006b) longline study comparing 0-degree offset circle hooks with 10-degree offset J hooks, hooking location differences were not significant for white marlin and sailfish. Similarly, Rice et al. (in

prep) detected no significant hook location differences for sailfish, white marlin or blue marlin caught on 0- versus 10-degree offset circle hooks deployed on longline gear.

Recreational Fishing: Mortality
In the striped marlin fishery study by Domeier et al. (2003), a subset of the fish caught on circle or J hooks were released bearing pop-up satellite tags to gain insight into post-release mortality. They reported: (1) identical mortality rates for striped marlin caught on 5-degree offset circle hooks versus 10-degree offset J hooks; and (2) a minor (i.e., not significant) difference in post-release mortality between fish caught on 0-degree offset versus 5-degree offset circle hooks. The Horodysky and Graves (2006) study was similar to the Domeier et al. (2003) study in that pop-up satellite tags were deployed on recreationally-caught white marlin to reveal post-release mortality. However, they found significantly higher post-release mortality for white marlin caught on "J" hooks (10-degree offset) versus circle hooks (0-degree offset).

Longline Fishing: Mortality
In the Kerstetter et al. (2006) study of the Brazilian longline fishery, they found significantly greater mortality in sailfish caught with 10-degree offset "J "hooks relative to 0-degree offset circle hooks; however, corresponding mortality comparisons for blue and white marlin were not significant. Using pop-up satellite tags, Kerstetter and Graves (2006a), found significantly higher post-release mortality in white marlin caught with J hooks (15-degree offset) versus circle hooks (0-degree offset). In the Kerstetter and Graves (2006b) longline catch study, mortality differences were not significantly different between hook types for white marlin and sailfish. In the Diaz (2007) longline study in the Gulf of Mexico, blue marlin and white marlin mortality rates were significantly higher for J hooks (10-degree offset) versus circle hooks (0-degree offset). For longline-caught blue marlin and white marlin, Rice et al. (in prep.) found significantly higher mortality associated with circle hooks with 10-degree offset versus 0-degree offset. For sailfish, higher mortality was also associated with 10-degree offset circle hooks, but the difference was not statistically significant.

Summary
Outlined above are the results of nine studies of potential relevance to billfish bycatch reduction during longline fishing via modification of hook type. Of these, four examine recreational fisheries that target billfish and five examine billfish as bycatch in commercial longline fisheries. Each study reports on some aspect of the relative "performance" of circle hooks with respect to billfish catch, injury and/or mortality (either at boatside or post-release as interpreted from pop-up satellite tag data). Focal species are blue marlin, white marlin, striped marlin and sailfish. No study found statistically significant catch rate differences for billfish between circle and J hooks. One study found significantly higher sailfish catch rates on 10-degree offset circle hooks as compared to 0-degree offset circle hooks. Of the eight studies examining billfish injury/bleeding associated with circle versus J hooks, four reported significantly more trauma associated with the latter hook type; the remainder did not detect significant differences. One of the three studies comparing billfish injury among different styles of circle hook found the incidence of deep-hooking increased with increasing degree of offset. In the six studies comparing billfish mortality in relation to circle and J hooks, four reported significantly higher mortality associated with J hooks than circle hooks. Of the three studies comparing billfish mortality rates between two types of circle hook, two reported no difference, whereas the second found the circle hook with greater offset (10-degree) resulted in higher (sailfish) mortality. Collectively, these studies

support the notion that minimizing or eliminating the use J hooks has conservation benefits for billfishes.

Sharks

Workshop participants discussed the status of shark bycatch in longline fisheries, drawing on their own knowledge on this topic and articles included in the workshop reader. A formal presentation and summary document were not presented.

Section 2: Breakout Session Discussion and Evaluation of Current Bycatch Reduction Efforts

Breakout session discussions took place during the afternoon of Day 1 and the morning of Day 2. The purpose of the breakout sessions was to provide participants with robust opportunities in small group settings to share current knowledge regarding bycatch reduction efforts. These discussions, in turn, were intended to inform Day 3 deliberations on best gear and fishing practices and development of an action plan for directing NMFS' future domestic and international sea turtle longline bycatch reduction efforts.

The goal of the breakout sessions was to invite participants to discuss and evaluate current longline bycatch reduction efforts. The primary focus was on sea turtle bycatch in longline fisheries, although Workshop participants were also asked to bring in relevant information regarding bycatch of other species groups (i.e., seabirds, marine mammals, billfish, and sharks).

Two parallel breakout groups[1] each addressed the same five topics. The breakout group instructions and discussion questions for each topic are listed below.

These breakout session discussions and subsequent plenary discussions provided a useful starting point for the Day 3 deliberations, which culminated in the recommended best gear and fishing practices and action plan presented in this meeting summary.

Discussion Topic 1: Global Longline Fishery Characterization

The purpose of this discussion was to help ensure that workshop discussions and recommendations consider the effects of all relevant global longline fisheries. Participants were asked to review and discuss each fishery on the list below to determine whether it accurately encompasses and categorizes longline fisheries of concern. Participants were also asked to identify which bycatch species are of concern for each fishing category.

- Classic pelagic swordfish – shallow set
- Classic pelagic tuna – deep set
- Artisanal mahi mahi
- Artisanal tuna, billfish, shark
- Other shallow set (Spain, Azores, Japan)

[1] Breakout group composition was organized to ensure a broad range of expertise in each breakout group.

Discussion Topic 2: Reducing Hooking

The purpose of this discussion was to explore and assess recent strategies for reducing hooking of sea turtles and other bycatch species. Participants were asked to respond to a series of questions on the topics of: hook design, bait type, use of lightsticks, time of setting and hauling, and fishing depth (see questions below).

1. Hook Design (type, size, offset): consider species and size class in discussions

    - How important are the following hook design elements to sea turtle bycatch reduction?
        - Hook size versus hook shape
        - Circle hook size and offset
        - Appendage and ring hooks and other adapted or non-circle hook designs
    - Is there any new information about circle hooks that could improve bycatch reduction?
    - Should NMFS continuing further developing and refining circle hooks as the best hook design?
    - What problems are associated with the lack of standardization in width measurement and hook design?

2. Bait

    - How important are the following factors to sea turtle bycatch?
        - Different bait types
        - Bait size
        - Baiting technique
        - Access to recommended baits
    - Is there sufficient information to develop "best practices" with regard to the use of bait?

3. Lightsticks

    - What are the impacts of lightsticks on sea turtle bycatch?
    - What new studies can best inform our understanding of this issue?

4. Time of Setting and Hauling

    - How important is the timing of setting and hauling to sea turtle bycatch?
    - Is there sufficient information to develop "best practices" for sea turtles with regard to the timing of setting and hauling?
    - If so, how would these practices vary by fishing category?

5. Fishing Depth

    - What is the impact of fishing depth on sea turtle bycatch?
    - Is there sufficient information to develop "best practices" with regard to fishing depth for sea turtles?
    - How would these practices vary by fishery category?

Discussion Topic 3: Reducing Entanglement

The purpose of this discussion was to explore and assess recent strategies for reducing entanglement of sea turtles and other bycatch species. Participants were asked to address the following questions.

- What do we know about the relative impacts of the following factors relative to reducing sea turtle entanglement?
    - Hook design
    - Hook placement relative to floats
    - Use of leaded swivels and their placement
    - Gangion design (material/stiffness/thickness)
    - Setting/hauling time
    - Fishing depth
    - Lightsticks
    - Bait type and size
    - Method of entanglement (e.g. foul hooked; foul hook location; entangled only)
    - Where on the gear entanglement occurs (e.g. gangion, mainline, floatline, combination)
    - Turtle species and size
- What do we know from other gear types that can inform the issue of longline entanglement?
- What studies are needed?

Discussion Topic 4: Safe Handling and Release

The purpose of this discussion was to explore current problems with dehookers and other possible changes to existing requirements for safe handling and release tools and/or techniques. Participants were asked to address the following questions.

- What are some of the problems with dehookers relative to certain hooks and how can they best be addressed?
- Are any changes needed to the existing requirements for safe handling and release tools and/or techniques?

Discussion Topic 5: Experimental Design

The purpose of this discussion was to explore key issues relative to current experimental data and estimation methods. Participants were asked to address the following questions.

- What are the key issues relative to the analytical confidence and statistical inference of:
  - Our experimental data
  - Our estimation methods
- What are the key issues relative to interpreting and standardizing research results?

Section 3: Plenary Presentations and Discussions on Global Implementation of Bycatch Reduction

Workshop participants received presentations and engaged in follow-up discussion on the topic of global implementation of bycatch reduction, especially as it relates to two key sections of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA):

- *Section 103*. Pat Moran provided an overview of international provisions in the MSRA and engaged the Workshop participants in a discussion of possible implications for reducing longline bycatch. Workshop participants discussed which specific countries and/or regional fishery management organizations (RFMOs) are the greatest concern for longline bycatch, how the U.S. is currently engaged with these entities, and how the U.S. can more effectively reach out to artisanal fleets and address artisanal bycatch issues.

- *Section 316*. Lee Benaka provided an overview of the Bycatch Reduction Engineering Program (BREP) established by the MSRA. Workshop participants discussed possible ways that they BREP may contribute to ongoing longline bycatch reduction efforts and the role that the BREP might play in driving gear modifications and research.

These discussions informed Day 3 development of an action plan for directing domestic and international longline bycatch reduction efforts.

Section 4: Plenary Discussion and Initial Prioritization of Research Needs

Throughout discussions on Day 1 and the morning of Day 2, any research needs identified were recorded for subsequent discussion. Then, during the afternoon of Day 2, participants reviewed and discussed the list of 34 research needs that emerged throughout the course of the prior breakout session and plenary discussions. The research needs were grouped under the following general categories: hook type/size; bait; light sources; species biology/behavior; fishing depth; gear and gear configurations; and fishing practices.

Then, as a preparation step for the Day 3 deliberations, participants were asked to prioritize the list of research needs, applying their own professional judgment and interpretation to these guiding considerations:

- Will the research provide the most significant conservation benefit for turtles, keeping in mind positive or neutral effects on other bycatch species?
- Will the research provide information urgently needed to motivate conservation actions in international longline fisheries, especially where we have limited or no success or progress?
- Will the outcomes (results) from the research answer key outstanding questions without which we are currently hampered or prevented from moving forward with sea turtle bycatch reduction?

The results of the informal ranking exercise are presented in Appendix D. The top four issues included:

1) Assess the effect of circle hook size on target catch retention.
2) Develop fisheries specific experimental designs to evaluate circle hooks for HMS species in the Atlantic, Pacific, and Indian Oceans.
3) Evaluate the effect of circle hooks (size and shape) on seabirds, billfish, marine mammals, and sharks.
4) Investigate the type and frequency of hooking location and injuries by type and size of hook.

During the plenary discussion that followed, participants recognized that the list of research needs flowed directly from the plenary and breakout session topics discussed on Days 1-2, and does not represent the complete universe of research priorities related to longline bycatch reduction. Participants also noted that many of the research needs identified were stated as broad needs rather than as specific research projects. As such, participants acknowledged that the research needs discussed do not constitute a comprehensive list of specific research topics on longline bycatch reduction.

Closed Federal Session (Day 3)

The primary purposes of the closed federal session on Day 3 were to develop two important products: 1) a list of best gear and fishing practices, 2) an action plan to guide U.S. efforts to reduce marine turtle bycatch in both domestic and international longline fisheries. As part of the second item, participants also intended to initiate planning for a possible follow-up international workshop on circle hooks.

Key outcomes from these federal discussions are highlighted in parts III and IV below.

PART III. BEST GEAR AND FISHING PRACTICES

On the morning of Day 3, the federal closed session, agency participants drew on the presentations and discussions from Days 1-2 as well as the information presented in the workshop reader to develop recommendations on best gear and fishing practices to reduce marine turtle bycatch in longline fisheries. Participants identified best gear and fishing practices for each of five major categories of fisheries: swordfish (classic, shallow), bigeye (classic, deep), other pelagics (tunas, sharks, combination), mahi-mahi (artisanal), and demersal. Best gear and fishing practice sub-categories discussed included: hook type/size, bait, gear configuration, light sources, set/haul time, fishing depth, and turtle avoidance tactics. The results of this exercise are presented in Appendix A.

In the plenary discussion, participants made the following additional key comments and suggestions for further developing best gear and fishing practices:

- Develop introductory text that addresses the following:

    - Clarify that while the above-recommended best practices focus specifically on marine turtles, consideration should also be given to the potential impacts on other bycatch species.
    - Discuss the lack of standardized criteria for defining “circle hook” and measuring hook size. Some participants noted they define a large circle hook as a circle hook with a “minimum width” of no less than 4.9 cm. Workshop participants used a “minimum width” definition during discussions on hook type and size. For this purpose, "minimum width" is defined as the shortest distance across the outside perimeter of the hook, while substituting the concavity in that perimeter by a straight line. This is the minimum dimension obtained by constraining the hook between a draftsman's parallel rules, or similar parallel surfaces, such as the walls of a cylinder. The logic of this dimension is that it represents the diameter of the narrowest tube through which a hook could pass, which is thought to be relevant to ingestion by sea turtles. Note that generally size "18/0" or larger circle hooks, or size "5.2 sun" or larger circle hooks, meet or exceed this minimum width dimension, but those size terms refer to the length of steel that is bent to manufacture the hook, not to its width. It is possible to manufacture those sizes of hooks with a minimum width that is less than 4.9 cm, such as by making the shank longer or the profile more oval.

- Insert links between the best practices identified in the table and data/information (e.g., journal articles, published reports) that support these best practices. This will be important for exporting these best practices to non-U.S. fisheries.

- Treat the best practices document as a “living document.”

- Post the best gear and practices on relevant NMFS websites.

PART IV. ACTION PLAN

Development of an Action Plan

On the afternoon of Day 3, federal participants were asked to contribute to the development of a near-term (1-3 years) action plan for guiding NMFS' domestic and international efforts to implement best practices to reduce marine turtle bycatch in longline fisheries.

This discussion was informed by Day 1-2 discussions on best gear and fishing practices, global implementation and the implications of MSRA, and research needs and priorities.

Based on the guidance of the Steering Committee, the workshop participants prepared a concise action plan, organized as a table with the following headings: domestic bycatch reduction, international bycatch reduction, safe handling and release practices, gear research, capacity building and outreach, and information dissemination and packaging.

The recommended action plan is provided in Appendix B.

In the plenary discussion, participants made the following additional key comments and suggestions related to developing the action plan.

- Develop introductory text for the action plan to address the following:
    - Clarify that while the action plan focuses primarily on marine turtles, consideration was also given to the potential impacts on other bycatch species.
    - As appropriate, actions in the plan should be considered within the context of MSRA.
    - The plan was not intended to include every possible action and does not preclude, for example, taking opportunistic or other actions that are likely to result in conservation benefits.

- NMFS needs to clearly identify gaps where the U.S. has not addressed domestic bycatch issues.

- Insert links between the action items and data/information (e.g., journal articles, published reports) that support these actions. This will be important to persuade other countries to pursue similar actions.

- The “gear research” action items reflect tailored research projects that were based on the top ranking gear research needs identified during the research prioritization exercise on Day 2.

- The Workshop participants did not fully complete the sections on the plan identifying timeline and responsible party. As a key next step, Workshop conveners completed this section and sent the updated action plan to all workshop participants for review.

Advice for Convening a Follow-Up International Meeting on Circle Hooks

In his welcoming remarks, NMFS Assistant Administrator Bill Hogarth described the need to expand the workshop's discussions to the international community. He indicated his aspiration to convene an international meeting on circle hooks in 2008 although funding would need to be secured*.

On Day 3, workshop participants discussed how to leverage the workshop's accomplishments. They also discussed preliminary planning for an international meeting on circle hooks, including possible scope, format, and participants for such a meeting. Key points raised included the following:

- Effects of circle hooks on both target and bycatch species should be considered at such a workshop.

- Recognize that the meeting has two potential audiences: technical experts, and policy decision makers. Some workshop participants suggested approaching the meeting as a two-step process. The first step would be to convene the technical experts, who need to review the demonstrated benefits of circle hooks. The second step would involve policy decision makers, who are ultimately responsible for implementing changes to gear and fishing practices. These participants noted, however, that a multi-step process would cost more money and take more time.

- One potential approach to save costs would be to convene the meeting in conjunction with the September 2008 American Fisheries Society annual meeting in Canada.

- Efforts should be made, if possible, to extend invitations beyond the commercial fishing sector to also include representatives of recreational longline fishing and private fisheries organizations.

*At the time this technical memorandum was printed, the proposed international circle hook workshop had not been scheduled pending resolution of funding issues.

APPENDIX A: BEST GEAR AND FISHING PRACTICES (See page 24 for discussion)

Best Gear and Fishing Practices to Reduce Marine Turtle Bycatch in Longline Fisheries					
Type of Fishery	**Swordfish (classic, shallow)**	**Bigeye (classic, deep)**	**Other pelagics (tunas, sharks, combination)**	**Mahi (Artisanal)**	**Demersal**
Hook					
Type	Circle	Circle	Circle	Circle	Circle
Minimum outer width (size)	> = 49 mm (e.g., 18/0)	> = 49 mm (e.g., 18/0)	> = 42 mm (e.g., 16/0), prefer larger if practical	> = X (e.g., 14/0), prefer larger if practical	insufficient info; larger is best
Offset	prefer non-offset, not > 10 degree offset	prefer non-offset, not > 10 degree offset	prefer non-offset, not > 10 degree offset	prefer non-offset, not > 10 degree offset	prefer non-offset, not > 10 degree offset
Bait					
Type	Whole fish	Whole fish	Whole fish	Whole fish	Whole fish
Size	As large as practical	As large as practical	As large as practical	As large as practical	As large as practical
Baiting Technique	Cover the point of hook	Cover the point of hook	Cover the point of hook	Cover the point of hook	Cover the point of hook
Gear Configuration					
Float line length	insufficient info	see Fishing Depth	insufficient info	At least 2 m long	n/a
Branchline length	length of branchline exceeds length of floatline by at least 10%	n/a	length of branchline exceeds length of floatline by at least 10% in shallow set fisheries	length of branchline exceeds length of floatline by at least 10%	n/a
Mainline and branchline type	mono	mono or tarred rope	mono or tarred rope	mono, at minimum 1 m of mono on either side of float and mono float line	insufficient info
Weights/leaded swivels	minimum weight 45 g within 1 m of the hook	minimum weight 45 g within 1 m of the hook	minimum weight 45 g within 1 m of the hook	n/a	n/a
Light Sources	insufficient info	Should not use	Should not use	Should not use	Should not use

APPENDIX A: BEST GEAR AND FISHING PRACTICES (Continued)

Type of Fishery	Swordfish (classic, shallow)	Bigeye (classic, deep)	Other pelagics (tunas, sharks, combination)	Mahi (Artisanal)	Demersal
Set / Haul Time	Minimize time gear is in the water during daylight hours				
Set Time	Set after dark	insufficient info	insufficient info	insufficient info	insufficient info
Haul Time	Begin haul before daylight	insufficient info	insufficient info	insufficient info	insufficient info
Fishing Depth	n/a	all hooks >100 m in depth	n/a	n/a	insufficient info; fishing below 100 m probably better
Turtle Avoidance Tactics	Move out of area and share turtle bycatch information with nearby vessels	Move out of area and share turtle bycatch information with nearby vessels	Move out of area and share turtle bycatch information with nearby vessels	Prohibit fishing off nesting beaches, in internesting habitats, and hotspot foraging habitats; move out of area and share turtle bycatch information with nearby vessels	Prohibit fishing off nesting beaches, in internesting habitats, and hotspot foraging habitats; move out of area and share turtle bycatch information with nearby vessels

Note where combinations of gear are needed to achieve conservation benefits.
Considerations should be given to the potential impacts on other bycatch species (e.g., seabirds, marine mammals, billfish, sharks).

APPENDIX B: TABLE OF NEAR-TERM ACTION PLAN (See page 25 for discussion)

Near-Term (1-3 Years) Action Plan for Guiding NMFS Domestic and International Efforts to Implement Best Practices to Reduce Marine Turtle Bycatch in Longline Fisheries			
FOCUS AREAS	**ACTIONS**		**ESTIMATED TIMELINE**
Domestic Bycatch Reduction	Evaluate domestic longline fisheries using current data and recommended best practices and modify regulations accordingly.		2008-2010
	Modify HMS bait requirements (e.g., prohibit squid) in the Atlantic and Gulf based on current data.		2009-2010
	Require circle hooks in all U.S. longline fisheries with documented sea turtle bycatch.		2009-2010
	Examine applicability of longline recommended best gear and practices to other hook and line fisheries.		2008-2009
International Bycatch Reduction	**RFMOs / IGOs**	Compare and harmonize sea turtle resolutions in various RFMOs.	By 2009
		Establish or strengthen observer programs in RFMOs with regard to sea turtle and other bycatch data collection.	By 2009
		Pursue binding measures in appropriate RFMOs based on recommended best gear and practices.	Ongoing
	ICCAT	Pursue binding circle hook measure at November 2007 meeting	Nov 2007
	IATTC	Pursue binding circle hook measure at June 2008 meeting.	June 2008
	WCPFC	Propose mandatory sea turtle bycatch mitigation measure at WCPFC 4.	Dec 2007
	IOTC	Evaluate current measures and work with member nations to adopt FAO guidelines and recommended best gear and practices.	By 2009
	FAO	Connect FAO guidelines and technical advice with recommended best gear and practices and recommend revising as needed.	COFI 2009
		Evaluate whether converting current FAO guidelines into CCRF technical guidelines is needed.	COFI 2009
		Seek incorporation of longline recommended best gear and practices into FAO technology, transfer, and training programs.	COFI 2009
Bilaterals	**Spain**	Convene a technical bilateral with Spain, with sea turtle bycatch reduction in longline fisheries as one of the primary agenda items.	2008
	Japan	Challenge Japan to provide ideas, data, and proposed mandatory management measures for bycatch reduction.	May 2008
	Taiwan	Work closely with Taiwan to capitalize on the commitments they've made to the U.S. on bycatch reduction.	Ongoing

APPENDIX B: TABLE OF NEAR-TERM ACTION PLAN (Continued)

FOCUS AREAS	ACTIONS		ESTIMATED TIMELINE
Bilaterals (Continued)	**Korea**	Re-evaluate results of Korean circle hook experiment.	Oct 2007
		Convene a bilateral with Korea, with sea turtle bycatch reduction in longline fisheries as one of the primary agenda items.	July 2008
	China	Convene a bilateral with China, with sea turtle bycatch reduction in longline fisheries as one of the primary agenda items.	2008
Turtle Agreements	**IAC**	Pursue fisheries specific conservation measures.	2009-2010
	IOSEA	Examine potential avenues for sea turtle longline bycatch reduction under MOU.	2008
MSRA	Use recommended best gear and practices to guide implementation of MSRA.		Ongoing
	Leverage MSRA as a tool (including positive recognition for reducing bycatch) to achieve bycatch reduction and ensure staff with sea turtle expertise are engaged in MSRA implementation.		Ongoing
Safe Handling and Release Practices	Examine whether existing guidelines can be simplified for broader use domestically and internationally.		2008
	Review needs for additional translation of guidelines.		2008
	Review Atlantic and Pacific guidelines and certifications for consistency.		2008
Gear Research	Conduct experiment (similar in rigor and analysis to NED experiment) on the effects of light sources on leatherback bycatch in cooperation with Canada.		2008-2009
	Conduct experiment (similar in rigor and analysis to NED study) on circle hooks and bigeye catch retention in cooperation with Spain to corroborate U.S. results.		2008-2009
	Develop USG-wide coordinated and prioritized research plan for longline sea turtle bycatch reduction.		By 2009
	Mine and analyze current observer and experimental data sets for all relevant information on other bycatch species to assess impacts of circle hooks, and ensure these data are collected in all future research.		2008
	Develop template for reporting research results from bycatch reduction experiments.		June 2008
Capacity Building / Outreach	Encourage international training in safe handling and release protocols.		Ongoing
Information Dissemination / Packaging	Convene an international workshop on circle hooks.		2008-2009
	Develop website on recommended best gear and practices with links to supporting data, research, regulations, etc.		2008
	Develop customized information package for particular longline fisheries or fleets for targeted dissemination where necessary for reducing bycatch reduction.		Ongoing

APPENDIX C: WORKSHOP AGENDA

TUESDAY, SEPTEMBER 18, 2007 (8:00AM – 6:00PM) – WALLINGFORD & FREMONT ROOMS

8:00 – 8:45 Welcome and Opening Comments – *Barbara Schroeder*
Introduction of Participants

8:45 – 9:00 Overview of Agenda, Ground Rules, and Workshop Format – *CONCUR, Inc.*

Morning Session: *Overview of Bycatch Species Groups*

9:00 – 9:40 Marine Turtles – *John Watson*
9:40 – 10:00 Seabirds – *Kim Rivera*

10:00 – 10:30 Coffee Break

10:30 – 10:50 Marine Mammals – *Lance Garrison*
10:50 – 11:10 Billfish – *Joe Serafy*
11:10 – 11:30 Sharks – *Group Discussion*

11:30 – 12:00 Working Group Guidance and Assignments for Afternoon Session – *CONCUR, Inc.*

12:00 -1:00 Lunch

Afternoon Session: *Working Groups to Discuss and Evaluate Current Bycatch Reduction Efforts*

1:00 – 1:30 Discussion Topic I: Global Longline Fishery Characterization
1:30 – 3:00 Discussion Topic II: Reducing Hooking

3:00 – 3:30 Coffee Break

3:30 – 5:30 Discussion Topic II: Reducing Hooking (continued)

5:30 – 6:00 Report Back from Working Groups in Plenary

WEDNESDAY, SEPTEMBER 19, 2007 (8:30AM – 5:30PM) – WALLINGFORD & FREMONT ROOMS

8:30 – 8:45 Opening Remarks – *Bill Hogarth, NMFS Assistant Administrator*

Morning Session: *Working Groups to Discuss and Evaluate Current Bycatch Reduction Efforts (continued)*

8:45 – 10:00 Discussion Topic III: Reducing Entanglement

10:00 – 10:30 Coffee Break

10:30 – 11:00 Discussion Topic IV: Safe Handling and Release
11:00 – 12:00 Discussion Topic V: Experimental Design

12:00 -1:00 Lunch

Afternoon Session: *Plenary Reports, Global Implementation, and Future Research*

1:00 – 1:30 Report Back from Working Groups in Plenary

1:30 – 3:00 Global Implementation of Bycatch Reduction and MSRA Section 103 – *Pat Moran*

3:00 – 3:30 Coffee Break

3:30 – 4:00 Global Implementation of Bycatch Reduction and MSRA Section 316 – Lee Benaka

4:00 – 5:30 Future Research Discussion and Prioritization

THURSDAY, SEPTEMBER 20, 2007 (8:30AM – 5:00PM) – WALLINGFORD ROOM

Federal Government Planning Session (federal participants only)

8:30 – 9:00 Planning Session Overview and Guidance – *CONCUR*

9:00 – 10:00 "Best Gear and Fishing Practices" - develop updated recommendations for reducing sea turtle bycatch in longline fisheries, while considering effects on all bycatch species

10:00 – 10:30 Coffee Break

11:00 – 12:00 "Best Gear and Fishing Practices" (continued)

12:00 – 1:00 Lunch

1:00 – 3:00 Develop Action Plan for Directing Domestic and International Marine Turtle Longline Bycatch Reduction

3:00 – 3:30 Coffee Break

3:30 – 4:30 Develop Action Plan (continued)

4:30 - 5:00 Next Steps and Closing Remarks

5:00 Meeting Adjourns

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APPENDIX E: GROUND RULES

The purpose of this workshop is to develop a framework for an Agency action plan to guide U.S. efforts to reduce marine turtle bycatch in both domestic and international longline fisheries. To inform the plan, workshop participants will review and discuss the results of all U.S. longline bycatch reduction efforts to date, fully assess the available information on the effects of these efforts on key bycatch species and target catch, and identify gaps in our knowledge. The following ground rules are intended to foster and reinforce constructive interaction and deliberation among the workshop participants. They emphasize clear communication, respect for divergent views, creative thinking and collaborative problem solving. To that end:

1. **Workshop organization.** Days 1-2 of the workshop are open to invited federal and non-federal participants as well as public observers. Day 3 will be a closed planning session in which only Federal Government officials will participate.

   This workshop is not chartered under the Federal Advisory Committed Act; nor is it noticed in the *Federal Register*. For these reasons, discussions during Days 1-2 of the workshop will focus on exchanges of facts and information. The aim is not to seek consensus advice on future Federal Government policies or actions from participants as a group. Any information, ideas, recommendations, or advice provided to NMFS will reflect the views of individual workshop participants. All of this information will be considered in the Federal planning session on Day 3.

2. **Participation and Roles.** Participants have been invited based upon their expertise in longline fishery bycatch issues.

   - Role of Participants: In their role of providing expert input for NMFS' consideration, participants are responsible for sharing pertinent information, asking clarifying questions, and expressing professional views in both plenary and breakout sessions. Everyone will participate; no one will dominate. Everyone will help stay on track.

   - Role of Observers: Observers may view and track the deliberations on Days 1-2. They may be called upon by the workshop conveners or facilitators to help clarify an unresolved point of discussion based on their expertise.

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

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

5. **Prioritization of future research needs.** During discussions focused on prioritizing future research needs, participants are encouraged to consider their own interests as well as those of other participants. Federal participants will consider the outcomes of the prioritization activity on Day 3 of the workshop.

APPENDIX F: RESULTS OF RESEARCH NEEDS PRIORITIZATION

Research Item	Score
Assess the effect of circle hook size on target catch retention.	25
Develop fisheries specific experimental designs to evaluate circle hooks for HMS species in the Atlantic, Pacific, and Indian Oceans.	24
Evaluate the effect of circle hooks (size and shape) on seabirds, billfish, marine mammals, and sharks.	23
Investigate the type and frequency of hooking location and injuries by type and size of hook.	23
Evaluate post-hooking mortality.	22
Evaluate the effects of light sticks or other light sources on leatherback bycatch and target catch. As a first step, compare Canadian and Japanese longline data to U.S. data.	18
Investigate increasing line stiffness and the effects on bycatch rates.	18
Develop a hook catalog.	17
Study effects of wire size and bend strength for target catch, marine mammals, sharks, and billfish.	14
Investigate what is attracting different leatherbacks to gear (light source investigations needed, see above) and characterize that interaction.	14
Compile an inventory of longline fishing fleets, including vessel characteristics, to inform where bycatch reduction measures might apply or be needed.	13
Evaluate actual fishing depth of individual gear configurations, such as with hook temperature and depth recorders.	12
Evaluate effects of appendage hooks on bycatch and target catch.	11
Conduct full factorial (2x2, hook type and bait type) studies.	11
Test live bait in the Gulf of Mexico to determine effects on bycatch rates and elsewhere for seabirds.	11
Test different types of circle hooks against each other.	9
Study turtles' vertical movements, especially relative to the thermocline, other oceanographic features, different life history stages, etc.	9
Investigate what is attracting other bycatch species to gear and characterize that interaction. Investigate reducing the visibility of gear (some in progress) making attractants invisible and scare items visible (artisanal).	9
Conduct research regarding tournaments and recreational fisheries in relation to circle hooks.	8
Examine role of the hook size and shape in reducing entanglement.	7
Explore light sources with variable brightness, blinking lights, wavelengths, etc. for different life stages and species.	6
Investigate interaction rates relative to hook/float placement as well as lead swivels.	6
Investigate seabird interaction rates with weighted branch lines or lead swivels.	6

Research Item	Score
Evaluate hauling and setting effects on bycatch (e.g., evaluate current bycatch data for deep set fisheries; if there is high bycatch of hard shelled turtles, there is a high likelihood they are being caught during setting or hauling). Consider entanglement and hooking.	6
Document and conduct research on the nature of marine mammal entanglement. Quantify hookings, nature of entanglements, and species involved.	5
Evaluate the effects of ringed hooks on sea turtles and target catch.	4
Evaluate fishing below 100 meters in areas where shallow set fishing has high turtle bycatch rates.	4
Investigate measuring sink rates with a line setter as a seabird mitigation strategy.	4
Examine 10 degree or less offset versus non-offset hooks relative to entanglement of turtles.	3
Study variable bait sizes with constant hook type keeping in mind regulatory constraints.	3
Explore shaded light sources that direct light downward.	3
Explore the effect of other hook designs (e.g., hybrid between J and circle hook) on bycatch and target catch.	2
Conduct experiment that adds light sources in fisheries not currently using them and removing from fisheries that do currently employ light sources to evaluate leatherback bycatch rates.	2
Re-examine data for association with float and increasing hooking/entanglement in epi-pelagic animals.	2

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