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Summary Report: Seabird Bycatch Mitigation in Pelagic Longline Fisheries Workshop

Museum of Natural History, Royal Society Room
Hobart, Tasmania
October 14, 2006

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Summary Report: Seabird Bycatch Mitigation in Pelagic Longline Fisheries Workshop
Museum of Natural History, Royal Society Room, Hobart, Tasmania
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The workshop "Seabird Bycatch Mitigation in Pelagic Longline Fisheries" was held on October 14, 2006 at the Museum of Natural History in Hobart, Tasmania. It was staged in Hobart to take advantage of the experts already in Hobart for a meeting of the Incidental Mortality Associated with Fishing (IMAF) ad hoc Working Group of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). The need for and timing of the meeting was an outgrowth of a research program developed by Washington Sea Grant (WSG) that was recently funded by the David and Lucile Packard Foundation to develop best management practices to conserve seabirds in pelagic longline fisheries. Fundamental to this proposed work was convening an "advisory committee body" to help guide the research program, which is to be staged in seabird hot spots in the southern hemisphere. Recognizing that the needs in the area of seabird bycatch mitigation for pelagic fisheries are much broader than any one research program, the scope of the workshop was expanded to a broader information sharing and planning exercise. The meeting was convened and facilitated by Ed Melvin, Marine Fisheries Research Scientist, WSG.

The objectives of the workshop were to:

- Share current and future plans for mitigation research and related initiatives
- Develop the framework for a 5-year mitigation research plan

The workshop had two parts (Appendix 1). The morning session focused on information sharing and included presentations highlighting three program initiatives specific to seabird conservation in pelagic longline fisheries, permutations of pelagic longline fishing gear, and pelagic mitigation research underway. The afternoon session was a facilitated group discussion focused on prioritizing seabird mitigation technologies for future research based on specific criteria. The workshop concluded with presentations on funding for mitigation research and closing remarks. Workshop participants and invitees provided brief summaries of their presentations, which are included here.

Introduction

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 regional fishery management organizations (RFMOs), constitute the largest conservation threat to Southern Ocean 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 near 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. To date no single mitigation technique achieves maximum success alone – there is no silver bullet. In general mitigation technologies work in one of five ways:

- Shrink the seabird access window behind the vessel either by line weighting or delivering baits below the area where birds can access baits as close to the stern as possible;
- Scare bird away from baits as they are deployed or retrieved;
- Make baits cryptic using dye or wrapping baits so the are unrecognizable as food;
- Manipulate the offal derived from fish processing is such a way as to minimize interactions during line setting and hauling; and
- Time area-closures, which manipulate the timing of the fishing season to minimize overlap between fishing activities and birds – usually minimizing overlap when birds are breeding and most aggressive.

In addition to reducing bird interactions with fishing gear, mitigation measures must be practical and safe to use, be available at minimal cost, not decrease the catch of target species and/or increase the bycatch of other taxa. When use of seabird mitigation is required by governments there is also a need to monitor compliance; those measures that are integrated into operations – such as line weighting, circle hooks, and side setting – are most easily complied with. Finally, the ideal suite of mitigation measures is applicable to a range of vessel sizes – those typical of domestic fisheries operating within the EEZ and to the distant water fleet (DWF) that fishes a range of EEZ's and/or the high seas.

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, Melvin et al. 2001, Lokkeborg 2003, 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 (Brothers 1991, Boggs 2001, Gilman et al. 2003a, Gilman et al. 2003b). Side setting was tested in Hawaiian fishery (Gilman et al. 2003b) and from a research vessels in Japan (Yokota and Kiyota 2006) and might be applicable to some 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.

Linkages

RFMOs and Seabird Conservation: Cleo Small, BirdLife International, United Kingdom

Recent progress within RFMOs in recognizing seabird bycatch issues has created an increasingly urgent need for advice on best-practice seabird bycatch mitigation measures for pelagic longline fisheries. Data from the BirdLife Albatross and Petrel tracking database indicate that up to 84% of breeding albatrosses are distributed in areas outside the CCAMLR boundary, and that pelagic longline fisheries for tuna and swordfish, those managed by the five tuna RFMOs, are some of the fisheries of most concern in relation to seabird bycatch in these areas. In 2004, the five tuna RFMOs had taken very few steps to address seabird bycatch, with only one (CCSBT) having a requirement for mitigation measures. However, in the last two years there has been significant progress. All 5 tuna RFMOs have now passed some form of seabird resolution; two (the Indian Ocean Tuna Commission and Western and Central Pacific Fisheries Commission) have, or will, be considering bycatch mitigation measures in 2006; and the remaining two (International Commission for the Conservation of Atlantic Tunas and Inter-American Tropical Tuna Commission) have or will be assessing the impact of seabird bycatch in their fisheries in 2006-8. There is an increasingly urgent need to provide advice on seabird bycatch mitigation to these RFMOs, and an urgent need to fill knowledge gaps through research. This research will be most useful to RFMOs if it also provides information on effects of mitigation measures on other species, including target catch, turtles and sharks; and if it provides data on economic costs of the measures. Since the need to provide advice to RFMOs is currently outpacing the speed at which current and new research can fill knowledge gaps, the question arises as to what is the best advice we can give to RFMOs pending research results.

ACAP Seabird Bycatch Working Group: Barry Baker, Australia

The Agreement on the Conservation of Albatrosses and Petrels (ACAP) is an international multilateral agreement that aims to conserve albatrosses and petrels by coordinating international activity to mitigate known threats to albatross and petrel populations. The Agreement provides a comprehensive framework and process to restore albatrosses and petrels to a favorable conservation status and reverse population declines. It was developed in response to the recognition that albatrosses and petrels are among the most threatened birds in the world, with mortality from interactions with fishing vessels the most serious threat to most species.

In June 2006 ACAP's Advisory Committee established a Seabird Bycatch Working Group (SBWG) to address issues related to fisheries interactions with seabirds. The SBWG will

undertake actions that will assist in assessment, mitigation and reduction of bycatch. Its membership will comprise representatives from all ACAP Parties, as well as invited specialists with expertise in mitigation research, RFMO and high seas governance, and management of seabird-fisheries interactions.

The SBWG has recently developed a strategy to implement their work programme. Key activities identified include collation of information on the foraging distribution of ACAP species and the degree of spatial and temporal overlap with fisheries; development of risk assessments for fishing operations on ACAP species in fishing regions; reviewing information on mitigation measures for various fishing methods, initially focusing on pelagic longline methods; and developing products to assist RFMOs to reduce bycatch, such as design for observer programs and guidelines for best-practice mitigation measures.

Albatross Task Force, Ben Sullivan
BirdLife International's Albatross Task Force works at-sea and on-shore to encourage the adoption of mitigation measures, and to collect baseline bycatch data, where required. The Task Force currently has three full time mitigation instructors working in South Africa, two focusing on pelagic longline fisheries and one on the hake trawl fishery. Two employees work in the pelagic fisheries of Brazil. There are also plans to have two people based in Chile by the end of 2006, and negotiations are underway to have a further 4-6 people working in South America and southern Africa in 2007/08. The Task Force was designed to provide capacity and experience to help advance research into the development of pelagic fishery mitigation measures. BirdLife was congratulated on progress made over the last 12 months in the implementation of the Task Force and was encouraged to further expand the scope and size of the project.

Pelagic Longline Gear
Graham Robertson, Australian Antarctic Division, Australia
Pelagic longline fishing gear can vary dramatically across fisheries and this variation should be considered in any discussion of seabird mitigation technologies for pelagic longline gear. The construction of pelagic branch lines can be used to provide a general indication of gear sink rates, fishing depth and whether or not gear is likely to be dangerous to seabirds. The presence or absence of weighted swivels in branch lines, amount and location of weight with respect to distance from the hook, branch line material used and length of lines connecting floats and mainline are important design features. Information is being compiled on branch line designs used in the main pelagic fisheries where seabird mortality occurs. These fisheries occur in Australia, New Zealand, Peru, Chile, Uruguay, Brazil, South Africa, the USA and the high seas Japanese-style tuna fisheries. When all the relevant information on pelagic longline fishing gear has been compiled, it will be made available to workshop members and other interested parties.

Discussion ensued on the use of wire traces or leaders on branchlines to prevent hook loss to toothed fishes. Dave Kreutz reported that that in some fisheries wire traces reduce depredation by echo-locating toothed whales, and Tony Forster reported that in some fisheries wire traces can cause increases in shark bycatch. These comments emphasize the need to consider multi-species effects in developing mitigation for seabirds. Graham Robertson noted that wire traces in branchlines could increase sink rates and potentially provide an alternative to weighted swivels, which can injure crew.

Existing and/or Planned Research Activities 2006-2007

Streamer Lines: Ed Melvin, Washington Sea Grant, USA

Washington Sea Grant has a funded research program to 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. The project is scheduled from October 2006 to September 2008 and is broken in to two phases. In phase one, they will convene an advisory committee to fine-tune aspects of streamer line design and develop logistical support in select southern hemisphere pelagic fisheries where seabird interactions are most intense. Streamer line 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. In phase two, they will 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.

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.

Streamer Line and Hook Sink Rate Trials: Samantha Petersen, *BirdLife International, South Africa*

Samantha was unable to attend the meeting but provided written materials, which are summarized here. Building on a strong relationship with the fishing industry, BirdLife International in partnership with the World Wildlife Fund (WWF) is engaged in a multifaceted program addressing the ecosystem impacts of trawl and longline fisheries, trialing mitigation technologies and implementing best practices aimed at reducing the incidental capture of seabirds and other sensitive species. Although streamer lines are a permit condition in South Africa pelagic longline fisheries to mitigate seabird mortality, the lack of an agreed effective and practical streamer line design has contributed to low compliance. High variability in tuna catch rates and the value of the rand dollar serve to further frustrate conservation efforts. Trials of streamer lines and demonstration projects are underway to increase compliance. Hook sink rates are also under continued study. Data are being collected at sea on the extent of seabird, turtle and shark bycatch and related operational and environmental factors in longline and trawl fisheries. The program also provides critical training for key players including fishery observers, compliance officers and fishery monitors in ports and harbors throughout South Africa.

Bait Setting Capsule: Phil Ashworth, Ashworth Marine Engineering, Australia

Ashworth Marine Engineering is currently working on furthering development of a bait setting capsule (now known as the BS30 Bait Setting Capsule; BSC), a concept originally conceived by

Dave Kellian of New Zealand and further developed in Australia by others including Tony Foster. Under funding from Peregrine Adventures and Packard Foundation, Ashworth Marine Engineering have re-designed the original concept to achieve automation, safety, repeatability, durability, ability for installation on vessels of varying design, data recording, maintenance and serviceability, and minimal cost. Ashworth Marine Engineering has reviewed the original design and concept and has now refined this and selected durable materials for the prototype design. They are currently manufacturing and assembling a prototype for modeling and factory testing. Future work involves field trialing and modifying the prototype as required. The work is planned to be completed within the next 12-18 months.

During subsequent discussion the workshop recognized the need to ensure engineering is inserted into the mitigation design process. The BS30 bait setting capsule shows great potential but mechanical reliability issues have dogged early prototypes. Solving this problem is essential to realize the potential of underwater setting of baits via the capsule. The Packard Foundation and Peregrine Adventures fund the project.

In response to questions Phil indicated that BSC units are projected to cost AU$12,000 to $18,000 each. He also noted that the units could target a range of depths but that as setting depth increases so does cycle time; however, he noted that limitation of cycle time could be avoided by using two units. The current prototype design depth is 10 m with a cycle time of 7 seconds– 3.5 seconds for two units. Tony Forster indicated that he was excited about the potential of the BSC because he sees it as preferred alternative to lead swivels, which can cause injury and negatively affect the catch rate of target species.

Graham Robertson, Australian Antarctic Division, Australia
On the completion of the R&D and operational testing stages of the underwater bait setting capsule by Ashworth Marine Engineering, the next step will be to conduct an experiment to determine the seabird deterrent capability of various pelagic line setting methods. The methods to be tested will be:

- Surface setting from the vessel stern (conventional method),
- Surface setting from the side (Hawaiian method), and
- Underwater setting from the stern (bait setting capsule).

The three setting methods will be tested head-to-head on a chartered tuna vessel under worse case conditions regarding the species of seabirds involved and intensity of interactions. The timing of the experiment will depend of developments with the bait-setting capsule, choice of location and season, vessel availability and funding. Ideally the experiment will be conducted in the latter part of 2007 or in the winter 2008. The experiment is likely to reveal clear-cut differences between setting methods with respect to seabird mortality rates and should be instrumental in providing guidance to fisheries management agencies worldwide on seabird-safe line setting methods. Funding for this research program has not been secured.

Bait Pod: Ben Sullivan, BirdLife International, UK
Ben Sullivan described a concept for a bait pod with a rubber skirt to protect baits from seabird attack during setting. The pod will be attached to each snood and will open at pre-determined

depths through a pressure diaphragm. Incorporation of light sticks into the design is being considered. Each unit will weigh around 60 gm and can be produced at US$2. At this stage flume tank tests are very positive. Field trialing under controlled conditions is planned in the future.

Ben indicated that the pod moves along the branchline on a one-way wheel, which prevents it from sliding back down the branchline towards the hook while retrieving a hook. He also indicated that the need to stack pods on deck for efficient storage and easy deployment is being incorporated into the design.

Dissolving Bait Capsule: Tony Foster, Retired Tuna Fisherman, Australia
Tony Foster described an idea for a cup-shaped dissolving bait capsule made of rice paper or a similar soluble material. The material surrounding baits would make the baits unrecognizable as food. The bait coverings would be designed so as to be easily stacked near bait bins and easily applied to the baited hooks as the branchlines are clipped on to the mainline and deployed.

Japanese Mitigation Research: Masashi Kiyota, National Research Institute of Far Seas Fisheries, Fisheries Research Agency, Japan.
Kiyota-san was unable to attend the meeting but provided an information paper summarizing mitigation research in Japanese tuna longline fisheries addressing several seabird avoidance measures including their advantages/disadvantages, economic impacts of their use and future research planned. For the purposes of this summary, we have focused on the latter.

Japan will be working to optimize streamer line design with an emphasis on small boats and developing a mechanized system for adjusting poles and retrieving streamers. Free experimental streamers will be distributed to near-shore longliners. Side-setting will be evaluated on two vessels to determine safety and practicality of fishing operations, fishing efficiency, and bycatch reduction. Research is planned to determine if turtle bycatch can be reduced by using circle hooks and information on the effect on birds will also be collected.

Although no specifically funded research was mentioned, he also discussed water-jets, line-weighting, underwater setting chute, thawed bait and bait casting machines, night setting, dyed bait and strategic offal discharge.

Side Setting: Eric Gilman, Blue Ocean Institute, USA
Eric Gilman was also unable to attend the meeting but provided an informational paper on technical assistance provided for Hawaii-based pelagic tuna and swordfish longline vessels. The report presented results of a project established to convert vessels to set from the side instead of the conventional position at the stern to reduce seabird bycatch and provide operational benefits. It was noted that side setting actually involved three measures – side setting combined with a bird curtain and 45 gm swivels used on each branchline.

The success of the technical assistance program was due to its timing with the completion of a research experiment, voluntary change to side setting by a portion of the fleet and a proposed amendment to government regulations on avoiding seabird bycatch to allow Hawaii longline vessels to side set in lieu of currently required seabird avoidance methods.

Side setting reduced the incidence of seabird captures to close to zero, reducing bird captures by nearly 100% in longline tuna gear and over 87% in longline swordfish gear compared to controls. When setting from the side crew set baited hooks close to the side of the vessel hull where seabirds, such as albatrosses, are unable or unwilling to pursue them. Ideally, when side setting with proper line weighting, by the time the stern passes, the hook has sunk beyond the reach of seabirds. Because side-setting promises to also provide operational benefits for longline vessels, broad industry uptake and voluntary compliance is realistic. Evidence of this is that over fifteen percent of the fleet converted to side set voluntarily. A significant contributing factor to this success is that vessels in this fleet traditionally use branch lines that achieve a rapid bait sink rate: Branch lines are weighted with a lead swivel of between 45 g and 60 g placed within 0.5 m of the hook, achieving an average sink rate of about 1 m/s. As of September 2006, of the 125 active vessels in the Hawaii-based longline fleet, 35 vessels (28%) are side setting.

Trials of modified gear designs are planned in the Hawaii-based longline swordfish fishery to reduce seabird and sea turtle interactions. These trials involve a modified weighting design (45 g swivels at 0.5 m from the hook), modified lengths of float and branch lines to place all baited hooks below 40 m and minimize gear in the upper 40 m, while side setting with a modified LP main line shooter and using wire trace to reduce the safety risk of lead hitting crew.

Blue-Dyed Bait: Mike Double and Lisa Cocking, Australian National University, Australia
Michael Double presented a study recently conducted at the Australian National University on the utility of blue-dyed bait as a seabird bycatch mitigation technique. First, the study used spectrophotometry to examine the spectral reflectance of dyed and non-dyed bait. Using the known visual sensitivities of a procellariform seabird, the visual distance between these reflectance profiles, and the modelled reflectance spectra of deep, pelagic 'blue' water was calculated. For both fish and squid bait, the calculations suggested that the blue dye drastically reduced the chromatic contrast between the bait and the ocean over almost all wavelengths, and predicted that for squid in particular the bait would be difficult to distinguish when viewed from above. Second, the study assessed bait crypsis through at-sea presentations of dyed and non-dyed bait on hook-free longlines and in surface presentation trials. These trials recorded significantly fewer seabird interactions with blue-dyed bait compared to the non-dyed controls. However, this response was only strong and consistent for blue-dyed squid bait; strikes on blue-dyed squid bait were very rare. Blue-dyed fish bait was less attractive to seabirds than non-dyed controls, but only marginally so. These data suggest that bait type must be considered when assessing the mitigatory effect of blue-dye, and that blue-dyed squid baits could significantly reduce seabird bycatch in pelagic longline fisheries.

It was noted that this approach of modelling visual systems and the light absorbance in water could also be employed to select the most appropriate colours for streamer lines, bait capsules, bait pods and even make bait highly visible to target fish species.

Fish Oil: Johanna Pierre, Department of Conservation, New Zealand
Experimental tests of the efficacy of school shark (*Galeorhinus galeus*) liver oil in reducing the numbers of seabirds attending fishing vessels and the number of dives seabirds executed in pursuit of pilchard (*Sardinops neopilchardus*) baits have produced varied results. In seabird assemblages that include the flesh-footed shearwater (*Puffinus carneipes*) and the globally

vulnerable Parkinson's petrel (*Procellaria parkinsoni*), shark liver oil was effective in reducing both numbers of seabirds attending vessels and the numbers of seabird dives on baits, compared to canola oil and seawater control treatments (Pierre and Norden 2006). However, shark liver oil did not deter a seabird assemblage dominated by five species of albatrosses (*Diomedea* sp., *Thalasarcche* sp.) and giant and cape petrels (*Macronectes hallii, M. giganteus, Daption capense*) (Norden and Pierre, in prep.). These results demonstrate the efficacy of shark liver oil as a natural and biogenic deterrent for specific seabird assemblages, but confirm that not all species should be considered susceptible to its deterrent effects. Future research will include trials on other species (e.g. white-chinned petrels), work to elucidate the mechanism by which the deterrent is effective, and evaluation of alternate deployment methods to avoid the discharge of this natural oil on the ocean surface.

Ranking Pelagic Mitigation Technologies for Future Research

The participants considered a range of seabird mitigation technologies either in use or suggested for use for seabird mitigation in pelagic longline fisheries. Discussion was restricted to mitigation during line setting; time constraints did not allow the group to consider mitigation during line hauling. Each mitigation method was grouped as primary, secondary, or other (Appendix 2). Primary measures were those considered likely to be effective without other mitigation measures, and secondary measures were those considered useful for deployment with other measures, but not capable of significantly reducing bycatch if used in isolation. Side setting, blue-dyed fish and squid bait, and fish oil were regarded as possible candidates for primary mitigation but were considered separately due their early stage of development and/or limited research results to date. Acoustic alarms, water jets, time-area closures, and artificial lures/bait were not considered. Each was assigned a priority ranking for future research based on the scientific literature and individual experience using the following criteria:

- Effectiveness on surface foraging seabirds
- Effectiveness on diving seabirds
- Practical use on the vessel
- Safe use on the vessel
- Capital Cost – costs for purchase of a specific technology
- Operational Cost – costs related to vessel operations (lost fishing time)
- Applicability to distant water fleets and domestic fleets
- Compliance – the ability to monitor use and performance

Each method was ranked for each criterion on a relative scale of 1 to 5, with 1 being the lowest ranking and 5 being the highest. Considering the ranking for each criterion, each mitigation method was ranked in a similar way resulting in a prioritized list of mitigation methods to focus future research.

The participants ranked the bait setting capsule and the bait pod as likely to be the most effective mitigation measures; however, because both are under development they do not pose viable alternatives currently. Of the available technologies streamer lines, weighted branchlines and night setting were ranked as most effective for both surface foraging birds and diving birds, noting that there are serious personal safety issues with weighted swivels on branchlines. Blue dyed squid (and not fish) was the only technology thought to be equally effective on surface

foraging seabirds and diving seabirds. The group noted that they were unaware of definitive research on the effect of circle hooks on seabird mortality (ranked with a question mark). Side setting was considered in isolation (as opposed to in combination with weighted branchlines or a setting curtain) and was ranked low (2) because side setting requirements in Hawaiian fisheries are combined with both weighted branchlines and a setting curtain, and Yokota and Kiyota (2006) reported that side setting must be used in combination with other mitigation measures. Blue dyed fish received the lowest ranking based on seabird crypsis data presented at the workshop. Fish oil was considered effective for diving seabirds only, and therefore, considered unlikely to be widely prescribed and may prove impractical to apply on a larger scale. The setting chute also ranked poorly on effectiveness given the most recent trials in Australia and Hawaii.

Streamer lines, the bait setting capsule and side setting were ranked as the highest priorities for future research. Weighted branchlines, the bait pod, and circle hooks received the second highest ranking. Blue-dyed squid was the only method ranked a three. All other methods were ranked low (underwater setting chute, night setting, fish oil, bait placement, line shooters, thawed bait, and strategic offal discharge).

Available time under this agenda item expired before participants could propose specific experiments to occur in 2006 to 2010 based on the rankings derived under Ranking Pelagic Mitigation Technologies for Future Research. Participants proposed that this task be taken up in the ACAP Seabird Bycatch Working Group and the bycatch work forming under the auspices of tuna and billfish RFMOs. Time constraints also precluded discussion of best locations to stage prioritized research. In ideal terms these would be locations where seabird interactions with difficult to deter seabirds are highest and where there is strong local support by industry, government and the scientific community. Locations where the BirdLife International Albatross Task Force has skilled practitioners on location would also be a priority.

Western Central Pacific Fisheries Commission Proposal

As an extension of the ranking exercise described above, the participants reviewed the seabird mitigation recommendation drafted by the 2006 meeting of the WCPFC Scientific Committee (Appendix 4). Participants shared knowledge and understanding of the scientific literature on each of the bycatch mitigation measures, in particular examining their effectiveness on both surface-foraging and diving seabirds, and their practicality and safety when used on fishing vessels. The attached table summarises the conclusions, highlighting strengths and weaknesses of each measures, and current data gaps (Table 1). Time expired before this exercise was complete; however a subset of the group completed the task immediately following the workshop.

The measures listed in Column A and Column B in the recommendation are a good depiction of measures believed to reduce seabird bycatch[1]. However, caveats can be associated with most of these measures – no single measure yet exists which can effectively reduce seabird bycatch on its own. Some possible combinations of measures are likely to be highly effective, while others may not. This reiterates the point made at the WCPFC Scientific Committee meeting on the importance of having combinations of measures, which is the strength of the Column A and

[1] (with the exception of bait casters)

Column B structure that is developed in the recommendation. It also underlines the importance of making it clear that these are interim measures, pending the results of conclusive research (See Appendix 4).

Funding For Mitigation Research

Kerry Lorimer, Peregrine Adventures, Australia
http://www.peregrineadventures.com/about_us/responsible_travel/
http://www.iaato.org/about.html

Peregrine is Australia's - and one of the world's - leading expedition cruise operators in Antarctica, operating two 100 passenger ships over 18 voyages each summer. On each voyage, a charity auction is held to raise funds for albatross conservation. To date, in excess of A$500,000 has been raised. The auctions are conducted by Peregrine staff - who also often donate the auction items - and all funds raised go directly to albatross conservation projects.

Peregrine's primary objective is to fund projects that will have the most significant, direct impact on reducing albatross attrition - particularly through longlining and other fishing methods. We seek projects that have the potential to achieve a 'cut through' - ie the aim is to identify critical areas that may be stalled or caught in a bottleneck due to lack of funds. For the past five years Peregrine has worked closely with Graham Robertson of the AAD (who was instrumental in Peregrine becoming involved in albatross conservation and who supplies Peregrine and other IAATO (International Association of Antarctic Tour Operators) members with DVD presentations for on-board passenger education) to identify a range of deserving research projects. These have included providing annual funding for Mangel and Shigueto's artisanal fisheries research and education project in Peru; providing funding for mitigation technique studies in the trawler fisheries of the Falklands (Ben Sullivan); albatross tracking studies (Carlos Moreno); and other research projects under the auspices of the IAATO Seabirds Advisory Group, headed by Graham Robertson. Peregrine has also provided funding for Sally Poncet's work on Albatross Island in South Georgia, both for population and tourism impact studies.

In addition to these 'grass roots' or 'bottom up' initiatives, Peregrine has established a unique partnership with WWF Australia (now also working with WWF internationally) to fund 'top down' projects. Most recently Peregrine sponsored a week-long international experts workshop to develop a broad-scale bioregionalisation of the Southern Ocean, with the aim of providing the foundation for CCAMLR's goal of determining a system of Marine Protected Areas (MPAs) in the Convention area. The resulting report will be presented at the CCAMLR meeting in Hobart in November, 2006.

Burr Heneman, David and Lucile Packard Foundation, USA
http://www.commonweal.org/programs/ocean-policy.html
http://www.packard.org

Burr Heneman (Commonweal Ocean Policy Program) representing the David and Lucile Packard Foundation, USA. Commonweal's Ocean Policy Program, based in California, promotes policies, management, and science for the conservation of marine living resources. Since January 2006, the program has advised The David and Lucile Packard Foundation on strategies and projects for the foundation's initiative on seabird and shorebird conservation in the Pacific.

The foundation's strategy for seabird conservation includes funding projects to reduce seabird mortality in fisheries. Toward that end, Packard has made grants to AAD for the current phase of development of the bait-setting capsule and to Washington Sea Grant for further engineering and field testing of streamer line techniques. The foundation also recognizes the importance of effective programs to gain adoption of bycatch mitigation techniques by fishermen but so far has not funded any projects in that area. Heneman suggested that, just as the workshop was an effective collaboration among those involved in seabird bycatch reduction, coordination and collaboration among funders could also be useful.

Wrap-Up

Ed Melvin, WSG

A consistent theme throughout this workshop was that seabird bycatch mitigation in pelagic fisheries is at a critical stage. Critical because the body of research demonstrating the effectiveness of mitigation technologies and practices is considerably less developed than that of demersal fisheries, yet several RFMO's are faced with requiring specific mitigation measures for their fleets right now. The proposal by the Scientific Committee of the WCPFC is an example of this challenge. Working Groups on seabird bycatch for pelagic fisheries are emerging, yet are uncoordinated at the global scale. ACAP is developing terms of reference of a seabird bycatch working group, while seabird bycatch working groups emerge across RFMO's. How these efforts will be coordinated so as to lead to the development and implementation of best management practices is of great importance and should be a high priority for those involved with the RFMOs and providing input to their meetings. Government delegations to these RFMOs need to effectively address this topic in a coordinated approach.

Workshop participants presented information on new initiatives and recent or planned research that are likely to provide improved tools to reduce seabird mortality. BirdLife International is working directly with RFMOs to identify ocean regions with high risk to seabirds and to support RFMO actions on required mitigation. ACAP is forming a seabird bycatch working group that is likely to provide a clearing-house of information on risks and best management mitigation with and emphasis on pelagic fisheries. BirdLife International through its Albatross Task Force is creating capacity for outreach in high-risk locations. New work is underway to optimize streamer line design and deployment systems, to trial side-setting, and to develop a bait setting capsule. The bait pod – a new idea designed to address both seabird and turtle conservation – is in development. Fish oil is undergoing further trials and a new research approach is providing insight on the efficacy of dying baits.

Our ad hoc workshop agenda was ambitious and our work continues. Although existing mitigation technologies and practices were placed in a hierarchy for future research, specific research activities in the form of a research plan were not identified, nor were specific principal investigators, best host locations or funding sources. A research plan cannot be developed in a day, but rather requires a sustained effort by the users – RFMOs and nations with pelagic fleets operating within their respective EEZs – and industry and research experts. Given the critical need for seabird conservation in pelagic fisheries and the uncertainty about the relative effectiveness of specific mitigation technologies and practices, a coordinated research plan is critical to achieve conservation of seabirds in pelagic fisheries. Seabird bycatch in pelagic fisheries was identified as a major threat to the conservation of seabirds over 17 years ago

(Brothers 1991) – a coordinated plan of research to demonstrate the effectiveness and practicality of seabird mitigation measures for pelagic fisheries and coordinated technology transfer are required to prevent another 17 years of sporadic research and continued seabird mortality.

A list of workshop participants and invitees are attached (Appendix 3). Continued communication and discussion is strongly encouraged and broader participation of others actively engaged with bycatch mitigation in RFMOs and the scientific community strongly encouraged.

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Appendix 1

Seabird Bycatch Mitigation in Pelagic Longline Fisheries Workshop
Museum of Natural History, Royal Society Room, Hobart, Tasmania
October 14, 2006; 9:00 AM

AGENDA

1. Introduction
Purpose and Objectives, E. Melvin

2. Linkages
- Regional Fishery Management Organization, C. Small
- ACAP Bycatch Working Group Activities, B. Baker
- Albatross Task Force, B. Sullivan

3. Pelagic Gear Descriptions
G. Robertson; others

4. Existing and/or Planned Research Activities 2006-2007
Five to 10 minute (maximum) presentations by participants of existing or planned research.

5. Pelagic Mitigation Technologies- Streamer Lines
Identify important streamer line design and performance features for research including towed device for prototype development

6. Pelagic Mitigation Technologies - Other
- Identify most promising mitigation technologies (or combinations) for future research
- Haul Mitigation
- Identify related engineering needs

7. Research Location
- Best locations/fisheries to host research: highly aggressive seabirds - season ("worst case"), local support and collaborative opportunities with industry

8. Mitigation Research 2006 to 2010
- Identify specific research phases

9. Potential Funding Sources
B. Heneman, K. Lorimer

10. Wrap-Up
Recap of the day's discussion and next steps, E. Melvin

Appendix 2

Mitigation	Effective surface feeding birds	Effective diving birds	Practical	Safe	Cost Cap	Cost Ops	DWF/ Dom	Compliance	Intuitive Priority
Primary									
Streamer lines	4	3	4	4	5	5	5/5	1	5
Weighted branchlines	4	3	5	1	4	4	5/5	5	4
Underwater Setting									
Chute	2	1	2	3	3	5	1/5	1	1
Bait setting capsule	5	4*	4	4	4	5	5/5	3	5
Bait Pod	5	4*	3	4*	4	4	5/5	1	4
Night Setting	4	3	5	4	5	3*	5/5	3	1
Secondary									
Circle Hooks	?	?	5	5	5	5	5/5	5	4
Bait placement/casting	2*	2*	5	3	4	4	5/5	1	1
Line shooter?	2	2	5	4	4	4	5/5	1	1
Thawed bait	2	2	3	5	5	5	5/5	1	1
Strategic offal discharge	2	2	3	5	5	5	5/5	1	1
Other									
Side Setting	2*	2*	3	4	4	5	5/5	5	5
Blue Dyed Squid	3	3	3	5	5	4	5/5	1	3
Blue Dyed Fish	1	1	3	5	5	4	5/5	1	1
Fish Oil	1	4	2	4	4	3	5/5	1	2

Appendix 3. Workshop Participants and Invitees

First Name	Last Name	Affiliation	Country	Email
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Rosemary	Gales	Department of Primary Industries Water and Environment	Australia	Rosemary.Gales@dpiwe.tas.gov.au
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Burr	Heneman	David & Lucile Packard Foundation	USA	burr@igc.org
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Susan	Waugh	Ministry of Fisheries	New Zealand	susan.waugh@fish.govt.nz

* denotes invitees unable to attend

Appendix 4

Seabird bycatch mitigation measures in pelagic fisheries

BirdLife International

On 14 October 2006 a workshop was held to prioritise research needed to address seabird bycatch mitigation in pelagic longline fisheries. In addition, the workshop participants shared knowledge on known and potential seabird bycatch mitigation measures in pelagic fisheries, examining the effectiveness of measures on both surface-foraging and diving seabirds, and their practicality and safety when used on fishing vessels. The workshop was organised by Washington Sea Grant, University of Washington, and was staged in Hobart to take advantage of experts present for the annual meeting of the ad hoc Working Group on Incidental Mortality Arising from Fishing (IMAF) of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).

Recognising the intention of the WCPFC to discuss seabird bycatch mitigation measures in December 2006, and the seabird mitigation recommendation drafted by the 2006 meeting of the WCPFC Scientific Committee, this document summarises knowledge shared at the meeting. The attached table discusses strengths and weaknesses of each mitigation measure, the need for combinations of measures, and current data gaps (Table 1). A full copy of the workshop report is available at http://wsg.washington.edu.

Conclusions

- The seabird recommendation from the WCPFC Scientific Committee in August 2006 would be a highly constructive step to reduce seabird bycatch in the WCPFC area.

- With the exception of bait casters, the mitigation measures listed are a good depiction of measures believed to reduce seabird bycatch in pelagic fisheries. However, caveats are associated with most measures. This reiterates the point made at the WCPFC Ecosystem & Bycatch meeting on the need to use combinations of measures. All fisheries in which seabird bycatch mitigation has been successful have found that combinations of measures are essential. As stated at the WCPFC Ecosystem & Bycatch meeting, the strength of the Column A and Column B approach is that it requires such combinations while also providing flexibility to select the combination most suited to their vessel.

- Streamer lines, night setting and weighted branch lines can be highly effective mitigation measures when used properly and in combination. Side-setting has been found effective in Hawaiian fisheries when combined with line weighting and a setting curtain. However, research is urgently needed to test the effectiveness of side-setting in the Southern Ocean, where deeper-diving seabird species are common. Further testing is also recommended on the effectiveness of blue-dyed squid in the Southern Ocean, on the effectiveness of lineshooters, and on best practises for offal management. A plan for research developed across pelagic fishery RFMOs would provide the necessary tools to reduce seabird mortality in pelagic fisheries worldwide.

- As noted at the 2006 WCPFC Scientific Committee meeting, the recommendations on seabird mitigation measures should be considered as interim. Measures will need to be re-evaluated as more information becomes available through research.

Recommendation to the Third Meeting of the WCPFC

- A seabird Conservation Measure based on the recommendation from the WCPFC Scientific Committee would be a highly constructive step to reduce seabird bycatch in the WCPFC area. The strength of the recommendation lies in its requirement for the use of two mitigation measures, providing the necessary use of a combination of measures, while also providing flexibility for fishermen to select the combination most suited to their vessel.

Table 1. Review of seabird bycatch mitigation measures listed in the seabird recommendation from the WCPFC Scientific Committee

Column A	Scientific evidence for effectiveness in pelagic fisheries	Caveats /Notes	Need for combination	Research needs	Minimum standards
Night setting	Duckworth 1995; Brothers et al. 1999; Gales et al 1998; Klaer & Polacheck 1998; Brothers et al. 1999; McNamara et al. 1999; Gilman et al. 2005; Baker & Wise 2005.	Less effective during full moon, under intensive deck lighting or in high latitude fisheries in summer. Less effective on nocturnal foragers e.g. White-chinned Petrels (Brothers et al. 1999; Cherel et al. 1996).	Recommend combination with tori lines and/or weighted branch lines	Data on current time of sets by WCPFC fisheries. Effect of night sets on target catch for different fisheries.	Night defined as nautical dark to nautical dawn
Side setting	Brothers & Gilman 2006; Yokota & Kiyota 2006.	Only effective if hooks are sufficiently below the surface by the time they reach the stern of the vessel. In Hawaii, side-setting trials were conducted with bird curtain and 45-60g weighted swivels placed within 0.5m of hooks. Japanese research concludes must be used with other measures (Yokota & Kiyota 2006).	Must be combined with other measures. Successful Hawaii trials use bird curtain plus weighted branch lines. In Southern Hemisphere, strongly recommend use wth tori lines until side-setting is tested in the region.	Currently untested in the Southern Ocean against seabird assemblages with diving seabirds and albatrosses - urgent need for research. In Japan, NRIFSF will continue testing in 2007.	In Hawaii, side setting is used in conjunction with a bird curtain and 45 weighted swivel within 1m of the baited hook.
Single tori line	Imber 1994; Uozomi & Takeuchi 1998; Brothers et al. 1999; Klaer & Polacheck 1998; McNamara et al. 1999; Boggs 2001; CCAMLR 2002; Minami & Kiyota 2004. Melvin 2003.	Effective only when streamers are positioned over sinking baits. In pelagic fisheries, baited hooks are unlikely to sink beyond the diving depths of diving seabirds within the 150m zone of the tori line, unless combined with other measures such as line weighting or underwater setting. Entanglement with fishing gear can lead to poor compliance by fishers and design issues need to be addressed. In crosswinds, tori line must be deployed from the windward side to be effective.	Effectiveness increased when combined with other measures e.g. weighted branch lines and/or night setting	Optimal design for pelagic fisheries still under development: refine to minimise tangling, optimise aerial extent and positioning, and ease hauling/retrieval. Current research by Ed Melvin (Washington Sea Grant), also program for small vessels by Global Guardian Trust in Japan. Controlled studies demonstrating their effectiveness in pelagic fisheries remain very limited.	Current minimum standards for pelagic fisheries are based on CCAMLR Conservation Measure 25-02

Table 1 continued.

Column B	Scientific evidence for effectiveness in pelagic fisheries	Caveats /Notes	Need for combination	Research needs	Minimum standards
Paired tori line	Two streamer lines best in crosswinds to maximise protection of baited hooks (Melvin et al. 2004).	Potentially increased likelihood of entanglement - see above. Development of a towed device that keeps gear from crossing surface gear essential to improve adoption and compliance.	Effectiveness will be increased when combined with other measures. Recommend use with weighted branch lines and/or night setting	Development and trialling of paired streamer line systems for pelagic fisheries.	
Weighted branch lines	Brothers 1991; Boggs 2001; Sakai et al. 2001; Brothers et al. 2001; Anderson & McArdle 2002; Gilman et al. 2003a; Robertson 2003; Lokkeborg & Robertson 2002, Hu et al. 2005.	Supplementary measure. Weights will shorten but not eliminate the zone behind the vessel in which birds can be caught. Even in demersal fisheries where weights are much heavier, weights must be combined with other mitigation measures (e.g. CCAMLR Conservation Measure 25-02).	Must be combined with other measures e.g. tori lines and/or night setting	Weight and position of weight both affect sink rate. Further research on weighting regimes needed. Safety issues and effect on target catch must be considered. Research on use of integrated-weight branch lines in pelagic fisheries also needs further exploration.	Global minimum standards not yet established. Requirements vary by fishery and vessel. Hawaii minimum requirements are 45g less than 1 m from hook. Australia requires 60 or 90g located 3.5 or 4 m from the hook, respectively.
Blue dyed bait	Boggs 2001; Brothers 1991; Gilman et al. 2003a; Minami & Kiyota 2001; Minami & Kiyota 2004; Lydon & Starr 2005. Double and Cocking, in press.	New data suggests only effective with squid bait (Double & Cocking). Onboard dyeing requires labour and is difficult under stormy conditions. Results inconsistent across studies.	Must be combined with tori lines or night setting	Need for tests in Southern Ocean.	Mix to standardized colour placard or specify (e.g. use 'Brilliant Blue' food dye (Colour Index 42090, also known as Food Additive number E133) mixed at 0.5% for a minimum of 20 minutes)
Line shooter	Reduced bycatch of Northern Fulmar in trials of mitigation measures in North Sea, Lokkeborg & Robertson 2002; Lokkeborg 2003. Increased seabird bycatch in Alaska (Melvin et al. 2001).	Supplementary measure. No published data for pelagic fisheries. May enhance hook sink rates in some situations but will not eliminate the zone behind the vessel in which birds can be caught. More data needed. Found ineffective in trials in North Pacific demersal longline fishery (Melvin et al. 2001).	Must be combined with other measures such as night setting and/or tori lines or weighted branch lines	Data needed for pelagic fisheries.	Not established

Table 1 continued.

Column B	Scientific evidence for effectiveness in pelagic fisheries	Caveats /Notes	Need for combination	Research needs	Minimum standards
Bait caster	Duckworth 1995; Klaer & Polacheck 1998.	Not a mitigation measure unless casting machines are available with the capability to control the distance at which baits are cast. This is necessary to allow accurate delivery of baits under a tori line. Needs more development. Few commercially-available machines have this capability.	Not recommended as a mitigation measure.		
Underwater setting chute	Brothers 1991; Boggs 2001; Gilman et al. 2003a; Gilman et al. 2003b; Sakai et al. 2004; Lawrence et al. 2006.	For pelagic fisheries, existing equipment not yet sturdy enough for large vessels in rough seas. Problems with malfunctions and performance inconsistent (e.g. Gilman et al. 2003a and Australian trials cited in Baker & Wise 2005)	Not recommended for general application	Design problems to overcome	Not yet established
Management of offal discharge	McNamara et al. 1999; Cherel et al. 1996.	Supplementary measure. May reduce the number of birds attracted to the vessel, and strategic discharge can be used to distract birds. Effectiveness in pelagic fisheries is not well established. There may be storage space constraints on smaller vessels.	Must be combined with other measures	Further information needed on effects in pelagic fisheries (long and short term)	Not yet established for pelagic fisheries. In CCAMLR demersal fisheries, discharge of offal is prohibited during line setting. During line hauling, storage of waste is encouraged, and if discharged must be discharged on the opposite side of the vessel to the hauling bay.
Thawing bait	Brothers 1991; Duckworth 1995; Klaer & Polacheck; Brothers et al 1999.	Supplementary measure. Must be combined with other measures. If lines are set early morning, full thawing of all bait may create practical difficulties.			

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Appendix: Seabird bycatch mitigation measures recommended by the WCPFC Scientific Committee in August 2006.

1. All longliners should thaw their bait before it is deployed.
2. In addition, south of 30ºS and north of 23ºN, CCMs should require their longline vessels to use at least two of the mitigation measures presented in Table 1, including at least one from Column A.

Table 1: Recommended mitigation measures

Column A	**Column B**
Side setting [with bird curtain]	Tori line*
Night setting with minimum deck lighting	Weighted branch lines
Tori line	Blue-dyed bait
	Deep setting line shooter
	Bait caster
	Underwater setting chute
	Management of offal discharge

* If tori line is selected from both column A and column B this equates to simultaneously using two (i.e. paired) tori lines.

3. In other areas, where necessary, CCMs are encouraged to employ one or more of the seabird mitigation measures listed in Table 1.
4. Other mitigation measures may be tested under *bona fide* research programmes.
5. Every effort should be made to ensure that seabirds captured alive during longlining are released alive and that wherever possible hooks are removed without jeopardising the life of the seabird concerned.
6. CCMs are encouraged to seek feedback from fishers and observers on the effectiveness and practicality of mitigation measures.
7. *These measures should be reviewed regularly, particularly when information becomes available on new or existing measures or on seabird interactions from observer or other monitoring programmes. An updated suite of recommended measures should then be considered.*
8. *To the extent possible CCMs should endeavour to harmonise their NPOAs with these measures.*