Developing Best Management Practices to Conserve Seabirds in Pelagic Longline Fisheries

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Executive Summary

We will develop a streamer line system for application to world high-seas pelagic longline fisheries as the cornerstone of seabird bycatch mitigation in these extensive, multi-national fisheries targeting tuna and billfish worldwide. Design will focus on: 1) engineering widely applicable and easy to use deployment, retrieval and rigging systems, as well as towed devices that minimize the fouling of streamer lines on gear to maximize practical application by crews; and 2) identifying optimal streamer line materials, configuration, and performance standards that minimize seabird attacks on baited hooks. Testing will entail measuring the behavioral response of "worst case" seabirds to alternative designs in "worst case" locations in cooperation with partner scientists and organizations. Products will include a preliminary report, a final report, and a package of seabird bycatch mitigation best practices that will be delivered to Regional Fisheries Management Organizations (RFMOs) via member nations and organizations. RFMOs may adopt these best practices in their respective pelagic longline fleets.

Background and Problem Definition

Seabird mortality in longline fisheries is a worldwide marine conservation problem (Robertson and Gales, 1998). Nineteen of the world's 21 albatross species are now globally threatened with extinction (IUCN, 2006). Incidental catch in fisheries, especially longline fisheries, is recognized as one of the principal threats to many of these species. Illegal unregulated and unreported longline fisheries (IUU) and longline fisheries outside the CCAMLR Convention area, which are primarily pelagic fisheries managed by RFMOs, constitute the largest conservation threat to Southern Oceans seabirds (CCAMLR Resolution 22/XXIII).

Longline fisheries consist of two basic types of gear: pelagic and demersal. In pelagic fisheries, the gear consists of baited hooks attached to a monofilament mainline by monofilament leaders (called snoods, branch lines or gangions), which can be up to 35 meters long. They are clipped on individually at regularly spaced intervals as the gear is deployed at 7 to 10 knots. The mainline is suspended from buoys spaced every 5 to 30 hooks, leaving buoys and the main line at the surface for up to 50 nautical miles (nm). In contrast, demersal longlines consist of relatively short gangions (~ 40 cm) permanently fixed to the mainline at 1- to 2-m intervals, yielding many more hooks per unit of line relative to pelagic gear. In general, demersal gear is set more slowly (5 to 8 knots) and no gear remains at the surface after it sinks from the surface at 10 to 50 m from the stern. Long gangions and floating surface gear create unique challenges for seabird mitigation in pelagic fisheries.

Seabird conservation in longline fisheries is achieved through a suite of mitigation measures or best management practices. Differences in gear and fishing strategies have yielded different approaches to seabird conservation for the two gear types. Streamer lines and adding weight to the mainline (line weighting) have become the proven and accepted mainstays of seabird bycatch mitigation in demersal fisheries primarily through a series of controlled studies (Agnew et al., 2000; Lokkeborg, 2003; Melvin et al., 2001; Robertson et al., 2003). In the Antarctic longline fisheries seabird bycatch has gone from tens of thousands in the early to mid 1990's to fewer than 100 birds in recent years due partly to the mandatory use of line weighting and streamer lines. In Alaska, seabird bycatch rates dropped eight fold since 1998 with the increasing use of streamer lines (*http://www.fakr.noaa.gov/protectedresources/seabirds/actionplans.htm*).

Although several seabird avoidance measures have been trialed to varying degrees in pelagic fisheries, proven and accepted seabird avoidance measures are lacking (Lokkeborg, in press). Streamer lines are the most widely prescribed seabird mitigation tool in pelagic and demersal fisheries, but controlled studies demonstrating their effectiveness in pelagic fisheries in the context of production fishing are non-existent. Using dyed bait, setting the gear sub-surface via a setting chute, and line weighting have met with mixed results (Boggs, 2001; Brothers, 1991; Gilman et al., 2003a; Gilman et al., 2003b). Side setting was tested to some degree and is being used increasingly in Hawaiian fisheries despite limited testing (Gilman et al., 2003b) and might be applicable to a limited number of vessels and fisheries. A setting capsule that delivers each bait well below the surface is in development, but remains untested and may not be widely applicable to high-seas fisheries (G. Robertson, pers. comm.). Night setting is a widely accepted practice to reduce the capture of diurnal seabirds such as albatrosses (Weimerskirch et al., 2000); however, this approach breaks down during full moon periods and does not address mortality of nocturnal feeders (most petrels; Brothers et al., 1999). Consequently, no proven tools exist to address seabird bycatch in high-seas pelagic fisheries, frustrating conservation efforts.

A streamer line, also called a bird or "tori" line, is a line that is attached to a high point near or at the stern and towed behind the vessel. Streamers are attached to the aerial portion of the line created by the drag of the line through the water. When deployed properly, the streamer line moves erratically and functions as a mobile scare crow hazing birds from the area above the sinking longline gear, hindering seabird attacks on baits, and consequently reducing seabird mortality. To be effective, a streamer line must be maintained over sinking baits; therefore, performance standards – the aerial extent of the streamer line and positioning of the streamer line relative to the baited hooks – are critical to streamer line effectiveness. Crosswinds pose a significant challenge as they increase the likelihood of the streamer line fouling on the mainline. Due to the potential for fouling on the gear, pelagic fleets deploy streamer lines in such a way that they are ineffective or are reluctant to use them. There is a critical need to develop best practices for pelagic longline fisheries that include a towed device that prevents fouling.

Despite their worldwide use, experiments to determine the optimal design and configuration of streamer lines have not been attempted (Melvin and Robertson, 2000). Designs and configurations used in world fisheries to date, and in the research cited above, stem from the best efforts and anecdotal observations of fishers, observers and researchers with the seabirds, seasons and conditions they encounter in their specific fisheries. Given the wide spread use of streamer lines in both demersal and pelagic longline fisheries, the need to optimize their design and performance is critical to seabird conservation (Melvin et al., 2004b).

Project Activities and Schedules

We propose to optimize the design, configuration and performance criteria for streamer lines for longline fisheries in general, and specifically to develop a best practice streamer line for pelagic fisheries and test its effectiveness in "worst-case" locations. This work will produce recommendations for best practices for seabird conservation in world pelagic fisheries and outreach materials for delivery to tuna and billfish RFMOs through partner institutions. Testing will take place at "worst case" times of year (breeding season) in "worst case" locations where these seabirds are known to be aggressive in fishery operations (fisheries of South Africa, Namibia, Brazil, Uruguay, Argentina, Chile and New Zealand). Designs that work in "worst-case" scenarios are highly likely to be robust in all applications worldwide. Work will be phased as to systematically adapt and incorporate design features that work best.

Phase I October 2006 to September 2007

Assemble an informal advisory committee.

This committee will incorporate the experience of seabird bycatch mitigation specialists, the industry, and fishery managers (RFMOs). The committee would provide direction on the following: most appropriate "worst case" seabird fishery locations to test streamer line designs; identify potential cooperating vessels in these fisheries and help make arrangements to work on these vessels; anticipate needs and concerns of the industry; and identify key design parameters for streamer line configurations and materials and design parameters for a towed device. In this process, we will gather and contrast streamer line designs used in world fisheries

Perform a preliminary assessment of pelagic fishery operations and practices.

The assessment will identify opportunities and constraints to applying streamer lines to pelagic longline fishery operations. We will confirm design parameters for streamer lines and the towed device in the course of a single fishing trip on a cooperating vessel in a fishery with a strong track record of applying seabird bycatch mitigation technologies.

Develop a prototype-towed device for a streamer line application.

We will work with marine engineers to develop a towed device that optimizes streamer line performance. Features are likely to include the following: track predictably in cross winds; provide adequate aerial extent; be self-righting once deployed; have smooth surfaces to minimize the likelihood of fouling on the mainline or damage to the vessel as it is retrieved; be easy to deploy and retrieve, and be inexpensive. We will iteratively test and refine prototype-towed device on local vessels of opportunity and provide to industry cooperators in the Alaska for testing and refine as necessary.

Develop a best – performance streamer-line prototype in a seabird "worst-case" location.

This component of the research activity will be staged in the course of production longline fishing in a pelagic or demersal fishery that represents a "worst-case" scenario for seabird-fishery interactions. It is reasonable to assume that the behavior of seabirds in response to baited hooks is potentially more intense in demersal fisheries owing to the fact that many more baits are deployed per unit time, and that seabird response to streamer line design features is similar between gear types. We will make arrangements via a charter or similar arrangement to deploy fishing gear during daylight hours to allow us to make visual observations of seabirds and gear.

The specific experimental design for this task will be finalized based on the preliminary assessment, logistics, and the input of the advisory committee. At this time we foresee two possible approaches: comparing existing streamer line designs in a controlled study to identify optimal designs and key design features, which are then refined based on that experience; or identifying key design features through our experience and that of the advisory committee and serially optimizing streamer line design by a process similar to that outlined below. In either case, our approach will encompass a serial optimization process using the following concepts.

We will manipulate the following streamer line design and placement parameters according to a hierarchy of importance (likelihood of affecting seabird behavior) based on our experience:

- Proximity of the streamers to the sinking hooks, incorporating the effects of wind;
- Streamer line aerial extent (which is a function of the height of the attachment point, drag created by a towed body at the vessel speed that longline gear is deployed and the diameter of the streamer line itself);
- Spacing, color, length and configuration of individual streamers; and
- Length and number of streamer lines.

As each feature is serially optimized, it will be incorporated into the subsequent test of the next design feature in the hierarchy. For example, once the optimal spacing of individual streamers is determined we would use that spacing to determine the optimal color, and so on through the hierarchy. The design features of the Alaska streamer line will be used as the standard of comparison. We would also evaluate practical considerations such as the need for swivels to keep the streamer line from rotating, options for placement and nature of streamer line davits, and gear deployment and retrieval systems.

At least two design features will be compared during each gear deployment (a set). At a minimum, one design will be deployed for the first half of each set, and the second design for the last half of each set. Observation protocols will be based on those used in our previous work in Alaska longline fisheries (Melvin et al., 2001 and Melvin et al., 2004a). Data collection for each design feature (or treatment) will include a series of 10-minute observation intervals separated by 10-minute rest intervals. For each observation period, we will count the number of seabird attacks by species as a function of distance astern yielding an estimate of attack rate by species and distance astern. At the midway point of each observation series for a specific treatment, we will count the number of seabirds by species in a 100 m hemisphere aft of the stern as gear is deployed.

We will establish a gross quantitative benchmark (percent change) to quickly eliminate design features that are clearly inferior based on the mean and variance of attack rate of the most aggressive seabird. We will use power tests to determine the sample size necessary to detect a 10% difference in design features that fall below the gross benchmark. Statistical comparisons of treatments will be completed prior to the subsequent gear deployment. This iterative process will yield one or more streamer line designs that will be compared in controlled experiments in Phase II.

Phase Two II October 2007 to 31 Dec 2008

Conduct controlled experiments in two "worst case" pelagic fisheries testing the effectiveness of prototype streamer line(s) and towed body design developed in Phase I.

Experiments will contrast the mortality rate and where appropriate the attack rate of seabirds in response to the prototype streamer line or lines and towed body developed in Phase I, with a control of no deterrent, and if possible one additional seabird mitigation technique. We will do these experiments in pelagic fisheries in two "worst case" locations with local partners. Local arrangements including permits, incentives for cooperating vessels, worst-case pelagic fisheries and alternative deterrents for controlled studies will be determined based on the recommendations of local partners and the advisory committee, as well as outcomes of Phase I research.

Controlled experiments will be performed in the course of production fishing during daylight hours. As resources allow we will attempt to collect data on at least two vessels in each location to address possible vessel differences. Data will be collected by Washington Sea Grant (WSG) trained technicians and/or by WSG staff. Data collection will include recording the mortality of all seabirds by species, and estimating seabird attack rate and seabird abundance during gear deployment. It is our experience that seabird attack rate can be a poor predictor of seabird mortality in some cases. For example, birds can make unsuccessful attempts at taking baits especially when lines are weighted to sink quickly or they attack baits below the surface where they are difficult to observe. Therefore, the primary null hypothesis will be that seabird mortality is the same for streamer lines and other seabird mitigation technologies. However, we will extend the null hypothesis to attack rate if attacks can be reliably quantified for all deterrents. If the deterrents tested are likely to effect fish catch, we will also collect fish catch data and extend the null hypothesis to fish catch rates. Data will be collected on a suite of environmental variables (such as wind speed and direction, swell height and direction, barometric pressure) and fishing operation variables (vessel speed, frequency of turning, offal discharge).

We will use generalized linear models to determine treatment effects and post-hoc techniques to compare differences in seabird mortality and attack rate and fish catch rate among treatments as appropriate. Environmental and vessel operations variables will be introduced as factors in these models in an attempt to isolate the variability derived from each treatment.

If seabird attacks are as intense as we plan by being in "worse case" locations, the control of no deterrent will be used under appropriate biologically based limits established by local resource managers. Limits might include not using a control of no deterrent if critically endangered species are present and establishing species-specific caps based on the population health of each species.

We have endeavored to minimize roadblocks to the success of this research plan; however, obstacles that might preclude success could occur. Failure to obtain local cooperation in "worst case locations" would constitute a serious setback. A lack of cooperation by either the fishing industry in finding individual vessels willing to host research and/or a lack of cooperation from local agencies in granting permits would be difficult to overcome. The towed device is critical to the successful application of streamer lines to pelagic fisheries; thus, a failure to develop a device that meets our performance criteria and is acceptable to cooperators could greatly limit our success. Although highly unlikely, this project would fail if streamer lines cannot be configured to deter seabird attacks in worst-case situations. The early formation of an advisory committee, the recruitment of highly capable engineering expertise and our experience with streamer lines minimize but do not eliminate these possible negative outcomes.

Project Outcomes and Deliverables

We will generate two reports: a preliminary report at the completion of Phase I, and a final report at the end of Phase II. The Phase I report will include an evaluation of progress of our research plan and an evaluation of Phase II. The final report at the completion of Phase II will include research results, recommendations for best seabird bycatch mitigation package for high seas pelagic fisheries (focus on developing a streamer line system that is effective, practical and safe), and recommendations for future research. Results will be reviewed by the advisory committee, and with their input, we will generate recommendations for best practices. Outreach materials will be delivered to RFMOs via BirdLife International's initiative to promote seabird conservation in world longline tuna and billfish fisheries operating between 20 and 55 degrees North and South latitudes and the governments of supporting nations (e.g. US and UK delegations). Materials can also be submitted to the Agreement on the Conservation of Albatrosses and Petrels (ACAP). ACAP is a multilateral agreement that focuses on international cooperation and exchange of information to promote conservation of these species. ACAP has identified collaborative work with RFMOs as a priority. These products will address the absence of a seabird mitigation package for world longline tuna and billfish fisheries, which pose the greatest known conservation threat to seabirds by legal fisheries.

Project Management and Organizational Background

The Washington Sea Grant (WSG) is a broad-based university program of integrated research, education, and advisory services dedicated to the goal of promoting the understanding, utilization, development and conservation of ocean and coastal resources. One of the four original Sea Grant Colleges, WSG is one of the largest in the national Sea Grant network.

Marine Advisory Services (MAS) is the principal outreach arm of WSG. MAS professionals work closely with university researchers, partner institutions, educational groups, industry, government agencies, citizen groups and other interested parties. They develop and run a program of research, education, technology transfer, problem solving and technical assistance for user groups and individuals in the marine community. The seabird conservation program, led by Ed Melvin, Marine Fisheries Specialist, designs and carries out research and outreach programs focused on developing solutions to the incidental mortality of seabirds in the commercial fisheries. Mr. Melvin will manage the overall program and is responsible as the Principal Investigator for the activities and products proposed in this proposal. The WSG seabird program team includes two Marine Conservation Specialists, Kim Dietrich and Michelle Wainstein. Kim Dietrich will coordinate the fieldwork and Michelle Wainstein, Ed Melvin and Kim Dietrich will collect data at sea, train local technicians, analyze data and generate reports and outreach materials.

Fred Karig and Eric Boget of the Applied Physics Lab at the University of Washington will design, fabricate and test the prototype towed device identified in Phase I and will refine the prototype device in Phase II.

Dr. Graham Robertson, Australian Antarctic Division and Dr. Ben Sullivan, BirdLife International, are scientists with exceptional expertise in developing and testing seabird bycatch mitigation technologies in longline and trawl fisheries. They will function as the cornerstone of the project Advisory Committee providing advice on experimental design and analyses. Together we will seek leverage opportunities among our collective research activities. Samantha Petersen, BirdLife International; Tatiana Neves, Projecto Albatroz; and Dr. Susan Waugh, New Zealand Ministry of Fisheries, will function as the points of contact for South African, Brazilian and New Zealand fisheries, respectively. Collectively these scientists and local contacts will form the core of the Advisory Committee providing information on local fisheries and cultural considerations, identifying local vessels for participation in the research activity, as well as other advisory committee members. Where possible they will also participate in data collection and analysis. Dr. Cleo Small, BirdLife International Save the Albatross Campaign, will advise the project on outreach to tuna and billfish RFMOs.

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Principal Staff

Ed Melvin is the Principal Investigator and Marine Fisheries Specialist for Washington Sea Grant based at School of Aquatic and Fisheries Sciences, University of Washington. In this role, he does a blend of collaborative research and directed outreach to help solve conservation related problems in the commercial fishing industry. For the past 11 years, he has focused on developing methods to reduce the incidental mortality of seabirds in a range of commercial fishing gear types including drift gillnets, longlines, and most recently, trawls. He is on the ESA Short-tailed Albatross Recovery Team, and serves on several international working groups including the Incidental Mortality working group of CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources). He was recently awarded the College of Ocean and Fisheries Distinguished Research Award and the NOAA Stewardship and Sustainability Award for his seabird conservation work in the Alaskan longline fisheries. Mr. Melvin received a MS in Fishery Sciences from Humboldt State University.

Kim Dietrich is a Marine Conservation Specialist for Washington Sea Grant, University of Washington. She has provided extensive support for WSG research programs developing seabird mitigation options for gillnet, longline and trawl fisheries by collecting data at sea, managing databases, carrying out statistical analyses and authoring reports. She has worked extensively at-sea as a fisheries observer on commercial fishing vessels in Alaska and as a zooplankton technician on Antarctic krill stock assessment surveys. Ms. Dietrich received her MS in Fishery Sciences from the University of Washington. Her thesis research explored the spatio-temporal variation and other factors affecting the rates of seabird bycatch in Alaska longline fisheries.

Michelle Wainstein is a Marine Conservation Specialist for Washington Sea Grant, University of Washington. She has provided support for WSG research programs developing seabird mitigation options for trawl and longline fisheries, providing support for field crews, managing databases, conducting analyses and authoring reports. She has over 10 years experience conducting research in the fields of marine and behavioral ecology, and for the past 5 years has been involved in seabird and island conservation. Components of her work have always been based in South America, and she is a fluent Spanish speaker. She received a PhD in Ecology and Evolutionary Ecology from the University of California at Santa Cruz.

Fred Karig is the Principal Mechanical Engineer at the Applied Physics Lab, University of Washington. His primary interest is instrument platforms for undersea measurements and for measurements at the interface between the sea surface and the ice canopy. He has experience in the design and construction of underwater equipment, including actuators, electrical cabling, acoustic transducer housings, submersible handling systems, towed instrument packages, and general-purpose winches. He has led numerous operations at sea and on the ice and has been in charge of logistics for most APL-UW ice stations (APLIS). Mr. Karig has been with the Laboratory since 1966. B.S.M.E. 1965, California State Polytechnic College

Eric Boget, Engineer in the Ocean Engineering Department, University of Washington, specializes in the operation of research vessels. He is licensed by the U.S. Coast Guard as a vessel operator and engineer. He is also experienced in rigging and deploying oceanographic equipment and is certified by the University as a research diver. He is currently responsible for the operation and maintenance of Applied Physics Lab-UW's research vessels. Mr. Boget joined the laboratory in 1990. Eric has a B.S. Marine Engineering & Marine Transportation 1984, U.S. Merchant Marine Academy.

Graham Robertson is a Principal Research Scientists in the *Southern Oceans Ecosystem* program of the Australian Antarctic Division. His work involves research on the ecology of fisheries-vulnerable seabirds, their interactions with fisheries, especially longlining, and the development of methods to reduce the number of seabirds that die in longline fisheries. He is currently conducting co-operative research with pelagic and demersal longline fishing industries in the Southern Hemisphere to develop gears and practices conducive to seabird conservation. He serves on a number of international working groups that address seabird conservation in fisheries. In 2004 he was awarded a Fellowship in Marine Conservation by the Pew Charitable Trusts. He received his PhD in seabird ecology from the University of Tasmania in 1994.

Ben Sullivan, BirdLife International Global Seabird Programme Coordinator is based at the Royal Society for the Protection of Birds (UK). He has worked as an at-sea observer and been responsible for developing and testing mitigation measures for longliners and trawlers. Ben maintains an active interest in practical projects working directly with fishermen and wider seabird/marine conservation issues. He is also responsible for managing an emerging international team of mitigation instructors (BirdLife, Albatross Task Force) that work directly with fishermen and fisheries managers to demonstrate the effective use mitigation measures to reduce seabird mortality. He received his PhD University of Queensland, Australia.

Samantha Petersen, Marine Program Manager, BirdLife South Africa, Cape Town, South Africa leads the Responsible Fisheries Programme, a collaborative effort between WWF, BirdLife South Africa and the Albatross Task Force (BirdLife International) and operates in South Africa, Namibia and Angola. The program evaluates the ecosystem impacts of Southern African trawl and longline fisheries, conducts mitigation trials and endeavours to implement suitable measures to reduce seabird, turtle, cetacean and shark bycatch in these fisheries. MS Zoology, University of Cape Town – PhD candidate, University of Cape Town.

Tatiana Neves, General Coordinator of Projeto Albatroz, which studies the interaction of the albatrosses and petrels with longline fisheries, and consultant for the Brazilian Institute of Environment and Natural Renewable Resources for the implementation of National Plan of Action/ Seabirds - Brazil. She has participated in several research cruises studying the distribution and abundance of the seabirds on the high seas. She has extensive experience working with ship owners, skippers and crew developing methods to reduce seabird mortality in Brazil’s longline fisheries. She has been participating and representing Brazil in several international meetings enhancing scientific and technical exchange as part of the Brazilian delegation to CCAMLR. She is assisting the Brazilian Government with the ratification process for Agreement for Conservation of Albatrosses and Petrels. Biologist and Master in Biological Oceanography by the Fundação Universidade do Rio Grande – Brazil.

Susan Waugh, principal scientist with Ministry of Fisheries in New Zealand. Susan coordinates the research programme run by that agency on protected-species interactions with fisheries. This largely involves contracting research on bycatch estimation, examining new technologies and practices for reducing incidental catch, and assessing risk to a suite of seabird and marine-mammal species from New Zealand fisheries take. Susan has worked at the Ministry of Fisheries for four years, and previously worked as a researcher on seabird ecology and environmental influences on demographic characteristics for albatrosses and petrels.