Discussion Paper on Seabird Interactions with Trawl Vessel Gear

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North Pacific Fishery Management Council
Protected Resources Report No. 2

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Background

At its April 2003 meeting, the North Pacific Fishery Management Council (Council) received a report from the U.S. Fish & Wildlife Service (USFWS) about an impending incidental take statement for short-tailed albatross (*Phoebastria albatrus*) in the trawl groundfish fisheries in the Gulf of Alaska (GOA) and Bering Sea/Aleutian Islands (BSAI). The USFWS and NOAA Fisheries are concerned about the potential incidental take of short-tailed albatross in Alaskan trawl fisheries, particularly those that utilize "third wire" gear for monitoring trawl performance.

"Third wires" are attached to electronic monitoring equipment usually attached to the trawl at the center of the headrope. These wires or cables extend behind the vessel, entering the water some distance astern. That distance depends on factors such as vessel size, towing speed, and depth of net. Other technologies exist that deploy an acoustic receiver on wires astern or alongside the vessel, which are referred to as paravane or netsonde cables. These receive an acoustic signal from the trawl rather than one carried over a wire. Towed acoustic receivers can be replaced by hull mounted receivers. Note, a net monitor cable in Alaskan fisheries can refer to both the "third wire" devices and the acoustic devices. In the several Southern Hemisphere trawl fisheries referenced in this paper, the term net monitor cable typically refers only to "third wire" devices from netsonde gear.

Observations from multiple fisheries suggest that seabirds have difficulty seeing the cable and thus collide with it in the air and on the water. Birds on the wing can hit the cable while in flight, resulting in injury or mortality. Birds on the surface immediately astern may be pinched between the cable and the surface as the cable moves forward with the vessel and rises and falls with swell and wake. As seabirds hit the cable they extend their wings, a very fragile appendage, and the force of the water and the cable wraps the wing around the cable. Unable to retract their wings, they are forced underwater and drown. At times both interactions occur - birds fly into the cable, fall to the surface and become pinched between the cable and the water. Seabird interactions with trawl gear are not limited to the net monitor cable (Weimerskirch et al. 2000, Sullivan and Reid 2002, Wienecke and Robertson 2002, Hooper et al. 2003, Sullivan et al. 2003, Sullivan and Reid 2003, and Sullivan et al. 2004). These same interactions are reported to occur with trawl warps in other fisheries, and both are exacerbated by continuous discharge of offal. Seabirds can also become entangled in the net as birds attempt to feed from fish in or falling from the trawl itself.

Fishery observers in Alaska trawl fisheries have reported mortalities of northern fulmars (*Fulmarus glacialis*), shearwaters (*Puffinus* spp.), and Laysan albatrosses (*P. immutabilis*) associated with the net monitor cables. While short-tailed albatross interactions with trawl gear have not been observed, they are at risk because their distribution overlaps with trawl fishing effort, they have been observed feeding on offal around trawl vessels, and mortalities of a similar species, the Laysan albatross, have been documented. Since the short-tailed albatross is listed as endangered under the Endangered Species Act (ESA), NOAA Fisheries is required to engage in ESA section 7 consultations with the USFWS for those fishery actions which may affect the listed species.

On September 18, 2003, the USFWS issued two biological opinions (USFWS 2003a, 2003b) on the effects of Alaska groundfish fishing on certain seabird species listed under the ESA. One of the biological opinions is a programmatic opinion on the fishery management plans (FMPs) for the GOA and BSAI groundfish fisheries (USFWS 2003a). The other is a more specific opinion on the total allowable catch (TAC)-setting process for the GOA and BSAI groundfish fisheries (USFWS 2003b). These opinions conclude that the BSAI and GOA groundfish fisheries are not likely to jeopardize the continued existence of the short-tailed albatross or Steller's eider, and are not likely to result in adverse modification of critical habitat for Steller's eiders (critical habitat for short-tailed albatross has not been defined). The TAC biological opinion includes an incidental take statement that establishes a limit of four short-tailed albatrosses every two years in the hook-and-line groundfish fisheries off Alaska, and two short-tailed albatrosses in the trawl groundfish fisheries off Alaska over the time period in which the biological opinion is in effect (this is estimated to be about five years). Associated with this incidental take statement is a non-discretionary term and condition: *The NMFS shall continue to work on developing a safe and reliable means of assessing short-tailed albatross interaction/collision with trawl vessel gear, to: (1) document whether take occurs, and if so, (2) estimate the rate of such take. A report of the interactions between short-tailed albatross and trawl gear shall be submitted to the Service by December 31, 2006.* A description of the net monitor cable used in Alaska fisheries from the USFWS Programmatic Biological Opinion (USFWS 2003a) can be found in Appendix 1.

During the April 2003 Council presentation, reference was made to seabird mortalities from net monitor cables in fisheries outside of Alaska. It was reported that a ban exists on the use of net monitor cables in several Southern Hemisphere trawl fisheries [New Zealand's domestic trawl fisheries, Australia's Heard Island and Macquarie Island trawl fisheries, and trawl fisheries managed by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)]. Some Council members expressed interest in this issue and in particular the scientific background that led to the ban. This paper provides a brief overview of the ban of the net monitor cable in these fisheries and concludes with a brief reference to work underway in Alaskan fisheries to address the issue of seabird interactions with trawl vessel gear.

Introduction

CCAMLR was established in 1982 as part of the multi-nation Antarctic Treaty system and the approval of the Convention on the Conservation of Antarctic Marine Living Resources. The goal of the Convention is to conserve marine life of the Southern Ocean, but also to allow for rational harvesting of fish and other marine organisms. The Commission manages marine resources within the geographic boundary of the CCAMLR Convention Area (Figure 1) (including whales and seals, which are also covered by other conventions); the Commission is composed of government representatives advised by fishermen, conservationists, scientists, and other users of marine resources in the area.

Several trawl and longline fisheries operate in the CCAMLR area, and thus quotas, seasons, and gear restrictions have been implemented or modified annually by the Commission to manage these fisheries. Since 1991, the Commission has prescribed various seabird avoidance measures for the longline fisheries, some of which served as a model for seabird avoidance measures employed by U.S. vessels in the Alaskan EEZ. The Commission received reports of mortalities of seabirds in various trawl fisheries near the CCAMLR area [squid trawl fishery around the Auckland Island shelf off New Zealand and the icefish trawl fishery on the Kerguelen Shelf (Kerguelen Island, French Territory)]. Much of the concern was for seabird collisions with net monitor cables deployed on some trawlers. This led to a ban on the use of net monitor cables in the trawl fisheries in the CCAMLR area commencing with the 1994-1995 fishing year.

CCAMLR Information on Seabird Interactions with Net Monitor Cables

The Commission meets annually to adopt new measures for the fisheries operating in the CCAMLR Convention Area. In 1991, during its tenth annual meeting in Hobart, Australia, CCAMLR received reports from its Scientific Committee about seabird mortality due to encounters with net monitor cables in trawl fisheries. The Scientific Committee cited three papers (SC-CAMLR-X/BG/4, SC-CAMLR-X/BG/14, and SC-CAMLR-X/BG/18) that provided data on this issue (two are reviewed below, and a third did not address net monitoring gear at all). Little information is available from the fisheries operating in the CCAMLR area on the extent to which seabirds encounter and strike net monitor cables. Note, 'net monitor cable' as used in the CCAMLR reports likely refers to a third wire device from the vessel stern to the trawl. This term does not reference devices using acoustic technology.

Representatives of the French Delegation reported to the Commission on incidental mortalities of seabirds and marine mammals in the fisheries around Kerguelen Island (Duhamel 1991). This report (SC-CCAMLR-X/BG/14) included estimates of mortality to albatrosses and petrels from trawl net monitor cables used in the mackerel icefish fisheries. The report provides some anecdotal comments on seabird mortalities that occurred prior to 1984, stating that the mortality rate was about 2 to 3 individuals per trawl haul. The mortalities were from collisions of birds with the cable, mainly by black-browed albatrosses and white-chinned, giant, and grey-headed petrels. Duhamel (1991) noted that seabirds following the trawl vessels were unlikely to see the net monitor cable because of its size (6-8 mm), and thus collided with the wire during their feeding activities associated with the trawl fishing activities. Birds with larger wingspans were more susceptible to injury. The report acknowledged that data are not precise because crews are usually occupied with other activities and are "…not disposed to gather this type of data." Duhamel (1991) expressed concern that the mortality to black-browed albatrosses and giant petrels from net monitor cables in the mackerel icefish fishery could be high enough to have a population level effect on these species. The report suggested that prohibition of the use of net monitor cables could positively affect the populations of these seabird species.

The Delegation of New Zealand reported on the incidental mortality to seabirds from the New Zealand subantarctic arrow squid trawl fishery (Bartle 1991a). Soviet vessels under contract to New Zealand conducted this fishery. Eleven observers were deployed on four vessels over 338 days of fishing and 897 trawl hauls in 1989 and 1990. The report (SC-CCAMLR-X/BG/4) noted a concern over the very high mortality (82-93%) of albatrosses that collided and entangled in net monitor cables. The species most affected was the white-capped albatross; 177 of 214 white-capped albatross mortalities were from encounters of birds with these cables. These data also were presented in a scientific paper (Bartle 1991b).

Bartle (1991a) summarized observer reports on how seabirds encountered the net monitor cables. The wire was grey in color and about 7 mm in diameter, making it difficult to see. The wire extended from the top of the gantry to 20 m behind the vessel where it entered the water. As the wire whipped up and down behind the trawl vessel pitching in the swell, albatrosses targeting offal or fish discards in the wake of the vessel were struck by the cable. While some birds were not harmed, others were killed or injured. Dead birds were occasionally retrieved in the trawl net or were wrapped on the wire and accumulated where it attaches to the headline monitor.

Bartle (1991a) speculated that this level of mortality could adversely affect the breeding population of New Zealand white-capped albatross, perhaps driving this species to extinction within 32 years at the mortality rate documented at the time. This report recommended several management options including required reconfiguration of the cable so that it does not extend above the sea surface behind the vessel, or requiring these vessels to fish without net monitor cables (using through-hull transducers instead). Based on this report, New Zealand's Ministry of Fisheries subsequently prohibited the use of netsonde cables in its trawl fisheries in 1992 (N. Smith, pers. comm.).

This information also formed the basis for a net monitor cable prohibition enacted with the opening of the Australian subantarctic trawl fishery around the Heard and MacQuarie Islands in 1996 (S. Kalish, pers. comm.).

CCAMLR Ban on Net Monitor Cables

Although the observations described for the New Zealand squid trawl fishery and the French Kerguelen Shelf fishery were outside of CCAMLR jurisdiction, the Scientific Committee noted that net monitor cables were used in the CCAMLR fisheries on krill, icefish (*Champsocephalus gunnari*), and lanternfish (*Electrona carlsbergi*). Therefore, it was reasonable to conclude that similar seabird mortality was occurring in these fisheries. Further, the Scientific Committee noted that new technology was available at that time which allowed the netsounders to operate by an acoustic link to the vessel, an alternative to the net monitor cables. Further, French researchers reported that once the net monitor cables were removed from nets, mortality of seabirds ended. Based on this cumulative information, the Scientific Committee recommended that the Commission phase out the use of net monitor cables as rapidly as possible (SC-CAMLR 1991a, SC-CAMLR 1991b).

Based on the recommendations of its Scientific Committee, the Commission prohibited the use of net monitor cables in trawl fisheries commencing with the 1994-1995 season (CCAMLR Conservation Measure 30/X) (CCAMLR-X 1991). The Commission required that net monitor cables still in use in the interim (1991 to 1994) would be deployed so as to reduce incidental seabird mortality, and required trawl fisheries to report annually on progress achieved toward phasing out this gear. During this interim period, the Commission recommended to the fishing industry that the net monitor cable be deployed by routing the cable from the aft gantry through a weighted snap block lowered from the stern ramp so the cable would be paid out directly underwater. These vessels were apparently using netsonde-type monitoring devices that sent a signal to the vessel over a third wire. These vessels were able to reconfigure and use acoustic transmission instead, and employ through-hull transducers rather than a towed receiver.

At its annual meeting in 1999, the Commission discussed other operational aspects of trawl fisheries that cause seabird mortalities including waste disposal and deck lighting. During this meeting, the Commission adopted Conservation Measure 173/XVIII which subsumed the Commission's earlier Conservation Measure 30/X. This new Conservation Measure included a continued prohibition of the use of net monitor cables in trawl fishing operations, and added measures prohibiting offal disposal (during gear deployment and hauling) and plastic packaging bands, and minimizing outwardly-directed deck lighting.

Also during its 1999 meeting, the Commission received two reports (WG-FSA-99/26 and 99/72) that discussed seabird interactions with trawl gear. One report (Weimerskirch et al. 1999) documented the mortality of albatrosses and other seabirds (species not specified) from encounters with a net monitor cable on a Ukrainian trawler fishing for Patagonian toothfish and mackerel icefish in the Kerguelin area of the Southern Ocean, an area not covered by the CCAMLR net monitor cable ban. The other report (Robertson and Wienecke 1999) discussed seabird encounters with trawl warp cables.

Summary

Based on observer reports of mortality of seabirds encountering net monitor cables used in some of the trawl fisheries operating near the CCAMLR area, in 1991 the Commission required a ban on the use of net monitor cables in trawl fisheries in the CCAMLR Area. The ban went into effect for the 1994-1995 fishing season in the CCAMLR area. In 1999, this regulation was incorporated into a more broad set of marine resources conservation measures that included the continuation of the ban of net monitor cables. The U.S. concurred with the Commission's recommendations, and a net monitor cable ban is now part of U.S. regulations that affect vessels of, and persons subject to, the jurisdiction of the U.S. for fishing activities in CCAMLR statistical reporting areas 48 and 58 (50 CFR 380.27(b)).

Prohibiting the use of net monitor cables represents one approach to reducing seabird mortalities caused by interactions with trawl vessel gear. In the last several years, research in New Zealand and the Falkland Islands/Malvinas Islands (Sullivan et al 2004) has been undertaken to develop trawl mitigation devices to reduce the number of seabird mortalities caused by seabirds colliding with trawl warp cables. Several different devices (Brady Baffler, warp scarer, tori lines) are being evaluated for effectiveness and manufactured for additional trials. The net monitor cables deployed in some Alaskan groundfish fisheries connect the vessel to a net-mounted trawl sonar device. These devices apparently carry more information to the vessel than netsonde gear, but do not afford vessels the option of an acoustic link between the net and the vessel (see Appendix 1). Scientists from the Washington Sea Grant Program, University of Washington, and NOAA Fisheries are coordinating efforts with the Alaska trawl industry and the New Zealand and Falkland Island/Malvinas Islands researchers to consider potential effective solutions for reducing seabird interactions with Alaska trawl vessel gear. A draft annotated bibliography compiled by the Washington Sea Grant Program of relevant work on seabird mortality occurring during trawl fishing operations is available in Appendix 2.

Acknowledgments

We extend our appreciation to Kim Dietrich and Ed Melvin of the University of Washington Sea Grant Program for providing the annotated bibliography attached to this report and for their thoughtful review and comments on an earlier report draft. We also acknowledge assistance from Stephanie Kalish, Australian Fishery Management Agency, and Neville Smith, New Zealand Ministry of Fisheries, in obtaining information on the domestic fisheries in Australia and New Zealand.

Literature Cited

Bartle, J.A. 1991a. Incidental catch of seabirds in trawl fisheries. Delegation of New Zealand, Report to the Commission for the Conservation of Antarctic Marine Living Resources, 1 July 1991, SC-CAMLR-X/BG/4. 11 p.

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Hooper, J., D. Agnew, and I. Everson. 2003. Incidental mortality of birds on trawl vessels fishing for icefish in Subarea 48.3. WG-FSA-03/79, CCAMLR, Hobart, Australia.

Robertson, G. and B. Wienecke. 1999. Seabird, seal and fishing vessel interactions in the Heard and MacDonald Islands and Macquarie Island Patagonian toothfish trawl fishery. WG-FSA-99/72, October 1999, Hobart, Tasmania.

SC-CAMLR 1991a. SC-CAMLR-X Report of the Tenth Meeting of the Scientific Committee. Paragraphs 8.27 through 8.34. CCAMLR, Hobart, Tasmania.

SC-CAMLR 1991b. Annex 6, WG-FSA Report, paragraphs 5.7 through 5.10. CCAMLR, Hobart, Tasmania.

Sullivan, B. J. and T. Reid. 2002. Seabird interactions/mortality with longliners and trawlers in Falkland Island waters 2001/2002. CCAMLR WG-FSA-02/36, Falkland Conservation, Seabirds at Sea Team, Stanley, Falkland Islands.

Sullivan, B.J., P. Brickle, T.A. Reid, and D.G. Bone. 2004. Experimental trials to investigate emerging mitigation measures to reduce seabird mortality caused by warp cable strike on factory trawlers. Unpublished report. Seabirds at Sea Team, Falklands Conservation, Falkland Islands; Falkland Islands Fisheries Department, Falkland Islands; British Antarctic Survey, Cambridge, U.K.

Sullivan, B. and T. Reid. 2003. Seabird mortality and trawlers in Falkland Island waters 2002/2003. Annual report of the Seabirds at Sea Team, Falkland Conservation. 58p.

Sullivan, B. J., T. A. Reid, L. Bugoni, and A. D. Black. 2003. Seabird mortality and the Falkland Islands trawling fleet. WG-FSA-03/91, CCAMLR, Hobart, Australia.

USFWS. 2003a. Programmatic Biological Opinion on the Effects of the Fishery Management Plans (FMPs) for the Gulf of Alaska (GOA) and Bering Sea/Aleutian Islands (BSAI) Groundfish Fisheries on the Endangered Short-tailed Albatross (*Phoebastria albatus*) and Threatened Steller's Eider (*Polysticta stelleri*). Anchorage Fish & Wildlife Field Office, Alaska. 83 p.

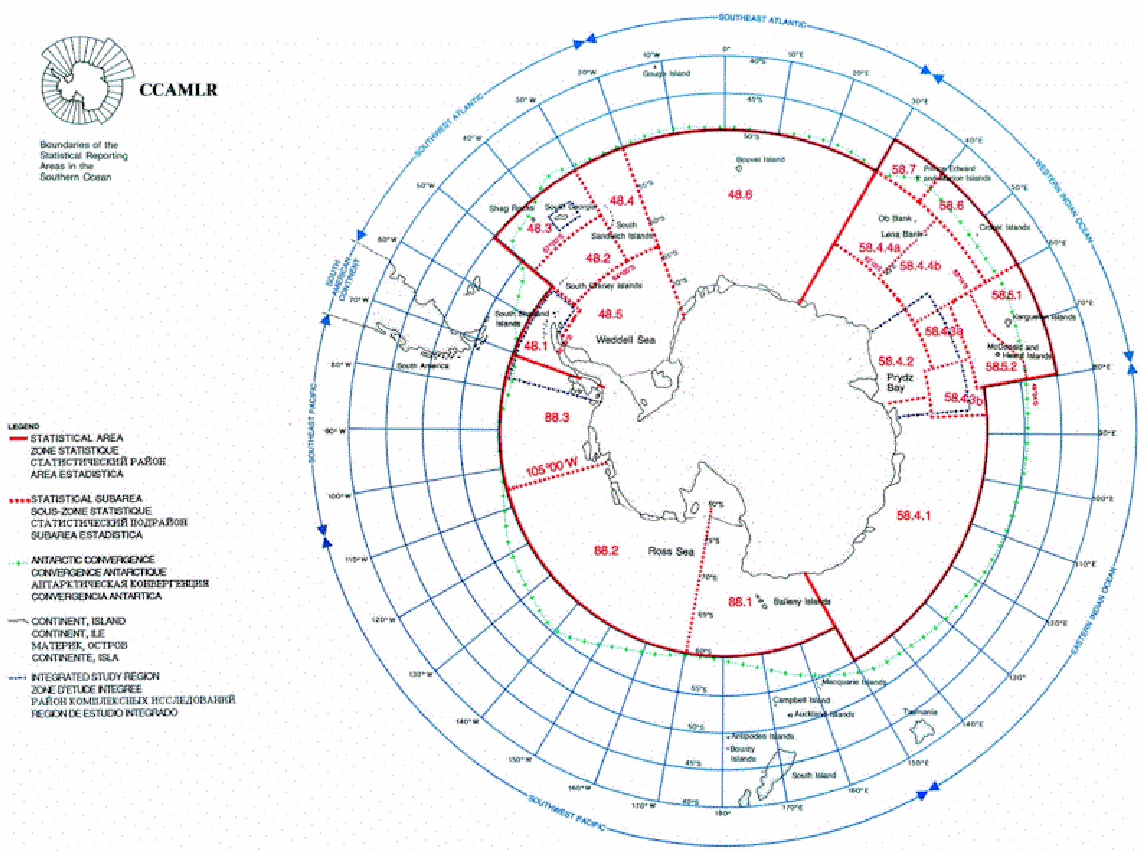
USFWS. 2003b. Biological Opinion on the Effects of the Total Allowable Catch (TAC)-Setting Process for the Gulf of Alaska (GOA) and Bering Sea/Aleutian Islands (BSAI) Groundfish Fisheries on the Endangered Short-tailed Albatross (*Phoebastria albatus*) and Threatened Steller's Eider (*Polysticta stelleri*). Anchorage Fish & Wildlife Field Office, Alaska. 38 p.

Weimerskirch, H., D. Capdeville, and G. Duhamel. 1999. Factors affecting the number and mortality of seabirds attending trawlers and longliners in the Kerguelen area. WG-FSA-99/26, September 1999, Hobart, Tasmania.

Weimerskirch, H., D. Capdeville, and G. Duhamel. 2000. Factors affecting the number and mortality of seabirds attending trawlers and long-liners in the Kerguelen area. Polar Biology 23:236-249.

Wienecke, B. and G. Robertson. 2002. Seabird and seal - fisheries interactions in the Australian Patagonian toothfish *Dissostichus eleginoides* trawl fishery. Fisheries Research 54:252-265.

Figure 1. Map of the CCAMLR Convention Area.



(Source: http://www.ccamlr.org/pu/E/conv/map.htm)

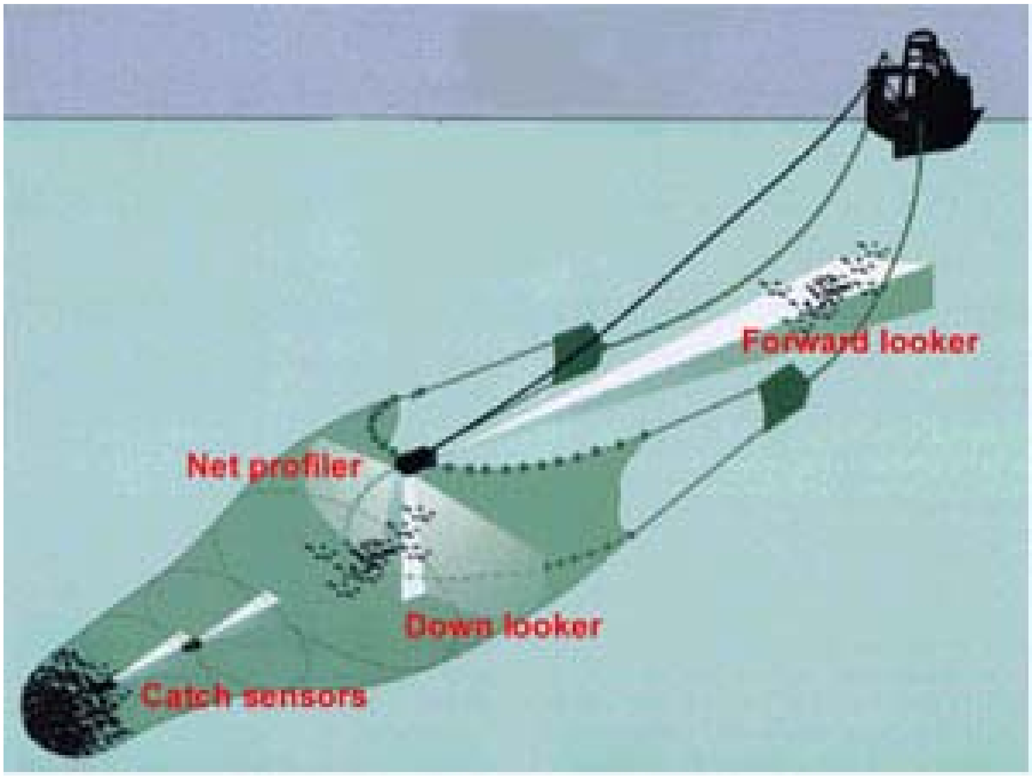


Figure 2. Illustration of trawl sonar and the net monitor cable.
(Source: http://www.wesmar.com/images/trawl2.jpg)

Appendix 1:

A description of the net monitor cable from the US Fish & Wildlife Service Programmatic Biological Opinion (USFWS 2003a).

> In some trawl fisheries, equipment mounted on the trawl net sends signals to the vessel to monitor net performance. This is most important in midwater fisheries, but is employed in some bottom trawl fishing applications as well. There are two primary methods for gathering net performance information and sending this information to equipment on the vessel bridge. One method employs an underwater echo sounder on the headrope of the trawl net to determine the height of the headrope above the ocean bottom and the opening depth of the net itself. This system can also detect whether fish pass above or below the echo sounder, thus showing where the fish are in relation to the net in the water column. Fishermen generally refer to this system as either an echo sounder or a netsonde. The signal is sent to the vessel acoustically through the water column, where it is received by a hydrophone that is either a side-deployed towed transducer or one that is mounted to the hull of the vessel. The system rarely, but sometimes, employs a transducer wire towed from the rear of the vessel.
>
> The other system is typically known as trawl sonar (Figure 2). This equipment is also mounted to the headrope and is sometimes referred to as the “suitcase.” The system provides information straight up and down, as the echo-sounder does, but it also sweeps side to side and can provide a 360 degree picture of the net, water column, and target fish. This system provides much better information regarding how the net is deployed and saves fishermen a great deal of time and effort because they can either fine-tune the net performance while towing, or realize early on that there is a major problem and bring the gear back to the surface. The trawl sonar is hard-wired to the vessel through a cable typically known as the third wire. Signals sent over this third wire are superior to those sent acoustically, as the third wire carries more information, sends a constant signal, and is not susceptible to disturbance from ambient noise or noise from the vessel itself.
>
> Either system can deploy cables outboard of the vessel. Seabirds attracted to offal and discards from the ship may either strike the hard-to-see cable while in flight, or get caught and tangled in the cable while they sit on the water, due to the forward motion of the vessel. When the cable or third wire encounters a bird sitting on the water, the bird can also be forced underwater and drown. On-board observations of birds (including Laysan albatross) colliding with either of these cables have been made by both researchers and observers. Some birds that strike vessels or fishing gear may fly away without injury, while others may be injured or killed.
>
> The main distinction between the two systems is the different location of the transducer cables and third wires. The netsonde transducer wires are deployed from the side of the ship and can be very close to where offal is discharged.

There, they are not so likely to be hit by flying birds, but very likely to encounter swimming birds. Alternatively, transducer wires can be suspended from relatively long outriggers; this gets them out of the offal discharge area, but puts them more into the birds' flying zone. In contrast, trawl sonar cables (third wires) are deployed from the center of the stern, above the main deck, and can be above the water for longer distances. Thus, they are more likely to intersect the birds' flying zone than the concentration of swimming birds feeding on offal. These differences in location are likely to affect the probability and mechanism of bird strikes.

Appendix 2: A draft annotated bibliography of relevant work on seabird mortality occurring during trawl fishing operations. (Compiled by Kim Dietrich and Ed Melvin, Washington Sea Grant Program, University of Washington, Seattle, WA.)

DRAFT

Annotated bibliography: seabird interactions with trawl fishing operations

Kim Dietrich and Ed Melvin
Washington Sea Grant Program
University of Washington

Seabird mortality occurs most often with cables running from the vessel to the net (net sonde and warps) and with the net itself. Mortality can also occur during vessel collisions. The latter are not included in this bibliography.

SEABIRD-TRAWLER INTERACTIONS (mortality and mitigation)

Bartle, J. A. 1991. Incidental capture of seabirds in the New Zealand subantarctic squid trawl fishery, 1990. Bird Conserv. Int. **1**:351-359.

Observers recorded seabird mortalities in squid trawl fishery. 83% (of 279 birds) were recovered from the netsonde cable; remainder entangled in various parts of the net. Average catch rate was 0.263 birds/tow. Proposed that weather and seabird abundance in area may have effect on interaction rates but very little data was collected on interactions while fishing. Suggested that hull-mounted transducers or towed aquaplanes could replace the towed transducer.

CCAMLR. 2003. Summary of observations aboard trawlers operating in the CCAMLR Convention area during 2002/03 season. WG-FSA-03/64, CCAMLR, Hobart.

Vessels fishing in CCAMLR area utilized a number of mitigation measures including streamer lines, acoustic devices, water jets, net weights and net cleaning. Streamer lines appeared effective at preventing warp strikes. Acoustic devices & water jets appeared ineffective.

CCAMLR. 2003. CONSERVATION MEASURE 25-03: Minimisation of the Incidental Mortality of Seabirds and Marine Mammals in the Course of Trawl Fishing in the Convention Area. CCAMLR, Hobart.

Prohibits the use of netsonde cables and offal discharge during setting/hauling. Recommends minimum lighting, cleaning net prior to each deployement and minimize time gear at surface. http://www.ccamlr.org/pu/e/pubs/cm/03-04/25-03.pdf

Crysell, S. 2002. Baffling Birds Brings Benefits. Seafood New Zealand magazine.

Good description (drawings/photos) of Brady bird baffler, a seabird deterrent for trawl vessels.

Hooper, J., D. Agnew, and I. Everson. 2003. Incidental mortality of birds on trawl vessels fishing for icefish in Subarea 48.3. WG-FSA-03/79, CCAMLR, Hobart.

Interaction and mortality data were collected during gear deployment and retrieval on 3 icefish trawl vessels in 2002/03. Net entanglement was the predominant form of mortality. Potential factors influencing catch were day/night, mesh size, net weighting, and a cleaned net. Only the weighting regime and day/night period were significant predictors of the probability of catching a bird during gear deployment and no variables were significant for gear retrieval. Recommended the following:

- All fish be removed from net meshes before re-deploying gear.
- All repairs to net/equipment be done while net is on deck. One large catch event (15 birds) occurred while net was at surface while crew replaced battery in acoustic netsounder.
- No offal discharge during gear deployment or haulback.
- Minimize surface time.
- Deploy paired streamer lines.

Labunski, E., and K. Kuletz. 2001. Observations of seabird interactions with the 'Third-wire' during trawl observations. US FWS, Anchorage, AK. Unpublished Report.

North Pacific groundfish observer logbook notes were summarized for 1993-2001. Seabird interaction observations were opportunistic. 10 of 26 observations (including ~100 individual birds) were interactions with the netsonde cable (or third-wire).

NMFS. 2003. Biological Opinion on the Effects of the Total Allowable Catch (TAC)-Setting Process for the Gulf of Alaska (GOA) and Bering Sea/Aleutian Islands (BSAI) Groundfish Fisheries to the Endangered Short-tailed Albatross (*Phoebastria albatrus*) and Threatened Steller's Eider (*Polysticta stelleri)*. NMFS, Juneau, AK.

Reasonable and prudent measures and terms and conditions – pages 15-19. http://www.fakr.noaa.gov/protectedresources/seabirds/section7/biop0903/esaseabirds.pdf

NMFS. 2003. Ecosystem Considerations for 2004. Ecosystem Considerations for the Stock Assessment and Fishery Evaluation (SAFE) prepared for the North Pacific Fishery Management Council, Anchorage, AK.

Text on incidental catch of seabirds encompasses pages 218 – 228 (with specific reference to trawl on pp. 226 & 228). Mean annual estimates (1998-2002) for catch in trawl gear range from 1,754 – 11,955. Estimates mix several demersal and pelagic trawl fisheries. http://www.fakr.noaa.gov/npfmc/SAFE/SAFE.htm

Sullivan, B. J., and T. Reid. 2002. Seabird interactions/mortality with longliners and trawlers in Falkland Island waters 2001/2002. CCAMLR WG-FSA-02/36, Falkland Conservation, Seabirds at Sea Team, Stanley, Falkland Islands.

Seabird interaction and mortality data were collected on 5 trawlers targeting *Loligo* squid and finfish. The majority of contacts were with the warps when seabirds were on the water and most resulted in no apparent injury. Mortality rates were highly variable by trip (0.12 – 1.0 birds/day) with a total of 16 seabird deaths recorded. The highest rate occurred on a trip with dense aggregations (1000-2000 birds) of seabirds around the vessel for most of the trip. Netsonde cables are not allowed in these fisheries.

Sullivan, B. J., T. A. Reid, L. Bugoni, and A. D. Black. 2003. Seabird mortality and the Falkland Islands trawling fleet. WG-FSA-03/91, CCAMLR, Hobart.

Seabird interaction and mortality data were collected on 7 finfish and squid trawl vessels during 2002/03 season. More than 46,000 contacts were recorded with the warp cable and while birds were on the water (87%). Most resulted in no apparent injury. Few contacts occurred during gear retrieval. A total of 73 birds were documented as dead (70 from warp cable + 3 by paravane cable). Mortality rates were highest during the pre-breeding period and lowest during the egg laying period. Factors influencing interactions included time, area fished and offal discharge.

Sullivan, B. and T. Reid. 2003. Seabird mortality and trawlers in Falkland Island waters 2002/2003. Annual report of the Seabirds at Sea Team, Falkland Conservation. 58p.

As above with more detail and initial information on the performance several deterrents (discharge management, modified streamer). Cable contacts (and probably mortality) influenced by amount and duration of offal discharge, time of year, wind speed & direction relative to towing, sea state as it impacts the vessel pitch.

Sullivan, B. J., T. A. Reid, and P. Brickle. Submitted 2004. Experimental trials to investigate emerging mitigation measures to reduce seabird mortality caused by warp cable strike on factory trawlers.

Tested 3 mitigation devices against a control of no deterrent on a single warp. Seabird mortalities caused by warps higher in the control (0.7 birds/trawl) compared to all treatments: Brady bird baffler (0.14 birds/trawl), Falkland Islands warp scarer (0.06 birds/trawl) and tori lines (0 birds/trawl).

Weimerskirch, H., D. Capdeville, and G. Duhamel. 2000. Factors affecting the number and mortality of seabirds attending trawlers and long-liners in the Kerguelen area. Polar Biology **23**:236-249.

Monitored on 5 trawl vessels targeting toothfish or mackerel icefish. Total number of birds attending trawlers was a function of overcast conditions and time of year. The presence of offal had no significant influence on the number of birds attending the trawlers. More birds were observed during overcast conditions. Mean mortality rate was 0.48 birds/day but much higher on vessels with net sonde cable and targeting the smaller icefish. Petrels were mostly caught in the upper meshes both during setting and hauling. Approximately 1/3 of mortality (17 birds) caused by netsonde cable. Sample size too small to model factors affecting trawl catch rates. http://www.springerlink.com/media/egepulqryhe18clrrvv3/Contributions/U/J/G/L/UJGL1U0FRP6FPLBP.pdf

Wienecke, B., and G. Robertson. 2002. Seabird and seal-fisheries interactions in the Australian Patagonian toothfish *Dissostichus eleginoides* trawl fishery. Fisheries Research **54**:252-265.

One of the first studies quantifying seabird-trawl interactions. Observations were made on 2 trawlers over 4 years. Differentiated between light and heavy contacts at multiple points on the gear. Mortality on warps and in upper mesh of net observed. Mortality not put in the context of a rate per hour or day although a total of 6 birds were documented as dead. Majority of contacts (98%) resulted in no apparent injury. Authors hypothesize that mortality was low due to specific permit conditions such as 1) no netsonde cable; 2) lights must be dim; 3) no discharge except for ‘stick water’ and 4) warps must be spliced to minimize injury to seabirds.

Yorio, P., and G. Caille. 1999. Seabird interations with coastal fisheries in Northern Patagonia: Use of discards and incidental captures in nets. Waterbirds **22**:207-216.

Described interactions between seabirds and coastal demersal trawlers in Patagonia including species composition of birds attending, description of foraging behavior and quantifying mortality. Observations were done in 5 coastal fisheries (usu. within 15 na mi from shore) during 1994-1996 on board 17 trawlers. Kelp gulls were predominant species attending trawlers followed by black browed albatrosses, shearwater species and white-chinned petrels. Fishing region appeared to have the greatest influence on attendance. Two (2) birds, a Magellanic penguin & Imperial cormorant, were killed in 394 hauls (net mortality). There is no mention of interaction with the trawl warps. Implies the use of discards (and other artificial food sources) may be having a positive effect on Kelp gull populations in Argentina.

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