2008 Annual Report
Seabird Interactions and Mitigation Efforts in the Hawaii Longline Fisheries

NOAA FISHERIES SERVICE
Pacific Islands Regional Office
Science, Service, Stewardship
August 2009
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Short-tailed albatross (*Phoebastria albatrus*), Midway Atoll, by Marc Romano, U.S. Fish and Wildlife Service.
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Acronyms

BiOp Biological Opinion
BFAL Black-footed Albatross
CFR Code of Federal Regulations
C.I. Confidence Interval
CMC Center for Marine Conservation
CPUE Catch Per Unit Effort
EEZ Exclusive Economic Zone
ESA Endangered Species Act
FR Federal Register
FMP Fishery Management Plan
HLA Hawaii Longline Association
LAAL Laysan Albatross
NMFS National Marine Fisheries Service
NOAA National Oceanic and Atmospheric Administration
NWHI Northwestern Hawaiian Islands
OLE Office for Law Enforcement, NOAA
PIFSC Pacific Islands Fisheries Science Center, NMFS
PIRO Pacific Islands Regional Office, NMFS
PMUS Pelagic Management Unit Species
PRIA Pacific Remote Island Areas
SFD Sustainable Fisheries Division, NMFS
STAL Short-tailed Albatross
USFWS U.S. Fish and Wildlife Service
WPFMC Western Pacific Fishery Management Council
Preface

The “Annual Report on Seabird Interactions and Mitigation Efforts in the Hawaii Longline Fisheries for 2008” is the most recent in a series of NMFS Pacific Islands Regional Office reports that describes sightings of short-tailed albatrosses and any interaction, i.e., hooking or entanglement in fishing gear, with the Hawaii-based pelagic longline fisheries. The report also contains observed and estimated total number of interactions with Laysan and black-footed albatrosses, and notes the levels of observer coverage on our longline vessels. There is an assessment on the effectiveness of required seabird interaction deterrents, a summary of the results of protected species workshops, and other information relative to NMFS mission to protect seabirds.

Dr. Marti McCracken of the NMFS Pacific Islands Fisheries Science Center provided the 2008 interaction estimates for protected species incidentally caught in the Hawaii deep-set longline fishery. Eric Gilman of the Blue Ocean Institute provided input on the effectiveness of seabird deterrence measures. Lesley Jantz of the NMFS Pacific Islands Regional Office Observer Program provided the Hawaii longline fishing effort and seabird interaction plots and general data requests. Eric Forney and Jeremy Willson, PIRO Observer Program, were essential in gathering data for the report. Dr. Beth Flint and Dr. Greg Balogh of the U.S. Fish and Wildlife Service provided the current status of albatross populations.

This annual report was prepared by Lewis Van Fossen, seabird and annual report coordinator, Adam Bailey and Ethan Brown, of the Sustainable Fisheries Division, NMFS Pacific Islands Regional Office.
Annual Report on Seabird Interactions and Mitigation Efforts in the Hawaii Longline Fisheries for 2008

August 2009

1. Introduction

National Oceanic and Atmospheric Administration’s (NOAA) National Marine Fisheries Service (NMFS), through its Pacific Islands Regional Office (PIRO), is responsible for managing, protecting, and conserving living marine resources in Federal waters of the U.S. western Pacific. PIRO accomplishes this mission through the implementation of regulations and policies designed to sustain healthy marine resources, prevent overfishing, rehabilitate depleted stocks, and promote the recovery of protected species. The NMFS Pacific Islands Fisheries Science Center (PIFSC) conducts fisheries research and provides scientific information and expertise on Pacific insular and pelagic marine resources and protected species. The Western Pacific Fishery Management Council (WPFMC) is responsible for developing and recommending to the Secretary of Commerce domestic fishery policies and management plans for the region. PIRO, PIFSC, WPFMC, and the U.S. Fish and Wildlife Service (USFWS) work cooperatively to prevent and mitigate the bycatch of protected resources, including seabirds, by U.S. domestic fisheries managed under fishery management plans.

To assess possible impacts of the Hawaii pelagic longline fisheries on the endangered short-tailed albatross (Phoebastria albatrus) population NMFS consulted with USFWS under Section 7 of the Endangered Species Act (ESA). A “Biological Opinion on the effects of the Hawaiian Longline Fishery on the short-tailed albatross” (BiOp) was issued by USFWS on November 28, 2000 (FWS 1-2-1999-F-02; USFWS 2000), and subsequently revised November 18, 2002 (FWS 1-2-1999-F-02R; USFWS 2002). The 2002 revision examined only the effects of the deep-set fishery on the short-tailed albatross after a suspension of the shallow-set fishery was ordered by the U.S. Court in Center for Marine Conservation (CMC) v. NMFS on April 1, 2001. USFWS issued a supplement to the BiOp in October 2004 entitled “Biological Opinion on the Effects the reopened shallow-set sector of the Hawaii Longline Fishery on the short-tailed albatross (Phoebastria albatrus)” (FWS 1-2-1999-F-02.2; USFWS 2004). Prior to its suspension, the Hawaii shallow-set longline fishery accounted for the majority of seabird mortalities, so the

1 American Samoa, Guam, Hawaii, Northern Mariana Islands, and the U.S. Pacific remote island areas (PRIA), consisting of Howland Island, Baker Island, Jarvis Island, Johnston Atoll, Midway Atoll, Kingman Reef, Palmyra Atoll, and Wake Island.

2 Western Pacific fishery management plans, if approved by the Secretary of Commerce, are implemented by NMFS regulations at 50 CFR 665. Five fishery management plans govern western Pacific fisheries: pelagics, bottomfish and seamount groundfish, crustaceans, precious corals, and coral reef ecosystems.

1
October 2004 BiOp evaluated only the effects of the April 2004 reopening of the shallow-set longline fishery on the short-tailed albatross. From 2004-2008, no short-tailed albatross interactions were observed or reported in the shallow-set longline fishery. This fishery operates under the requirement to have 100% observer coverage.\(^3\) The BiOp on the deep-set fishery, issued on November 18, 2002, remains in effect. The deep-set fishery operates under annual observer coverage of at least 20%.

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species without special exemption. Take is defined as to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct.” An incidental take of one STAL is anticipated per year for the shallow-set fishery under the 2004 BiOp (USFWS 2004) and 15 over a 7-year period for the deep-set fishery (USFWS 2002).

The three BiOps (USFWS 2000, 2002, 2004) require NMFS to report annually any observed interactions and sightings of short-tailed albatrosses with the Hawaii longline fisheries, and any observed and estimated total number of interactions with Laysan (\(P. \text{immutabilis}\)) and black-footed (\(P. \text{nigripes}\)) albatross by set type.\(^4\) In addition, NMFS must report on the status of observer coverage, provide assessments of the effectiveness of required seabird deterrents including a review of the observer data from vessels choosing to side-set, and summarize the results of the federally-mandated protected species workshops conducted by NMFS. This report includes the reporting requirements under the Terms and Conditions of each BiOp for the Hawaii longline fisheries operating during 2008.

On June 12, 2001, NMFS issued an emergency rule that closed the shallow-set fishery and implemented the Terms and Conditions of the November 28, 2000, Short-tailed Albatross BiOp issued by USFWS (66 FR 31563). Some traditional swordfish vessels switched to targeting tunas further widening the disparity of the numbers of hooks deployed between the two fisheries. It is interesting to note that even with the reopening of the shallow-set fishery in 2004, the number of hooks deployed per year in the deep-set continues to increase (Fig. 8). About twice as many hooks were deployed in the deep-set fishery from 2005 through 2008 as were in 2000. Conversely, the number of hooks deployed in the shallow-set fishery from 2005 through 2008 was less than half of the number deployed in 2000.

In April 2004, the shallow-set fishery was reopened under a suite of new management measures that required new gear configurations, and specialized turtle dehooking equipment and handling procedures were put in place to reduce incidental captures of sea turtles and increase their post-hooking survival (69 FR 17329, May 19, 2004).

Requirements for the shallow-set fishery (50 CFR 665 subpart C) include:

- Maximum of 2,120 sets are permitted annually (approx. half of historical average);

\(^3\) The Hawaii shallow-set longline fishery reopened with a final rule on April 2, 2004 (69 FR 17329).

\(^4\) NMFS described deep-set (tuna) and/or shallow-set (swordfish) type.
• 18/0 circle hooks with 10° offset;
• Mackerel-type bait; no squid;
• Sea turtle handling measures including dehooking equipment;
• Annual attendance at mandatory Protected Species Workshops for vessel operators and owners; and
• Interaction limits for loggerhead sea turtles (n=17) and leatherback sea turtles (n=16).

Additionally, NMFS places observers on 100% of shallow-set vessels.

2. Description and Status: Short-tailed Albatross

The short-tailed albatross (STAL) is the largest of the northern hemisphere albatross species (body lengths of 33-37” as compared with 31-32” for Laysan and 27-29” for black-footed albatrosses, USFWS 2005). They are long-lived and reach breeding age around six years old (USFWS 2004). Their plumage varies in color as they mature. Shortly after fledging (leaving the nest), STALs develop a distinctive large pink bill with a gray tip and thin black line at its base which they have for the rest of their lives. The feet are pinkish. When STALs are one year old, their plumage may resemble a black-footed albatross (BFAL), but may be distinguished from BFALs primarily by their pink bills (the BFAL has a black beak). As the STAL matures, its stomach, and back become white in color. It is the only albatross in the North Pacific with a white back. The color on the upper surface of the wings is variable, being proximally white and distally brown. A fully mature STAL has a golden-colored head.

STALs once ranged throughout most of the North Pacific and Bering Sea, with known nesting colonies on western Pacific islands near Japan and Taiwan (Hasegawa 1979). During the early 20th century, the species was nearly extirpated due to overharvest for feathers and oil. Between 1880 and 1903, 5 million STALs were harvested on Torishima alone (USFWS 2004). The population began to recover during the 1950s, likely due to habitat management and habitat protection, and is growing annually (Fig. 1). Today, the only known active breeding colonies of STALs are on Torishima south of Honshu Island, Japan, (30° 29’ N, 140° 18’ E) and Minamikojima in the Senkaku Islands just north of Taiwan (25° 43’ N, 123° 33’ E) (USFWS 2004). It is estimated that 80-85% of the known breeding STAL use a single colony at Tsudame-zaki, on Torishima, an active volcanic island (Suryan et al. 2007). In 2008, the worldwide STAL population estimate was 2,771 individuals (G. Balogh, USFWS, pers. comm. July 2008), with 418 eggs observed laid on Torishima Island during the 2008-2009 breeding season (J. Jacobs, USFWS, pers. comm. March 2009).

3. Description and Status of Other Albatross Species

There are no recorded observed interactions between short-tailed albatrosses and Hawaii pelagic longline vessels, and interactions are thought to be very rare. Surrogate species are used to predict expected interaction rates. Black-footed albatrosses are used as surrogate species to assess the effects of fishery interactions and the efficacy of mitigation measures on the short-tailed albatross population due to their relatedness, similar habitats, and likely similar foraging strategies.

_Laysan Albatross_

The Laysan albatross (LAAL) is one of the most abundant albatrosses in the world (BirdLife International 2004). They are characterized by a white head, neck and under parts. There is dark plumage surrounding the eyes. The back and dorsal side of the wings are dark brown. Ventrally, the wings are variably white and brown differing between individuals. The tail is dark brown.

Because variables such as population structure, mortality, and individual breeding frequency are not fully understood, a total world population estimate cannot be determined for LAAL. Instead,
an estimate of total numbers of nesting pairs has been used to monitor LAAL populations. The worldwide breeding population of LAAL is estimated at 590,000 pairs in 2005 (Naughton 2007) and 99% of the world’s LAAL breed in the Northwestern Hawaiian Islands (NWHI). Other breeding sites are in Japan and Mexico.

Black-footed Albatross

BFALs have black legs and black bills with a prominent ring of white plumage at the base of the bill. Overall, the plumage is dark brownish-gray. Birds older than two years have white plumage surrounding the vent. The world breeding population of BFAL was estimated to be 61,700 pairs in 2005 (Naughton et al. 2007) and according to USFWS, approximately 97% of BFALs breed in the NWHI (72 FR 57278). A smaller population of approximately 2,000 breeding pairs nests in the Bonin Islands south of Japan. Walsh and Edwards (2005) have demonstrated that the Japanese sub-population is reproductively isolated from NWHI BFALs.

Population Status of Proxy Species

Direct counts of populations cannot be made because not all birds (e.g., juveniles and some adults) return to the breeding colonies every year. Instead, the numbers of breeding pairs, or numbers of active nests, are used to assess the health of albatross populations. Environmental factors such as foraging success may influence how many albatrosses return to a colony to breed. Therefore, foraging success should not be considered to assess short-term changes in population. However, this measurement can be used to assess long-term trends in populations. Figures 2 and 3 illustrate trends in breeding pair numbers at Midway Atoll, Laysan Island, and French Frigate Shoals from 1998-2009.
Figure 2. Number of black-footed albatross breeding pairs in three areas in the Northwestern Hawaiian Islands 1998-2009.
(Source: Flint 2009)

Figure 3. Number of Laysan albatross breeding pairs at three islands in the Northwestern Hawaiian Islands.
(Source: Flint 2009)
4. Description of the Hawaii Pelagic Longline Fisheries

Background

Historically, the Hawaii-based longline fishery has had the most seabird interactions when compared to other U.S. managed fisheries in the tropical Pacific (NMFS 2001). The fishery began around 1917 employing techniques brought to Hawaii by Japanese immigrants. Early Hawaii-based longliners used tarred, braided rope and flagged marker buoys. A relatively small number of vessels continued targeting tuna using this gear through the late 1980s. The fleet expanded from 37 vessels in 1987 to 138 vessels in 1991 with the influx of longline vessels targeting swordfish using monofilament mainlines and radio buoys from the East Coast and Gulf of Mexico (NMFS 2007).

Managers officially began considering the deep- and shallow-set components as distinct fisheries in December 2008 (73 FR 73032) based on the deep-set regulatory definition. Specifically, a deep-set must have: all float lines on the vessel at least 20 m in length, 15 or more branch lines between any two floats, no light sticks may be used, and a maximum of 10 swordfish may be retained or landed by the vessel. If any one of these criteria is not met, the vessel is considered to be shallow-setting. There are additional differences. The deep-set fishery generally targets bigeye tuna (*Thunnus obesus*), and the shallow-set fishery targets swordfish (*Xiphias gladius*). In addition to tunas and swordfish, a variety of other pelagic fish species are caught in both fisheries. Some of these species are kept and considered catch, while others are discarded and considered bycatch. The general characteristics of the two gear types are provided in Table 1 and Fig. 4, illustrating the differences and similarities between them.

Table 1. Characteristics of the Hawaii shallow-set (swordfish-targeting) and deep-set (tuna-targeting) longline fisheries.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Shallow-set</th>
<th>Deep-set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set depth</td>
<td>~ 25-75 m</td>
<td>~ 40-350 m</td>
</tr>
<tr>
<td>Hook type</td>
<td>18/0 offset circle hook (10° offset)</td>
<td>3.6-3.8 mm tuna hooks or 14/0-16/0 circle hooks</td>
</tr>
<tr>
<td>Bait</td>
<td>Fusiform fish (mackerel)</td>
<td>Saury, sardines</td>
</tr>
<tr>
<td>Light sticks used?</td>
<td>Yes</td>
<td>No, not permitted</td>
</tr>
<tr>
<td>Set deployment/retrieval</td>
<td>Night/Morning</td>
<td>Morning/Night</td>
</tr>
<tr>
<td>No. hooks between floats</td>
<td>~ 4</td>
<td>~ 27</td>
</tr>
<tr>
<td>Approx. no. hooks per set</td>
<td>850</td>
<td>2,000 to 3,000</td>
</tr>
</tbody>
</table>

5 For the purpose of this report, “bycatch” is defined as discards plus unseen mortality due to fishing operations. This includes incidental interactions with seabirds.
Matsumoto et al. (2007) demonstrated through archival tagging studies that bigeye tuna tend to congregate at depths reached by the lower half of mainline in the deep-set fishery. This is consistent with earlier findings for bigeye in the pelagic zone (Musyl et al. 2003). As seen in Fig. 4, deep-set gear is intended to reach depths where bigeye tuna concentrations are highest. The deep-set configuration is achieved by use of a line shooter. The line shooter deploys the line faster than the vessel is moving forward, thus forming deep sags in the line. In contrast, shallow-set gear is usually deployed by simply allowing the mainline to spool off of the mainline reel as the vessel is underway; no line shooter is used. Also, shallow-setting deploys fewer hooks between floats. This results in the line being set relatively shallow in the water column where swordfish tend to congregate at night. The two fisheries operate in overlapping, but primarily different areas (Figs. 5 and 6).
Figure 5. Observed fishing effort in the shallow-set fishery, 1994-2008.
(Source: PIRO)

Figure 6. Observed fishing effort in the deep-set fishery, 1994-2008.
(Source: PIRO)
The majority of the fishing effort in the shallow-set fishery has occurred to the north of the Hawaiian Archipelago, while the majority of deep-set effort has been distributed centrally around the islands, and to the south.

Effort, as measured by number of vessels or number of trips, has been relatively stable from 2000 to 2008 for the combined fisheries (both shallow- and deep-sets) (Table 2). The number of sets made and total number of hooks deployed for the fisheries have increased during the 2000 to 2008 period. Even at its highest effort, the shallow-set fishery has always deployed far fewer hooks per year than the deep-set fishery (Table 2).

(Source: NMFS 2008, PIFSC, WPFMC)

<table>
<thead>
<tr>
<th>Year</th>
<th># Vessels</th>
<th># Trips</th>
<th># Sets</th>
<th># Hooks (Total)</th>
<th># Hooks (Deep-set)</th>
<th># Hooks (Shallow-set)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>125</td>
<td>1,135</td>
<td>12,930</td>
<td>20,282,826</td>
<td>17,192826</td>
<td>3,090,000</td>
</tr>
<tr>
<td>2001</td>
<td>101</td>
<td>1,075</td>
<td>12,169</td>
<td>22,327,897</td>
<td>21,837897</td>
<td>490,000</td>
</tr>
<tr>
<td>2002</td>
<td>102</td>
<td>1,193</td>
<td>14,225</td>
<td>27,018,673</td>
<td>27,018,673</td>
<td>0</td>
</tr>
<tr>
<td>2003</td>
<td>110</td>
<td>1,215</td>
<td>14,560</td>
<td>29,297,813</td>
<td>29,297,813</td>
<td>0</td>
</tr>
<tr>
<td>2004</td>
<td>125</td>
<td>1,338</td>
<td>15,976</td>
<td>31,967,874</td>
<td>31,891,124</td>
<td>76,750</td>
</tr>
<tr>
<td>2005</td>
<td>124</td>
<td>1,533</td>
<td>18,083</td>
<td>34,895,229</td>
<td>33,566,423</td>
<td>1,328,806</td>
</tr>
<tr>
<td>2006</td>
<td>127</td>
<td>1,437</td>
<td>17,247</td>
<td>35,192,344</td>
<td>34,486,898</td>
<td>705,446</td>
</tr>
<tr>
<td>2007</td>
<td>129</td>
<td>1,515</td>
<td>19,379</td>
<td>40,197,926</td>
<td>38,825,977</td>
<td>1,371,949</td>
</tr>
<tr>
<td>2008</td>
<td>129</td>
<td>1,470</td>
<td>19,468</td>
<td>41,564,853</td>
<td>40,078,613</td>
<td>1,486,240</td>
</tr>
</tbody>
</table>

**Summary of 2008 Fisheries Effort**

In 2008, 129 Hawaii longline vessels made 1,470 trips in 2008 (Table 2). The trips targeted tunas (bigeye, albacore, yellowfin) and swordfish. A total of 1,380 tuna trips and 90 swordfish trips were made. There were 8,146 sets made at or above 23° N latitude. Of these, 6,614 were deep-sets and 1,532 were shallow-sets (PIFSC, unpub.). Of 41,564,853 total hooks fished, the deep-set fishery deployed a reported 40,078,613 hooks in 17,881 sets and the shallow-set fishery deployed a reported 1,486,240 hooks in 1,587 sets (PIFSC, unpub.).

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6 Hooks deployed in the shallow-set fishery for 2000 and 2001 include hooks reported deployed for swordfish and mixed species targeted trips. Mixed targeted trips were generally reported for smaller shallow-set vessels that would often target swordfish at the beginning of fishing trips and target tuna or marlins towards the end. Source: WPFMC.

7 The shallow-set fishery was closed on March 20, 2006 after reaching the interaction limit for loggerhead sea turtles (17) on March 17, 2006. There is an interaction limit for this fishery of 16 leatherback turtles that has never been reached.
5. Seabird Mitigation Measures

Background

The emergency rule (66 FR 31563, June 12, 2001) that closed the shallow-set fishery also implemented non-discretionary terms and conditions of the BiOp issued by the USFWS on November 28, 2000 (USFWS 2000). A final rule (67 FR 34408, May 14, 2002) subsequently implemented the requirements contained in the emergency rule. The required seabird mitigation techniques applied when making deep-sets north of 23° N and required fishermen to employ a line-setting machine with at least 45 g weights attached within 1 m of each hook. They must have also used thawed blue-dyed bait and strategic offal discards during the setting and hauling of longline gear. These measures were revised (70 FR 75075, December 19, 2005) to satisfy the terms and conditions of the 2004 BiOp. The seabird mitigation requirements for Hawaii-based longline fishermen are listed in Table 3.

Description of Mitigation Measures

Vessel operators have the option of either using side-setting (as defined under the regulations) or an alternate suite of mitigation methods. A variety of seabird deterrence methods for longline fisheries have been tested and found to reduce interaction rates and mortality of seabirds (e.g., Brothers 1995; Brothers et al. 1999; Gilman et al. 2003, 2005, and 2007; McNamara et al. 1999). When employed effectively, seabird interaction avoidance measures have the potential to nearly eliminate seabird interactions. To resolve the problem of seabird mortality in these fisheries, there is a need to identify deterrent methods that not only have the capacity to minimize seabird interactions, but are also practical and convenient to use by fishermen (Gilman et al. 2005).

The following seabird deterrent methods are explained in more detail:

- Side-setting;
- Strategic offal discarding;
- Thawed blue-dyed bait;
- Weighted branch lines; and
- Night setting.
Table 3. Summary of current seabird regulations for the Hawaii longline fleet, effective as of January 18, 2006.
(Source: PIRO)

<table>
<thead>
<tr>
<th>X = Required Measure</th>
<th>Side-Setting</th>
<th>Stern-Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weights (minimum 45 g) attached within 1 m of the hook</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Set from port or starboard side</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Setting station at least 1 m forward of stern corner</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Line shooter at least 1 m forward of stern corner (if used)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Deploy gear so that hooks do not resurface</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Use bird curtain</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Use thawed &amp; blue-dyed bait</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Maintain at least 2 - one lb containers of blue dye on board the vessel at all times</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Use line shooter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employ strategic offal discards</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Begin set 1 hr after local sunset &amp; complete before dawn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follow all seabird handling procedures</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

**Side-setting**

Side-setting involves deploying the gear from the side of the vessel, as compared to the conventional approach of setting from the stern (Fig. 7). The effect is that baited hooks are deployed closer to the side of the vessel’s hull where seabirds are unable or unwilling to pursue them. With proper weighting, baited hooks deployed in this manner will sink to a depth where a
North Pacific albatross species could not reach them. Additionally, deploying a bird curtain inhibits the ability of seabirds to land along the side of the vessel where baits are accessible. An ancillary benefit of this technique is reduced bait loss for fishermen.

![Diagram of side-setting and stern setting](Source: Gilman et al. 2003)

**Figure 7. Depictions of side-setting and stern setting.**

Side-setting requirements are as follows:

- Deploy the mainline as far forward on the vessel as practicable, including mounting line shooters (if used) at least 1 m forward from the stern corner of the vessel;
- Set the mainline and branch lines from the port or starboard side of the vessel;
- Attach weights (45 g minimum) to branch line within one meter of the hook;
- When seabirds are present, the longline gear must be deployed so that baited hooks remain submerged and do not rise to the sea surface; and
- A bird curtain must be deployed, that consists of the following three components (See example in Fig. 8):
  - A pole that is fixed to the side of the vessel aft of the line shooter and that is at least 3 m long;
  - At least three main streamers that are attached at regular intervals to the upper 2 m of the pole and each of which has a minimum diameter of 20 mm; and
Branch streamers attached to each main streamer at the end opposite from the pole, each of which is long enough to drag on the sea surface in the absence of wind, and each of which has a minimum diameter of 10 mm.

If all of the above conditions are not met by a vessel, it is not considered to be side-setting by NMFS.

![Figure 8. Bird curtain example design. (Source: Modified from Gilman et al. 2003)](image)

Sea trials and observations of fishing operations indicate that side-setting is the most effective of any single seabird mitigation method in reducing albatross mortality in the Hawaii longline fisheries. Side-setting produced the lowest seabird interaction rates when compared to underwater setting chutes and blue-dyed bait in both deep-set and shallow-set fisheries (Gilman and Kobayashi 2007). In 2005, observers did not observe any seabird interactions on vessels employing side-setting. Out of 124 active Hawaii longline vessels, 44 converted their vessels to side-setting by December 2005. In 2006, 35 vessels were configured to employ side-setting. In 2008, the trend of other vessels opting to side-set continued. A partial survey of longline vessels found that some of the remaining side-set deep-setting vessels were planning on reconfiguring to stern setting vessels. No shallow-setting vessels were found to be using the side-setting technique in 2008. Some vessels that were outfitted for side-setting never used it and some vessels have reverted to stern-setting (Brothers and Gilman 2007). It is not known how many deep-set vessels have reverted to stern setting. Anecdotal information suggests that fishermen were concerned that setting the gear off of the side of the vessel might lead to fishing gear getting tangled in the propeller, but whether or not this has been widely realized is unknown. Some fishermen have reported no problems with propeller-fouling from side-setting and prefer this method over stern-setting. Another reason cited for not utilizing side-setting, or reconfiguring back to stern-setting was that after stern crew shelters had been erected, vessel
owners wanted to utilize the shelters after the expense and for crew safety. Again, because of its effectiveness and the high likelihood of compliance, even in the absence of observers, it is the seabird mitigation technique preferred by NMFS for deep-set vessels.

Vessel operators targeting swordfish are unlikely to switch to side-setting due to their unwillingness to place weights within one meter of the hook. Therefore, these vessels, even if they set their gear from the side, would not conform to the definition of side-setting under current regulations. While weights (≥45 g) are normally placed on shallow-set branch lines, they are usually situated far from the hook near the middle of the branch line. Fishermen usually cite safety considerations as the reason for placing weights near the middle of branch lines rather than closer to the hook.

**Strategic Offal Discards**

Strategically discarding offal is a technique developed by fishermen to mitigate interactions with albatrosses attempting to steal baits from hooks before the branch lines could be retrieved. Fishermen would throw swordfish heads and livers over the side of the vessel to distract albatrosses away from the baited hooks. NMFS observers in the mid-1990s noted that strategically discarding offal seemed to reduce incidental hookings and entanglements of albatrosses.

Strategic offal discards have been proven to be effective in reducing interactions with seabirds – if employed properly. Strategic offal discards reduced gear contacts with seabirds in the Hawaii longline shallow-set fishery by 51% and seabird interactions by 88% (McNamara et al. 1999). However, over time, this practice is believed to attract birds to the vicinity of the vessel, increasing bird abundance, searching intensity, and interactions by reinforcing the association that birds make with specific longline vessels being a source of food (Brothers et al. 1999). Brothers (1996) hypothesizes that seabirds learn to recognize, by smell, specific vessels that provide a source of food, implying that vessels that consistently discard offal and fish bycatch will attract more seabirds than vessels that do not discard offal and fish waste. NMFS continues to monitor the effectiveness of strategic offal discards and other mitigation measures.

Strategically discarding offal to reduce seabird interactions requires vessel operators to:

- Retain sufficient quantities of spent bait and fish offal with hooks removed for use as strategic offal discards during fishing operations;
- Retain swordfish heads and prepare them by removing the bill, and cutting them lengthwise between the eyes (See Fig. 9);
- Retain swordfish livers; and
- Discharge all spent bait and fish parts on the opposite side of the vessel during gear deployment and retrieval, if seabirds are present.
Traditionally in the Hawaii-based longline fisheries, only swordfish were gilled and gutted at sea. However, in December 2004, the Food and Drug Administration (FDA) regulations required all fish be gilled and gutted at sea. Results from an analysis of Hawaii longline fisheries observer data indicate that only 18% of deep-sets employed strategic offal discards (Gilman 2004). This percentage increased to approximately 50% in 2005, partially due to the new FDA regulations.

**Thawed Blue-dyed Bait**

Dyeing bait to a specific blue color is a means to reduce the visibility of baits by reducing their contrast with the sea surface. The bait is thawed to increase sink rates and to allow a more effective penetration of the blue dye.

Almost all bait used in the Hawaii longline fisheries consists of fusiform fish: mackerel (saba), sardines, and saury (sanma). Using squid for bait is prohibited in the shallow-set fishery to reduce sea turtle interactions. While squid may still be used in the deep-set fishery, the cost is prohibitive. Several concerns have been noted by fishermen regarding the required bait treatments of thawing and dyeing and bait type:

- Blue dye is absorbed less readily by fish than by squid;
- Baits must be thoroughly thawed in order to ensure maximum dye absorption;
- It is difficult to achieve the NMFS-required color intensity due to scale loss by fish baits,
- thawing the bait results in its lower retention because thawed bait falls off the hook more easily than partially frozen bait;

---

8 Note that when deep-setting south of 23° N, strategic offal discards are not required.
9 This percentage is an estimated value, as observer data was recorded differently beginning in June 2005 when the regulation for recording “strategic offal discards” on the observer’s data forms changed to be recorded only when seabirds are present (NMFS 2006).
• Thawed blue-dyed bait results in slower hook setting rates because of the time spent thawing and dyeing the bait blue during the setting of longline gear, and
• Dye can be messy, dyeing the hands and clothes of the crew and the deck of the vessel.

While fishermen must comply with blue dyed bait requirements and the benefits have been experimentally proven, they do not favor the technique. Gilman et al. (2007) suggest most of the practicality and convenience problems could be addressed if pre-blue-dyed bait were commercially available.

Weighted Branch Lines

Weights placed close to the hook on branch lines are intended to quickly sink baited hooks, before foraging seabirds can take the baits and then become hooked or entangled in longline gear. Hawaii longline vessels use a range of weight sizes from 45 to 80 grams within 1 m of the hook to quickly sink their branch lines to desired target depths. A recent study comparing the effective sink rates of 45 g (1.2 m/s) and 60 g (1.3 m/s) weighted branch lines concluded the difference in sink rates to be negligible (Brothers and Gilman 2005). 45 g weights are the current minimum weight requirement for deep-setting vessels fishing north of 23° N, and for side-setting vessels wherever they fish.

Night Setting

The use of night setting as a seabird mitigation measure requires that fishermen set their gear no earlier than one hour after local sunset, and complete the set no later than the following sunrise, using only the minimum number of lights necessary to conform to navigation rules and best safety practices. Night setting is based on the premise that seabirds cannot see baited hooks in the dark and, thus, do not attack them. The effectiveness of this measure may potentially be affected by moon phase and cloud cover, vessel lighting, and the use of light sticks to illuminate baits making them more conspicuous. Night-setting has been identified as an effective seabird mitigation measure, reducing seabird interactions by 73% (McNamara et al. 1999) and even by as much as 98% (Boggs 2001). In the past, shallow-set vessels were able to set before sunset, resulting in correspondingly high sea bird interaction rates. Interaction rates have remained low in the shallow-set fishery with the requirement for night setting.

Because the time at sunset changes with longitude and Hawaii-based longline vessels operate over a wide geographical area, NMFS observers aid fishermen to determine when it is legal for them to begin gear deployment. NMFS observers are trained to use issued Global Positioning System units to determine the exact time of sunset for their vessel’s longitude. This has proven to be very helpful, especially on cloudy evenings.

Mitigation Research in 2008

In 2008, Gilman et al. (2008) found that mitigation measures reduced interactions with albatross by 67%. As has been previously pointed out, lead weights are important to increase sink rates to

10 Light sticks are used to make baits more conspicuous to swordfish feeding at night.
quickly place baited hooks beyond the reach of seabirds (Brothers and Gilman 2005, Gilman 2008). In 2008, Gilman (2008) conducted safe-lead experiments to test designs that may increase fishermen safety, thus encouraging the use of heavier weights to increase sink rates. There were at-sea and shoreside components to the project. Both components of the project showed that the two designs that were tested worked as expected and would probably result in increased crew safety. However, sample size was small and further research needs to be conducted to perfect the technique (Gilman 2008). Another experiment with a larger sample size (Marine Safety Solutions 2008) reinforced conclusions from the previous studies.


Background

NMFS observers have been deployed aboard Hawaii longline vessels since 1994 to document protected species interactions, collect fishery-related information, and perform other biological work as requested by PIRO. The terms and conditions of the 2004 Pelagics BiOp (NMFS 2004) required 100% observer coverage on shallow-setting vessels, whereas the 2005 BiOp on the deep-set fishery (NMFS 2005) directs NMFS to maintain an annual level of at least 20% observer coverage on deep-setting vessels.

Table 4 provides a brief history of seabird data collection requirements for the Hawaii Longline Observer Program under program protocols and the terms and conditions of applicable biological opinions.

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Authorities</th>
<th>Observer Data Collection Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002-2004</td>
<td>November 2001 Revision to November 2000 STAL BiOp (USFWS 2002)</td>
<td>Record all STAL interactions with fishing gear. Record all STAL sightings. Record sightings and behavior of albatrosses during the set and haul of the mainline. Record seabird sightings in the vicinity of the longline gear during setting and haul operations. Return all dead STAL specimens to port.</td>
</tr>
<tr>
<td>2004-Present</td>
<td>1) November 2002 Revision to November 2000 STAL BiOp (USFWS 2002)</td>
<td>Record all STAL interactions with fishing gear. Record all STAL sightings. Record sightings and behavior of albatrosses during the set and haul of the mainline. Record seabird sightings in the vicinity of the longline gear during setting and haul operations. Conduct two (2) five-minute scan counts for seabird abundance on shallow-sets during the first hour of setting operations as daylight permits and every two hours during haul operations. Return all dead STAL specimens to port.</td>
</tr>
</tbody>
</table>

Observer Coverage in 2008

In 2008, NMFS maintained an observer coverage rate of 21.7% for the deep-set fishery (Fig. 10). NMFS met its obligations for observer coverage above 23° N under the Terms and Conditions of the 2002 BiOp with a 25.2% coverage rate in 2008 observing 1,967 out of 7,796 sets (Fig. 11). All shallow-sets above 23° N latitude were observed in 2008.
Figure 10. Observer coverage on deep-setting vessels, 2000-2008. (Source: PIRO)

Figure 11. Observer coverage on deep-setting vessels north of 23° N latitude 2000-2008. (Source: PIRO)

7. Protected Species Workshops in 2008

The Protected Species Workshops present information on sea turtle, seabirds, and marine mammals. Topics covered include species identification and life history, mitigation techniques, current regulations, and any updates on current research pertinent to the fisheries. Participants receive folders containing current regulation summaries and information placards. Written materials and some video presentations are provided in English, Vietnamese, and Korean, which are the predominant languages of captains of Hawaii longline vessels. In recent years, crews have been recruited from various parts of Micronesia, the Philippines, and Indonesia to work on Hawaii longline vessels. The majority of materials have been translated into Tagalog to
accommodate crews from the Philippines. The employment of Indonesian workers is fairly recent, and outreach materials have not yet been prepared for this group. Additionally, outreach materials have been translated into Samoan for use in the American Samoa-based longline fishery.

The Protected Species Workshops have been conducted annually by PIRO, Sustainable Fisheries Division (PIRO SFD) since 2000. Workshops are mandatory for all operators and owners of vessels permitted for use with any limited entry longline permit issued under 50 CFR 665.21 (50 CFR 665.34). Participants receive a certification card upon completion of the workshop, and the card must be carried on board the vessel during fishing operations. PIRO SFD collaborates with USFWS, PIFSC, NMFS Office for Law Enforcement (OLE), and PIRO Observer Program, and Protected Resources Division in the development of content material for the workshops. This collaborative approach has resulted in informative and successful workshops. In 2008, NMFS trained 325 longline vessel operators and owners in Hawaii, American Samoa, and Guam through the workshops (Fig. 12).

![Protected Species Workshop Attendance](image)

**Figure 12. Protected Species Workshop certifications for Hawaii, American Samoa, and Guam longline fishermen, 2000-2008.**
(Source: PIRO)

PIRO SFD made available an online version of the Protected Species Workshop in 2008. In 2008, 93 people took the workshop training online. In addition to the online course, NMFS SFD continues to hold traditional classroom-style workshops.
8. Seabird Interactions

Background

In 2000, an estimated 2,433 seabirds were incidentally taken in both fisheries (Fig. 13). In 2001, the number of seabirds incidentally taken dropped to an estimated 510 seabirds in Hawaii longline fisheries. This reduction can be primarily attributed to the closure of the shallow-set fishery in 2001 (due to sea turtle interactions). The swordfish fishery remained completely closed throughout 2002 and 2003. During this period, the deep-set fishery interacted with an estimated 373 seabirds (116 in 2002 and 257 in 2003).

In April 2004, the swordfish fishery re-opened under a new management program that limited effort in the fishery to a maximum of 2,120 sets annually (69 FR 17330). During 2004, 26 albatrosses were estimated to have been incidentally taken in the shallow-set and deep-set fisheries. It should be noted that the shallow-set fishery was open only from October through December in 2004. In 2005, NMFS estimated that 194 seabirds were interacted with by the combined fisheries. Even with the shallow-set fishery open for the entire year, that fishery did not experience the high interaction rates that occurred in prior years (e.g., 2000). While the shallow-set fishery was closed in 2006 because it reached the loggerhead sea turtle interaction limit, both the total numbers of birds taken (as would be expected) and the seabird interaction rate (0.015 seabirds per 1,000 hooks) remained low compared to years prior to the 2001 shallow-set closure.

A key factor contributing to the decrease in estimated seabird interactions over the years is the implementation of seabird deterrence measures. In June 2001, a suite of seabird measures became mandatory in the Hawaii longline fishery. Since then, the number of seabirds...
incidentally taken in the Hawaii longline fisheries has continued to remain low under more recent mitigation measures implemented on January 18, 2006 (70 FR 75075).

Efforts were made to analyze observer data to determine the effectiveness of three treatments: 1) side setting with un-dyed baits; 2) stern setting with un-dyed baits; and 3) stern setting with blue-dyed baits using observer data from the deep-set fishery (Gilman 2006). The results were inconclusive due to the small number of albatross interactions (n=6). Because albatross interactions in the deep-set fishery are such rare events, the sample size of 323 sets was not adequate to make any statistical conclusions regarding the efficiency of blue dye. An analysis with a larger sample size determined that the current regulations reduced the observed rate of incidental seabird interactions in the deep-set fishery by about 83% (Gilman and Kobayashi 2007). The only treatment that showed a significant difference in efficacy above side-setting for stern setting vessels was when heavier (> 60 g) weights were used with thawed, blue-dyed baits.

Spatial and temporal placement of fishing operations and the localized seabird abundance around vessels likely influence interaction rates, and thus, the efficacy of seabird mitigation measures. The PIRO Observer Program records relative seabird abundance during fishing operations through visual counts. Including relative seabird abundance into analyses will improve the understanding of the relative success of seabird mitigation measures and enable the calculation of more precise interaction rates. For instance, it is possible that observed reductions in seabird interaction rates result from fewer albatrosses in the vicinity of observed fishing vessels due to changes in fishing patterns. However, it was found that there were no discernable spatial differences in fishing effort since the reopening of the swordfish fishery in 2004 compared to historic fishing effort for either the deep-set fishery or the shallow-set fishery (NMFS 2006).

Regulations designed to protect sea turtles in the shallow-set fishery likely provided an ancillary benefit to reduce seabird interactions. For instance, the shallow-set fishery was closed in March 2006 because the interaction limit on loggerhead sea turtles was reached. The closure meant that fewer potential incidental interactions with seabirds occurred that year.

**Observed Interactions**

There were no observed or reported interactions with STALs in either the deep-set or shallow-set Hawaii longline fisheries during 2008. However, there was an increase in observed seabird interactions in the deep-set fishery with NMFS observers recording incidental interactions with 34 BFAL, 14 LAAL, 14 shearwaters (*Puffinus* spp.), one red-footed booby (*Sula sula*), and one unidentified seabird (likely a petrel or storm petrel) for a total of 64 interactions with a 21.7% observer coverage rate for trips leaving port in 2008. The simple observed interaction rate in the deep-set fishery for seabirds was 0.007 seabirds per 1,000 hooks and 0.005 birds per 1,000 hooks for albatrosses alone. Interactions with six BFAL and 33 LAAL were observed in the shallow-set fishery in 2008 for an interaction rate of 0.029 seabirds per 1,000 hooks (Fig. 14). 100% of shallow-set trips were observed.
Figure 14. Total observed black-footed and Laysan albatross interactions in the Hawaii pelagic longline fisheries in 2008.
(Source: PIRO)

Observed Interaction Statistics

The types of interactions in 2008 occurred in roughly the same proportions in the deep-set and shallow-set fisheries with hookings accounting for the majority of observed interactions. A smaller proportion of albatrosses were entangled. There were five albatrosses observed hooked and entangled in the shallow-set fishery. No seabirds were observed both hooked and entangled in the deep-set fishery (Table 5).

Table 5. Types of Interactions between Albatrosses and Hawaii Longline Vessels in 2008.
(Source: PIRO)

<table>
<thead>
<tr>
<th></th>
<th>Deep-set (44 Total)</th>
<th>Shallow-set (39 Total)</th>
<th>Combined (83 Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hooked</td>
<td>43 (98%)</td>
<td>31 (79%)</td>
<td>74 (89%)</td>
</tr>
<tr>
<td>Entanglement</td>
<td>1 (2%)</td>
<td>3 (8%)</td>
<td>4 (5%)</td>
</tr>
<tr>
<td>Hooked and Entangled</td>
<td>0 (0%)</td>
<td>5 (13%)</td>
<td>5 (6%)</td>
</tr>
</tbody>
</table>

An interaction with a seabird is automatically classified as “Injured”, if the animal is not “Dead”, and is seldom given an “Alive” release code. “Alive” is a rare release condition, and could only happen if a seabird were to become lightly entangled, not hooked, and free itself without the aid of the observer (Eric Forney, NMFS, pers. comm. April 2009). No albatrosses in either fishery were observed released alive (Table 6). There is a strong correlation between the release condition and the phase of fishing operations in which seabirds are captured. If seabirds are caught during gear deployment, they are unlikely to survive gear interactions. In contrast, the majority of seabirds caught during gear retrieval are usually released injured. Based on observer
data, it can also be determined whether an albatross was captured during gear deployment and the soak period or gear retrieval. The most probable time of capture was determined from observer interaction descriptions.

Table 6. Release condition for albatrosses captured incidentally to fishing operations in the Hawaii longline fisheries in 2008.
(Source: PIRO)

<table>
<thead>
<tr>
<th></th>
<th>Deep-set (44 Total)</th>
<th>Shallow-set (39 Total)</th>
<th>Combined (83 Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alive</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Injured</td>
<td>2 (5%)</td>
<td>24 (62%)</td>
<td>26 (31%)</td>
</tr>
<tr>
<td>Dead</td>
<td>42 (95%)</td>
<td>15 (38%)</td>
<td>57 (69%)</td>
</tr>
</tbody>
</table>

In 2008, most (95%) albatrosses captured in the deep-set fishery were dead when recovered, and two were observed captured during the gear retrieval phase of fishing operations (Table 7). The observer narratives are consistent with the interpretation that captures occurred during gear deployment in the deep-set fishery.

In contrast, the majority (62%) of albatrosses captured in the shallow-set fishery were released injured, and were directly observed occurring during the gear retrieval operations (haul). The remaining incidental interactions (38%) in the shallow-set fishery resulted in mortalities. Most interactions that occurred during the haul (64%) happened when albatrosses were attempting to steal baits from branch lines that were being retrieved. The rest of the interactions (36%) appear to have occurred during gear deployment or when the gear was soaking. All of the albatrosses in both fisheries that were determined to have been caught during gear deployment/soak were recovered dead.

Table 7. Probable time of capture for observed albatross interactions in the Hawaii longline fisheries in 2008.
(Source: PIRO)

<table>
<thead>
<tr>
<th></th>
<th>Deep-set (44 Total)</th>
<th>Shallow-set (39 Total)</th>
<th>Combined (83 Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set/Soak</td>
<td>42 (95%)</td>
<td>14 (36%)</td>
<td>57 (69%)</td>
</tr>
<tr>
<td>Haul</td>
<td>2 (5%)</td>
<td>25 (64%)</td>
<td>26 (31%)</td>
</tr>
</tbody>
</table>

**Increased deep-set interactions in 2008**

There was an increase in the number of seabird interactions in the deep-set fishery in the second quarter of 2008, compared to each second quarter from 2004 until 2008. In the second quarter of 2008, NMFS observed 51 interactions with an observer coverage rate of 32.0%. In the same time
period of 2007, NMFS observed 6 interactions with seabirds in the deep-set fishery with an observer coverage rate of 19.8%. Included in 2008, there was an unusually high number (14) of shearwaters observed killed incidentally to fishing operations. There were no observed shearwater interactions in 2007, and five in 2006.

The increased number of interactions seems to have resulted from a shift in spatial/temporal fishing patterns in the deep-set fishery from years past. Fig. 15 shows a significant amount of deep-set fishing effort taking place north of Hawaii between 25° N and 30° N in the second quarter of 2008. In contrast, the effort pattern in the second quarter of 2007 was more typical of previous years, with less fishing effort north of Hawaii (Fig. 16). There was also significantly more overall fishing effort, i.e., the number of sets, in the second quarter of 2008 when compared to the same period in 2007.

![Figure 15. Fishing effort and seabird interactions for the deep-set fishery, 2nd Quarter 2008.](Source: PIRO)
Seabird bycatch composition was unusual in 2008. In addition to albatrosses being captured, many shearwaters, a red-footed booby, and another unidentified seabird (not an albatross) were also captured. The shearwaters and unidentified seabird were taken incidentally to fishing operations occurring north of Hawaii in the second quarter of 2008. The unidentified seabird was entangled in a branch line during gear retrieval. It appears that all of the shearwaters were captured during gear deployment.

**Estimated Interactions**

Interaction estimates are calculated for the deep-set fishery in which \( \geq 20\% \) observer coverage is maintained annually (NMFS 2005). In the shallow-set fishery, 100\% observer coverage is required; therefore, observed interactions are assumed to equal total interactions.

Because of fluctuations in the deep-set fleet’s activity and observer availability, coverage levels vary throughout the year. These fluctuations make it impractical to sample trips so that each trip has an equal chance of being selected. Furthermore, it is inappropriate to estimate the total number of incidental interactions by simply raising the average observed catch rate by the total amount of effort as this estimator assumes a simple random sample.

The Horvitz-Thompson estimator methodology used for the deep-set fishery is an unbiased estimator based on the sampling design (McCracken 2009). The sampling design uses a systematic sample as the primary sample and a daily random sample as a secondary sample. The
systematic component uses a random number generator to select trips based on the call in order in which longline vessels notify the PIRO Observer Program of a fishing trip. (See Appendix and 50 CFR 665.23 Notifications for explanations.) This systematic schedule is usually designed to provide a 15% sampling rate. The daily sample selects trips randomly from vessel notifications at the end of a business day when observers are available. This hybrid approach to sampling is necessary to address the needs of fishing vessels to be able to fish, the availability of observers varies, and the need to maintain a minimum 20% annual observer coverage rate for deep-set vessels. For instance, right after an observer training class, there may be more than an adequate number of observers available to cover 20% of deep-set trips, and sampling can easily follow the systematic schedule. Often during these periods the coverage rate is above 20% and vessels have a greater chance of being sampled. Conversely, if there are other demands on observers, like when trying to cover 100% of shallow-set trips, NMFS cannot simply prevent deep-set vessels from fishing. This may lead to periods of low observer coverage and lower probabilities that a particular vessel will be sampled. The Horvitz-Thompson estimator used by McCracken (2009) accounts for the interplay between observer availability and fleet activity which, in turn, influences the probability of whether a trip is sampled, or not.

While point estimates derived through the Horvitz-Thompson estimator are considered reliable, periods of low observer coverage (i.e., small sample size) lead to wider confidence intervals. Because seabird interactions are rare events, confidence intervals were computed using accepted methods for estimating confidence intervals for rare events (Poisson variants). Confidence intervals for the yearly total were not computed because it is unreasonable to assume the interaction rates are constant throughout the year (McCracken 2009).

In 2008, the Hawaii deep-set longline fishery was estimated to have incidentally interacted with 118 BFAL and 55 LAAL. The estimated interaction rates for 2008 in the deep-set fishery by species were 0.003 BFAL per 1,000 hooks and 0.001 LAAL per 1,000 hooks. The overall deep-set fishery interaction rate was 0.004 albatrosses per 1,000 hooks (McCracken 2009).

For both longline fisheries in 2008, there were an estimated 124 interactions with BFAL and 88 interactions with LAAL, totaling 214 for both species. Total estimates for the fisheries were determined by combining the estimated interactions (i.e., point estimates) in the deep-set fishery with the total number observed in the shallow-set fishery. Fleet-wide albatross interactions for both fisheries (estimated deep-set plus observed shallow-set) from 2000 through 2008 are depicted in Fig. 17. It should be taken into account that the shallow-set fishery closed in April 2001, and re-opened in October 2004.
Relatively more BFALs are taken compared to their population size (recall that the BFAL nesting pair population is about one tenth that of LAALs) than are LAALs since they are taken in about even total numbers. This trend seems to be consistent over the years (Fig. 17). Fernandez et al. (2001) note that BFAL is commonly seen following ships, and the results of a satellite telemetry study by Hyrenbach et al. (2002) suggests that BFALs may selectively forage during the breeding season in the same areas that are fished by Hawaii-based longline vessels. Both studies show that during the early breeding period (January and February) both species may make short foraging trips to areas that are often fished by Hawaii-based longline vessels close to the NWHI. The Hyrenbach et al. (2002) study also demonstrates a preference by LAALs for boreal and sub-arctic waters away from pelagic longline fishing grounds later in the breeding season (March and April). The differences in behavior and preferred foraging areas during the breeding season between the two species may have some influence on why BFALs are caught in disproportionate numbers relative to their population size.

**Short-tailed Albatross Sightings in 2008**

NMFS observers sighted three short-tailed albatross in 2008 approximately 800 – 1,200 nautical miles northeast of the Hawaiian Islands. The approximate locations of the sightings are shown in Fig. 18, and the details of which were provided to USFWS.
9. Summary

In 2008, observer coverage for the combined Hawaii-based fisheries averaged 26.7% (21.7% for deep-setting vessels and 100% for shallow-setting vessels; 5,197 of 19,468 total sets) based on trips arriving back to port in 2008. Additionally, NMFS observers monitored 37.6% of all longline sets north of 23° N and 25.2% of deep-sets north of 23° N that were hauled in 2008 (NMFS unpub. 2009). Of 41,564,853 total hooks fished, the deep-set fishery deployed about 40 million hooks in 17,881 sets, and the shallow-set fishery deployed more than 1.4 million hooks in 1,587 sets (NMFS 2008).

No interaction was observed or reported with a STAL by either deep-setting or shallow-setting Hawaii-based vessels. NMFS observers sighted three STALs during longline fishing operations, but no interactions occurred. The shallow-set fishery was observed to interact with six BFALs and 33 LAALs, an interaction rate of 0.029 albatross per 1,000 hooks. It was estimated that there were 118 BFAL and 55 LAAL interactions in the deep-set fishery in 2008. Overall, the deep-set fishery had an estimated interaction rate of 0.004 albatrosses per 1,000 hooks. Since 2004, the estimated total number of interactions with albatrosses hooked or entangled incidentally to fishing operations by Hawaii pelagic longline fisheries has been reduced by 92-99% compared to year 2000 estimates. Additionally, there were 14 shearwater species, one unidentified seabird (not an albatross), and one red-footed booby observed captured incidentally to fishing operations. It is unknown what exactly may have led to the increased numbers of non-albatross interactions.
in 2008. For instance, while the number of shearwater interactions was higher than in recent
years (five observed in 2006 and two in 2004), this may have been a function of the higher
fishing effort during the second quarter of 2008. NMFS will continue to monitor the Hawaii-
based longline fisheries and evaluate observer data and mitigation techniques to reduce all
seabird interactions.

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Appendix 1.

Interaction estimates with incidentally caught sea turtles and seabirds in the Hawaii longline deep-set fishery

Estimation of Incidental Interactions with Sea Turtles and Seabirds in the 2008 Hawaii Longline Deep Set Fishery

Marti L. McCracken
Pacific Islands Fisheries Science Center
National Marine Fisheries Service

This report provides estimates of the number of incidental interactions with protected species of marine turtles and seabirds by the Hawaii longline deep set fishery in the year 2008 (Table 1). Within this report, an incidental interaction means an event during a longline fishing operation in which a protected animal is hooked or entangled by the fishing gear. An incidental interaction estimate refers to the estimated total number of incidental interactions for all longline deep set fishing trips landing in the specified time period. A longline deep set fishing trip is defined as any commercial fishing trip by a vessel with a Hawaii longline permit that departs or returns at a Hawaii port, excluding those trips using certificates for swordfish fishing.

The interaction estimates are based on a random sample of longline trips on which scientific observers are deployed. In 2008, observed trips were selected using two sampling schemes to accommodate fluctuating coverage levels and utilize observers efficiently. Coverage levels vary throughout the year because of fluctuation in the fleet’s activity level, demands of 100% coverage in the Hawaii longline shallow set fishery for swordfish, and an influx of observers after completion of NMFS observer training. Because observers are not paid while waiting to be deployed, they must be assigned with minimal delay when available. The alternative of paying them while they are waiting to be deployed would increase the cost of the observer program. The two sampling schemes attempt to reach a balance between obtaining a probability sample and being cost effective. A probability sample implies that all trips have a probability of being sampled and the sampling probabilities are known. These sampling probabilities form the basis of design-based estimators. An unbiased design-based estimator has the merit that it is unbiased regardless of the characteristics of the population being surveyed.

The primary scheme was a systematic sample. Before departing on a fishing trip, longline vessels were required to call the NOAA Fisheries Pacific Islands Regional Office (PIRO) observer program contractor at least 72 hours prior to their intended departure date. To enable sample selection, the PIRO contractor numbered calls sequentially in the order in which they were received. Herein, this assigned number is referred to as the call number. Prior to the beginning of a quarter, a systematic sample of call numbers was drawn by PIFSC and supplied to the contractor. The trips associated with these selected call numbers were designated to be sampled. Although every reasonable effort was made to sample selected trips, there were some selected trips that departed without an observer. In this situation, the PIRO contractor recorded that the trip was not sampled along with a short explanation of why it was not sampled. If a trip was selected but the vessel did not leave within a reasonable amount of time, usually the observer
was reassigned to a different vessel trip. When the selected vessel was ready to depart, a different observer was assigned to it.

The systematic sample requires having an observer available to be deployed whenever a selected trip is ready to depart. Achieving this requirement under full targeted coverage, typically 20% coverage, throughout the year requires having enough observers on contract to accommodate higher levels of fleet activity and paying them when they are not deployed on a vessel. These requirements frequently cannot be met under the current level of funding; therefore, the quarterly sample selected under the systematic design was usually slightly smaller than the targeted coverage, typically 5% less. When this occurred, the additional trips needed to reach the full targeted level were selected using a secondary sampling scheme. This secondary scheme was used when all trips selected by the systematic sample were already covered and an observer was ready to be deployed. In this instance, a trip was randomly selected with equal probability from the calls received that day that had not already been selected. If more than one observer needed to be assigned, the appropriate number of trips was sampled with equal probability from this pool of call-ins. The coverage obtained by this secondary sampling scheme was flexible and dependent on the need to deploy observers. The additional samples drawn under the secondary sampling scheme depart from traditional probability samples because the days when additional samples were drawn were not randomly selected but determined by the need to deploy observers. Trips sampled by the systematic and secondary protocols are used to estimate incidental take.

Because the systematic sample was selected quarterly, point estimates of incidental interactions were computed on a quarterly basis and then summed to estimate the year’s total interactions. All observed incidental interactions on a trip were assigned to the quarter when the vessel returned to port after completing the trip. Some quarterly estimates of interactions therefore involve interactions that occurred during an earlier quarter. Accordingly, these estimates are not the best source of information on seasonality of interactions.

The contractor’s sampling records were used to approximate sampling probabilities. Examination of these records revealed periods of time within a quarter when coverage appeared to have been greater or less than the full targeted coverage. Specifically, periods of time for which the number of secondary samples were greater than expected represent higher coverage, and those for which the number of secondary trips were fewer than expected represent lower coverage. Before computing the sampling probabilities, periods of comparable coverage were identified. The sampling probabilities were computed by enumerating the number of call-ins during consecutive time periods of comparable coverage and assuming that the secondary samples were selected with equal probability from those trips that had not been selected as part of the systematic sample. When coverage was below that of the anticipated systematic sample, the sampling probabilities were computed by enumerating all call-ins during this period and assuming that the trips sampled were selected with equal probability.

Because the coverage level changed with the fluctuations in observer availability and fishing activity, the observed trips were not selected with equal probability. Therefore, the Horvitz-Thompson estimator was used to estimate total interactions, as it takes into account unequal sampling probabilities. The incidental interaction records used to compute the Horvitz-
Thompson estimator were those available in the Longline Observer Database System on 10 March 2009.

Confidence intervals for the quarterly incidental interactions were estimated using the approximated sampling probabilities and assuming that the number of incidental interactions per trip for a given species was an independent Poisson variate with a constant mean value. The assumption that the average rate of incidental interactions was constant throughout a quarter is questionable but necessary to compute confidence intervals. Confidence intervals for the yearly total were not computed, as it seems unreasonable to assume that incidental interaction rates were constant throughout the entire year. A quarter’s confidence interval does not incorporate information beyond the quarter’s data. Therefore, for some species the upper bound of the confidence interval may seem high given historical records. For example, there has not been an observed incidental interaction with a short-tailed albatross during the history of the observer program and based on this information it seems highly improbable that the incidental interaction levels would be as high as the upper bounds of the confidence intervals for this species.
Table 1. Point estimates of the number of incidental interactions by species and corresponding 95% confidence intervals (C.I.) for the Hawaii deep set longline fishery in 2008.

Point estimates were computed by quarter, using data for vessels returning to port during the quarter, then summed to derive the annual statistics. All protected species of sea turtles and seabirds with an observed interaction are listed as well as species that most commonly interact with the fishery or are of special concern because of their endangered species status.

<table>
<thead>
<tr>
<th>Quarter</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Annual Total</th>
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<td></td>
<td></td>
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<td>0 [0,12]</td>
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<td>0 [0,12]</td>
<td>0 [0,22]</td>
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<td>Green</td>
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<td>0 [0,12]</td>
<td>0 [0,22]</td>
<td>0</td>
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<td>Albatrosses</td>
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<td>Black-footed</td>
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<td>Other seabirds</td>
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<td></td>
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<td>0 [0,22]</td>
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</table>
U.S. Secretary of Commerce
Gary Locke

Under Secretary of Commerce for Oceans and Atmosphere and Administrator, National Oceanic and Atmospheric Administration—NOAA
Dr. Jane Lubchenco

Acting Assistant Administrator for Fisheries
NOAA Fisheries Service
James W. Balsiger, Ph.D.

www.nmfs.noaa.gov

National Marine Fisheries Service
1315 East West Highway
SSMC 3, F/SF, Room 9535
Silver Spring, Maryland 20910

U.S. Government – 2009