Annual Report on Seabird Interactions and Mitigation Efforts in the Hawaii Longline Fishery for 2005

ADMINISTRATIVE REPORT AR-PIRO-05-06

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Pacific Islands Regional Office

April 2006

PACIFIC ISLANDS REGIONAL OFFICE

This report is used to ensure the dissemination of preliminary results, interim reports and special studies. The material is not ready for formal publication. Abstracting, citing or reproduction of this information is not allowed. Contact the Pacific Islands Regional Office of the National Marine Fisheries Service if additional information is required.

Cover photo: Short-tailed albatrosses (*Phoebastria albatrus*), Torishima Island, Japan. Photo courtesy U.S. Fish and Wildlife Service.

Annual Report on Seabird Interactions and Mitigation Efforts in the Hawaii Longline Fishery for 2005

Prepared by
Anik Clemens
Sustainable Fisheries Division

National Marine Fisheries Service
Pacific Islands Regional Office
1601 Kapiolani Blvd. Suite 1110
Honolulu, HI 96814

(808) 944-2200

April 2006

Table of Contents

List of Tables

List of Figures

List of Acronyms

BiOp	Biological Opinion
BFAL	Black-footed Albatross
CI	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	Northwest Hawaiian Islands
OLE	Office of Law Enforcement
PIFSC	Pacific Islands Fisheries Science Center
PIRO	Pacific Islands Regional Office
PMUS	Pelagic Management Unit Species
PRIA	Pacific Remote Island Areas
SFD	Sustainable Fisheries Division
STAL	Short-tailed Albatross
USFWS	U.S. Fish and Wildlife Service
WPFMC	Western Pacific Fisheries Management Council

Annual Report on Seabird Interactions and Mitigation Efforts in the Hawaii Longline Fishery for 2005

1.0 Introduction

In the western Pacific, the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS), through its Pacific Islands Regional Office (PIRO), is responsible for managing, protecting, and conserving living marine fishery resources in Federal waters of the U.S. Pacific islands areas.[1] In addition to ensuring that federally managed fisheries do not adversely affect essential fish habitat, PIRO also works to protect and recover endangered and threatened species. The 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 fishery management plans for this region. The 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 governed under fishery management plans.[2]

Seabird mitigation measures, authorized under the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), are prescribed in fishery management plans governing fisheries operating in the U.S. Exclusive Economic Zone (EEZ) and international waters of the western Pacific region. To assess possible impacts of the Hawaii pelagic longline fishery on the endangered short-tailed albatross (*Phoebastria albatrus*) population, 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 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 of the reopened shallow-set sector of the Hawaii Longline Fishery on the STAL" [FWS 1-2-1999-F-02.2: USFWS 2004]. Prior to its suspension, the shallow-set sector of the Hawaii longline fishery accounted for the majority of seabird mortalities, so the October 2004 BiOp evaluated only the effects of the April 2004 reopening of the shallow-set longline fishery on the short-tailed albatross. During 2004 and 2005, no short-tailed albatross interactions were reported in the Hawaii shallow-set longline fishery.[3] The BiOp issued on November 18, 2002, on the deep-set sector remains in effect.

---

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

[2] Fishery management plans are developed by the WPFMC and, if approved by the Secretary of Commerce, implemented by regulation by NMFS. Five fishery management plans governing western Pacific fisheries including pelagics, bottomfish/seamount groundfish, crustaceans, precious corals, and coral reef ecosystems.

[3] The shallow-set sector of the Hawaii longline fishery reopened with a final rule on April 2, 2004 (69 FR 17329).

The three BiOps (USFWS 2000, 2002, 2004) require NMFS to report annually any observed interaction of short-tailed albatross with the Hawaii longline fishery, and any observed and estimated total number of interactions with Laysan (*P. immutabilis*) and black-footed (*P. nigripes*) albatross by set type.[4] Interactions with short-tailed albatrosses are rare; therefore, interactions with other species are used as a surrogate in order to gauge the effectiveness that seabird deterrents might have on the short-tailed albatross. Information is gathered on black-footed and Laysan albatrosses (surrogate species) because these species exhibit similar foraging behavior to the short-tailed albatross. In addition, NMFS must report on the status of observer coverage, provide assessments of the effectiveness of required seabird deterrents including review of the observer data from vessels choosing to side-set, and summarize the results of the Federally-mandated Protected Species Workshops. This report includes the reporting requirements for the Hawaii longline fishery operating during 2005.

[4] NMFS described tuna (deep-set) and/or swordfish (shallow-set) type.

2.0 Description and Status: Short-tailed Albatross

The short-tailed albatross (STAL) is the largest of the northern hemisphere albatross species. They are long-lived and slow to mature. They have distinctive pink bills, and the plumage varies in color at different stages of its life. When the STAL is one year old, the bird looks similar to a BFAL, except for the STAL's bill and flesh colored legs and feet. As the STAL gets older, its head, neck, stomach and back become lighter in color. A fully mature STAL has a golden head, a bright pink bill, and a characteristic thin black line around the base of its bill. STALs once ranged throughout most of the North Pacific Ocean and Bering Sea, with known nesting colonies on numerous western Pacific islands in Japan and Taiwan (Hasegawa 1979). During the early 20th century, the species declined in numbers to near extinction, primarily from direct harvest at breeding colonies in Japan. The species began to recover during the 1950s and currently, due to habitat management and habitat protection, the population is growing exponentially at about 7.3% annually (Fig. 1). Today, the only known currently-active breeding colonies of STALs are on Torishima and Minami-kojima islands, near Japan, as well as Tawain, and the Northern Mariana Islands. As of 2005, 80-85% of the known breeding STAL use a single colony, Tsudame-zaki, on Torishima, an active volcanic island. The current worldwide STAL population is estimated to be approximately 2,000 individuals, with 302 nests observed on Torishima island during the 2004-2005 breeding season (H. Freifeld, USFWS, pers. comm., March 5, 2006).

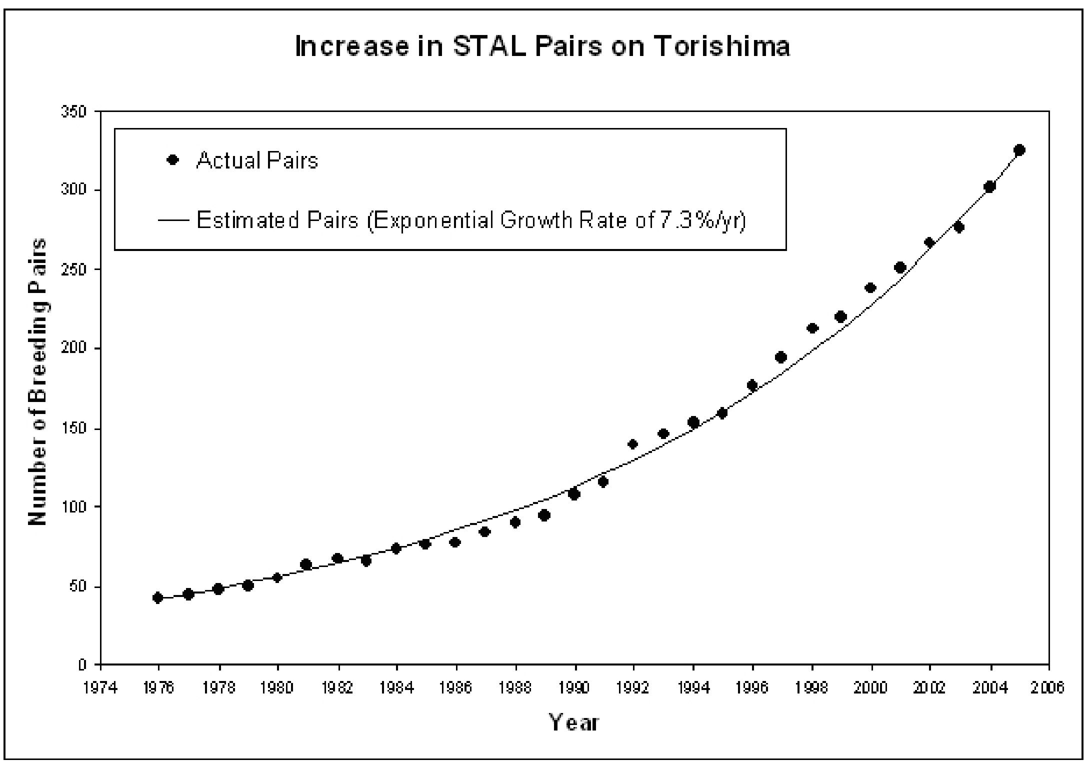

Figure 1. Estimated pairs of short-tailed albatross on Torishima Island, Japan, 1974-2005.
(Source: USWFS)

3.0 Description and Status of Surrogate Species: Laysan and Black-footed Albatrosses

The Laysan albatross (LAAL) is the most abundant albatross in the world. They are characterized by a white head, neck and underparts. Their upper wings and back are black to dark gray and they have flesh-colored legs, feet, and bill. They also have dark plumage highlighting their eyes. In the U.S.A., the LAAL is designated by the USFWS as a "bird of conservation concern" (USFWS 2002), meaning that it is a high priority species that without additional conservation actions are likely to become candidates for listing under the U.S. Endangered Species Act (ESA). Approximately 99% of the world's LAAL breed in the Northwestern Hawaiian Islands (NWHI), estimated at 590,683 breeding pairs as of the hatch year 2005 count (Flint 2005). Other breeding sites are in Japan and Mexico. The largest breeding colony is at Midway Atoll, where the December 2005 nest count was almost 500,000 nests. When unmated birds at the colony are included, a LAAL count would total over one million individuals. The current world population of LAAL is estimated at 3.4 million individuals (NMFS 2005).

The black-footed albatross (BFAL) is slightly larger than the Laysan and prefers to nest in more open areas. The BFAL has black feet, legs, and bills. The plumage is brown and there is a white ring around the base of the bill. Birds older than two years have white on their tail feathers. In the U.S.A., the BFAL is designated by the USFWS as a "bird of conservation concern" (USFWS 2002). Like the LAAL, the BFAL breeds primarily in the NWHI (approximately 96% of the population). An estimated 61,141 breeding pairs were found on the NWHI in the hatch year 2005 count (Flint 2005). Other breeding sites are in Japan and Mexico. The December 2005 BFAL count at Midway Atoll marked the fifth consecutive year of increased numbers of BFAL nests. The current world population of BFAL is approximately 300,000 individuals (NMFS 2005).

4.0 The Hawaii Pelagic Longline Fishery in 2005

The Hawaii longline fishery is the most important commercial fishery managed under the Fishery Management Plan for Pelagic Fisheries of the Western Pacific region (FMP) (NMFS 2001a). The Hawaii longline fishery is comprised of a deep-setting component, targeting tuna, and a shallow-setting component, targeting swordfish. In April 2001, the shallow-setting component of the fishery was restricted by Federal Court orders intended to protect threatened and endangered sea turtles taken incidentally in the fishery (66 FR 31562, June 12, 2001). In April 2004 (69 FR 17329), the shallow-setting component of the Hawaii longline fishery was reopened under a suite of management measures that required new gear configurations and specialized turtle dehooking equipment, in order to prevent the incidental capture of and increase the post-hooking survival of sea turtles.

Key regulations of the shallow-set component (69 FR 17354, April 2, 2004) include:

- 100% observer coverage
- 2,120 shallow set certificates issued per year
- 18/0 circle hooks with 10 degree offset
- Mackerel-type bait
- Sea turtle handling measures including dehooking equipment; and
- Annual attendance at mandatory Protected Species Workshops for vessel operators and owners

The Hawaii longline fishery operating in 2005 consisted of both deep-set and shallow-set components (see Appendix 1). There were 124 active Hawaii longline vessels that made 1,533 trips (Table 1). The trips targeted tunas (bigeye, albacore, and yellowfin tuna) and swordfish. A total of 1,427 tuna trips and 106 swordfish trips were made[5]. Of the total number of trips in 2005, 749 trips were made above 23° N. latitude (PIFSC, unpubl.). Table 2 shows the catch per unit effort (CPUE) values attained by the Hawaii longline fishery in 2005.

[5] For comparison, in 2004, 1,332 tuna trips and 6 swordfish trips were made.

Table 1. Hawaii Longline Fishery effort data, 1999–2005 (vessels departing in calendar year 2005).
(Source: PIFSC)

Year	Vessels	Trips	Sets	Hooks	Lightsticks
1999	122	1,165	12,805	19,145,304	818,149
2000	125	1,135	12,930	20,282,826	715,975
2001	101	1,075	12,169	22,327,897	26,519
2002	102	1,193	14,225	27,018,673	1,569
2003	110	1,215	14,560	29,297,813	0
2004	125	1,338	15,976	31,967,874	36,625
2005	124	1,533	18,083	34,895,229	750,417

Table 2. Hawaii Longline Fishery catch per unit effort (number of species caught per 1000 hooks), 1999–2005.
(Source: PIFSC)

Year	No. Tuna	No. Sharks	No. Billfish	No. Other PMUS*
1999	9.21	4.59	3.9	4.8
2000	8.18	3.91	2.88	4.8
2001	8.64	2.1	1.61	4.21
2002	7.48	1.87	0.98	4.27
2003	6.33	2.32	1.77	4.58
2004	6.42	2.34	1.24	5.49
2005	5.32	2.15	1.69	5.06

* Other Pelagic Management Unit Species (PMUS): mahimahi, moonfish, oilfish, pomfret, and wahoo.

5.0 Seabird Deterrence Measures and their Effectiveness

A variety of seabird deterrence methods have been tested and found to reduce interaction rates and/or mortality of seabirds with longline fisheries (e.g., Brothers 1995; Brothers et al. 1999; McNamara et al. 1999; Gilman et al., 2003, 2005, in press). When employed effectively, seabird 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).

Since June 2001, the Hawaii longline fishery has been required to use seabird deterrence measures. An emergency rule published on June 12, 2001 (66 FR 31563), closed the swordfish fishery and implemented the terms and conditions of the BiOp issued by the USFWS on November 28, 2000 (USFWS 2000). These measures included a suite of mitigation techniques to be used north of 23° N. latitude: thawed blue-dyed bait, strategic offal discards, a line-setting machine, and 45 g weights attached to the hook end of each branchline. On May 14, 2002, a final rule (67 FR 34408) was published in order to codify the terms and conditions contained in the 2000 BiOp. The suite of seabird mitigation techniques was defined as follows: when making deep sets north of 23° N., vessels must employ a line-setting machine with at least 45 g weights attached within 1 m of each hook, use thawed blue-dyed bait and strategic offal discards during the setting and hauling of longline gear. These measures were further altered by a final rule on December 19, 2005 (67 FR 75075), to satisfy the terms and conditions of the 2004 BiOp. These measures, which became effective on January 18, 2006, include the following:

When fishing north of 23° N. latitude, all deep-setting Hawaii longline vessels must either:

- Side-set (including using 45 g weighted swivel within 1 m of the hook, and a bird curtain)

or

- Use thawed, blue-dyed bait;
- Discard offal strategically, only when seabirds are present;
- Use at least 45 g weights within 1 m of each hook;
- Use a line shooter or basket gear;
- Handle all seabirds in a manner that maximizes the probability of their long-term survival;
- Notify NMFS immediately if a STAL is hooked or entangled; and
- Retain all dead STAL and submit the carcass upon return to port.

All shallow-setting Hawaii longline vessels, wherever they fish, must either:

- Side-set (including using 45 g weighted swivel within 1 m of the hook, and a bird curtain)

or

- Night set

- Use thawed, blue dyed bait;
- Discard offal strategically, only when seabirds are present;
- Handle all seabirds in a manner that maximizes the probability of their long-term survival;
- Notify NMFS immediately if a STAL is hooked or entangled; and
- Retain all dead STAL and submit the carcass upon return to port.

Fishermen are educated on these regulations during mandatory annual Protected Species Workshops, and observers are educated on these regulations during mandatory observer training. Vessel operators, crew, enforcement officials, and observers all receive the same current seabird mitigation information summarized in Table 3.

Table 3. Summary of seabird regulations for the Hawaii longline fleet, effective as of January 18, 2006.

(Source: NMFS PIRO)

Effective Date: January 18, 2006 X = Required Measure		**Side Setting**			**Stern Setting**	
	Shallow Set	Deep Set >23°N	Deep Set <23°N	Shallow Set	Deep Set >23°N	Deep Set <23°N
45 g weights	**X**	**X**			**X**	
Weights within 1m of the hook	**X**	**X**			**X**	
Blue-dyed bait (thawed)				**X**	**X**	
2 (1 lb) containers of blue dye				**X**	**X**	
Set from port or starboard side	**X**	**X**				
Setting station at least 1 m forward of stern corner	**X**	**X**				
Line shooter at least 1 m forward of stern corner (if used)	**X**	**X**				
Deploy gear so that hooks do not resurface	**X**	**X**				
Bird curtain	**X**	**X**				
Use line shooter					**X**	
Retain fish parts and spent bait (hooks removed)				**X**	**X**	
Retain and prepare swordfish head and liver				**X**	**X**	
Begin set 1 hr after sunset/complete before dawn				**X**		
Follow seabird handling procedures	**X**	**X**	**X**	**X**	**X**	**X**

The following seabird deterrent methods are explained in more detail:

- strategic offal discarding;
- thawed blue-dyed bait;
- weighted branch lines;
- night setting; and
- side-setting.

Strategic Offal Discarding

Strategic offal discarding involves throwing overboard fish offal (i.e., fish, fish parts, and spent bait) while setting and hauling gear, on the opposite side of the vessel from where the longline gear is being set or hauled. Swordfish heads must be removed and cut in half vertically (between the eyes) before discarding. Livers must also be removed and discarded. In the past, only swordfish were dressed at sea (heads and guts were removed before the carcasses were packed on ice in the vessel's hold). Recently, however, tuna are being dressed at sea as well. Thus, a supply of offal can be routinely generated for the next set on both swordfish- and tuna-targeting vessels. Gilman (2004), in his analysis of Hawaii longline observer data, found that only 18% of tuna-targeting sets employed strategic offal discards. This percentage increased in 2005 to approximately 50%[6], partially due to more vessels gutting their tunas. Vessels that do not gut their tuna at sea must retain spent bait and valueless bycatch (such as snake mackeral and lancetfish) during the haul to use for the next set when strategic offal discards are required.

Strategic offal discards have been known to be effective in reducing interactions with seabirds. Tests by McNamara et al. (1999) showed that strategic offal discards reduced gear contacts with seabirds in the Hawaii longline shallow-set fishery by 51% and seabird interactions by 88%. However, over time, this practice is believed to attract birds to the vicinity of the vessel, increasing bird abundance, searching intensity, and interaction (Brothers et al. 1999). In the long-term, strategic offal discarding may reinforce the association that birds make with specific longline vessels being a source of food. 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 have higher seabird abundance and interaction rates than vessels that do not discard offal and fish waste. Nevertheless, vessels that practice strategic offal discards have shown lower bird interaction rates versus those that do not employ strategic offal discarding at all.

Strategic offal discarding is a cost-effective mitigation technique with an initial maximum investment of $150, especially for swordfish-targeting vessels which routinely generate large quantities of offal. However, this requirement is difficult to monitor for compliance, especially when observers are not onboard. Regulations promulgated on December 19, 2005 (70 FR

---

[6] This percentage is an estimated value, as observer data was recorded differently beginning in June of 2005 when the regulation for "strategic offal discards" changed to be recorded only when seabirds are present (T. Swenarton, NMFS PIRO, pers. comm., April 4, 2006).

75077) modified the requirement to use strategic offal discards only when seabirds are present, so the requirement hopefully will become less of a burden on fishermen.

Thawed Blue-dyed Bait

Dying bait to a certain blue color is an attempt to reduce a seabird's ability to see the bait by reducing the bait's contrast with the sea surface. The bait is thawed in order to increase sink rates. In a study by Gilman et al. (2003), blue-dyed bait showed to be 63% effective at avoiding seabird interactions, in the deep-set fishery, as a stand-alone seabird avoidance technique.

Blue dye is taken up less readily by fish baits such as sardines and sanma, than by squid bait, and fishermen report difficulty in achieving the desired intensity of the blue color specified by the regulations, due to the shedding of deciduous scales found on baitfish. Squid bait is no longer being used in the Hawaii longline fishery because of the number of turtle takes while using squid bait. Blue-dyed bait usually results in less bait retention because thawed bait falls off the hook faster than partially frozen bait. Thawed blue-dyed bait also results in slower hook setting rates because of the time spent thawing and dying the bait blue during the setting of longline gear. This technique is often inconvenient for crew because the dye can be messy, dyeing the hands and clothes of the crew and the deck of the vessel, and is therefore not employed consistently from vessel to vessel.

This deterrence measure is relatively inexpensive, costing approximately $1,400 annually. However, compliance with this method is difficult to monitor. Gilman et al. (in press) found that blue-dyed bait produced a higher seabird interaction rate than side-setting or an underwater setting chute, when used with either tuna or swordfish gear. Most of the practicality, convenience, and enforceability problems could be addressed if pre-blue-dyed bait were commercially available. Thawed blue-dyed bait is part of the suite of measures currently required for vessels that do not side-set in the Hawaii longline fleet.

Weighted Branch Lines

Weights at the hook end of branch lines are intended to quickly sink baited hooks, before foraging seabirds can take the baits and subsequently become hooked or entangled in longline gear. Hawaii longline vessels use 45 g, 60 g, and/or 80 g weights attached to their branchlines to sink their branchlines and mainlines quickly 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, Gilman 2005). Thus, 45 g weights are the current weight requirement for deep-setting vessels fishing north of 23° N. latitude and for side-setting vessels, wherever they fish.

This deterrence method has an associated cost of approximately $5,700 (start-up) and $2,400 (annual maintenance) for deep-setting and/or side-setting vessels. Compliance with this method is easy to enforce dockside, because the gear is prepared before vessels leave port.

Night Setting

Night setting involves beginning fishing operations (the set) no earlier than one hour after local sunset, and completing the set no later than sunrise, using only the minimum vessel lights necessary for safety. The concept is that seabirds cannot see the baited hooks in the dark, and, therefore, do not dive for the bait, thus avoiding interactions with longline gear. The effectiveness of this measure is influenced by the moon phase, vessel lighting, light sticks, and cloud cover. In 2005, as seen in the observer data, many of the seabird interactions on shallow-setting vessels took place during the full moon phase (Tom Swenarton, pers. comm., April 2005).

Night setting is required only for shallow-setting (swordfish-targeting) vessels. This is because when targeting swordfish the gear is set shallow, many times without weighted branchlines, and baited hooks remain near the surface for longer periods of time than when deep-setting. If night setting is executed following the regulations, it proves to be a very effective method of avoiding seabird interactions. A study by McNamara et al. (1999) shows night setting to be 73% effective at avoiding seabird interactions, whereas a study by Boggs (2001) shows night setting to be 98% effective. Vessels use light sticks on each branchline in order to entice nocturnal foraging swordfish to the bait. Lightsticks are the only monetary cost associated with this deterrent method.

Side-setting

Side-setting involves setting the gear from the side of the vessel, as opposed to the conventional approach of setting from the stern. The effect is that baited hooks are set closer to the side of the vessel's hull where seabirds are unable or unwilling to pursue the hooks. Ideally, when side-setting with proper line weighting, by the time the stern passes the point where the hook entered the water, the hook has sunk below the maximum diving depth of the birds. A bird curtain (a bird scaring device) deployed in combination with this technique reduces the ability of seabirds to establish a flight path along the side of the vessel, thus increasing the effectiveness of this method to avoid capturing seabirds.

In the current seabird regulations (70 FR 75075, December 19, 2005), vessels choosing to side-set must adhere to the following specifications:

1) Deploy the mainline as far forward on the vessel as practicable, and at least 1 m forward from the stern of the vessel;
2) Set the mainline and branch lines from the port or starboard side of the vessel;
3) If the mainline shooter is used, it must be mounted as far forward on the vessel as practicable, and at least 1 m forward from the stern corner of the vessel;
4) Branch lines must have weights with a minimum weight of 45 g;
5) One weight must be connected to each branch line within 1 m of each hook;
6) 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
7) A bird curtain must be deployed, that consists of the following three components:

a) a pole that is fixed to the side of the vessel aft of the line shooter and that is at least 3 m long;
b) 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
c) 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.

Side-setting shows the highest promise of any seabird mitigation method tried to date in terms of effectiveness. In deep-set and shallow-set trials conducted by Gilman et al. (in press), side-setting was shown to produce the lowest seabird interaction rates when compared to setting with two lengths of an underwater setting chute (a device that sets hooks underwater), or setting with blue-dyed bait. In 2005, observers did not record any seabird interactions on vessels employing side-setting. Out of 124 active Hawaii longline vessels, 44 had converted their vessels to side-setting by December 2005. An effective seabird avoidance measure with the ability to provide large operational benefits for many vessels, side-setting is anticipated to become the preferred technique for tuna-targeting vessels in upcoming years. However, swordfish vessels are unlikely to switch to side-setting. Only one vessel that targeted swordfish in 2005 practices the technique of side-setting (Tom Swenarton, pers. comm., March 2006). This is likely because of the weight requirement for side-setting, which is a 45 g weight placed within 1 m of the hook. Vessels that target swordfish place their weights halfway between the branchline and the hook in order to keep their mainline shallow, and therefore, swordfish vessels are unlikely to switch to side-setting (Eric Gilman, pers. comm., April 2006).

Side-setting results in high fishing efficiency relative to other treatments, based on bait retention and hook setting rates. This deterrent minimizes bait theft by the use of a bird curtain and by sinking the baits quickly out of reach of diving seabirds. It also increases fishing efficiency by eliminating the need to transport gear from the stern of the vessel to amidships between setting and hauling operations. Side-setting does require an initial investment to prepare the vessel for this technique, including adjusting the vessel deck design (approx. $1,000), and purchasing and fabricating a bird curtain ($200). A side-setting technical assistance project, however, begun in 2005, provides assistance for vessels to convert their deck designs to side-set, including reimbursements for relocating their setting machines and installing a bird curtain. In 2005, the project, funded by PIFSC and the Hawaii Longline Association (HLA), converted 28 vessels to side-setting. This project will continue in 2006, with funding provided by PIRO. Monitoring the requirement to side-set is relatively easy to enforce, as the orientation of the gear on deck can be monitored through dockside inspection, and vessel operations can be readily observed at sea.

6.0 Seabird Interaction Estimates and Fishing Effort

Historically, seabird[7] interaction estimates in the Hawaii longline fishery were an order of magnitude higher than interaction estimates seen in 2005[8]. In 1999, an estimated 2,320 seabirds were caught in the combined deep-set and shallow-set components of the Hawaii longline fishery. In 2000, an estimated 2,433 seabirds were captured. In 2001, interaction estimates decreased to 510 seabirds, likely due, in part, to the suspension of the swordfish fishery beginning in April 2001. A decrease in fishing effort in the swordfish fishing grounds (where albatrosses tend to forage during the breeding season: late winter through early spring) contributed to the lower number of seabirds captured (Eric Gilman, pers. comm. 2005). The swordfish fishery was closed throughout 2002 and 2003, when an estimated 116 seabirds and 257 seabirds, respectively, were captured by the deep-set tuna fishery. In April 2004, the swordfish fishery re-opened under a management program with an annual limit on shallow-sets allowed north of the equator (69 FR 17330). During 2004, 26 albatrosses were estimated to be captured in the combined shallow-set and deep-set components of the Hawaii longline fishery. The low numbers can be attributed to a combination of a decrease in fishing effort with the closure of the swordfish fishery and the effectiveness of seabird deterrence measures. In 2005, with the same seabird deterrents in place and fishing effort very similar to that in past years, 194 seabirds were estimated to be captured in the combined shallow-set and deep-set components of the fishery. However, the swordfish fishery, opened the entire year, likely had an effect on seabird interaction estimates (i.e., 100 more swordfish trips were conducted in 2005 than in 2004).

Another contributing factor to the decrease in seabird interaction estimates 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 with the implementation of an emergency rule (66 FR 31563). The final rule for this suite of seabird deterrence techniques was published in May 2002 (67 FR 34408). Since then, the numbers of seabirds caught in the Hawaii longline fishery have remained substantially low. New seabird measures in place as of January 18, 2006 (67 FR 75075) are projected to result in continued low numbers of seabird interactions. The relative effects of these measures, however, are difficult to quantify. Fishing operations are not designed to experimentally test seabird interaction deterrents, so deterrents are not utilized independently of other measures. There are no “control” sets. Therefore, it is not possible to determine the efficacy of seabird measures under commercial fishery operations.

[7] For the purposes of this report, “seabird” includes black-footed and Laysan albatrosses.

[8] These seabird interaction estimates do not include additional birds that may have fallen off the line during setting or hauling operations, which would contribute to the “drop off rate” included in seabird analyses. Only seabirds that are observed hauled aboard, or seen interacting with the gear during setting or hauling procedures, are counted in these estimates. In the 2004 BiOp (USFWS 2004), under the section entitled “Conservation Recommendations”, the USFWS states that “Understanding the rate at which birds may ‘fall off’ longline gear will influence the analyses that relate to estimating the number of Laysan and black-footed albatross that are killed in the Hawaii longline fishery each year. Refining these analyses will help the NOAA Fisheries and [USFWS] gauge the effectiveness of the various seabird deterrent devices and ultimately, help reduce the risk of interaction between short-tailed albatross and the Hawaii-based longline fishery.” Currently, NOAA Fisheries does not have a procedure for calculating the drop off rate of seabirds during fishing operations; however, NOAA Fisheries is looking into this for future data collection protocols.

During the fall of 2004, the NMFS observer program started to record relative seabird abundance during setting operations. Incorporating the relative abundance of seabirds into analyses of the effectiveness of seabird mitigation measures and seabird interaction estimates will improve our understanding of the relative success of seabird mitigation measures and enable more precise interaction rates (Jeremy Bisson, NMFS PIRO, pers. comm. April 26, 2006). Seabird interaction rates reported in this manner will not be influenced by differences in albatross abundance at fishing grounds (Gilman et al. 2005). For instance, it is possible that observed reductions in seabird interaction rates are a result of vessels fishing at grounds with fewer or no albatrosses present compared to earlier years. A comparison of the location of fishing grounds between historical data (1994-2004) and 2005 data (Figs. 2-5) indicate that the location of fishing effort has not substantially changed over this period. Therefore, if the relative albatross abundance has also not substantially changed over this period, then fluctuation in seabird interaction rates would not be a result of changes in the location of fishing effort, rather the fluctuation would be attributed to the relative successes of the mitigation measures employed.

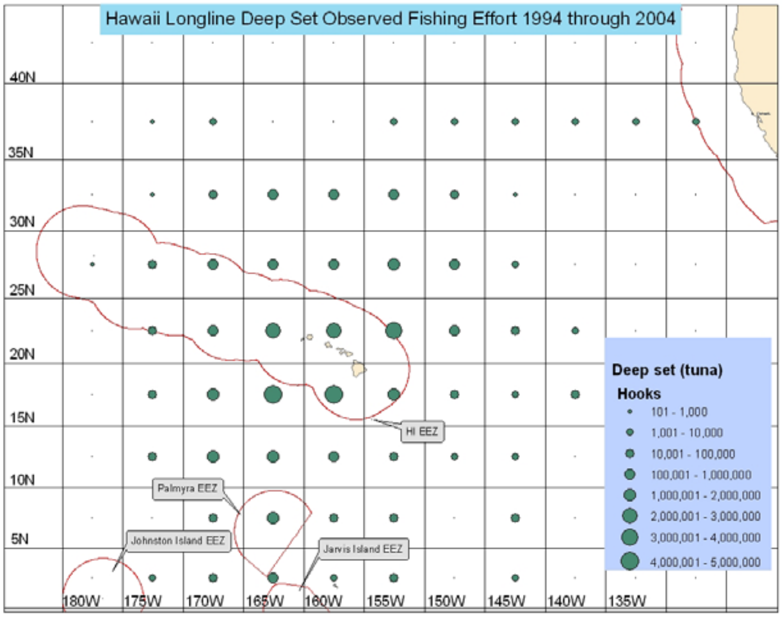

Figure 2. Observed fishing effort in the deep-set fishery, 1994-2004.
(Source: NMFS PIRO)

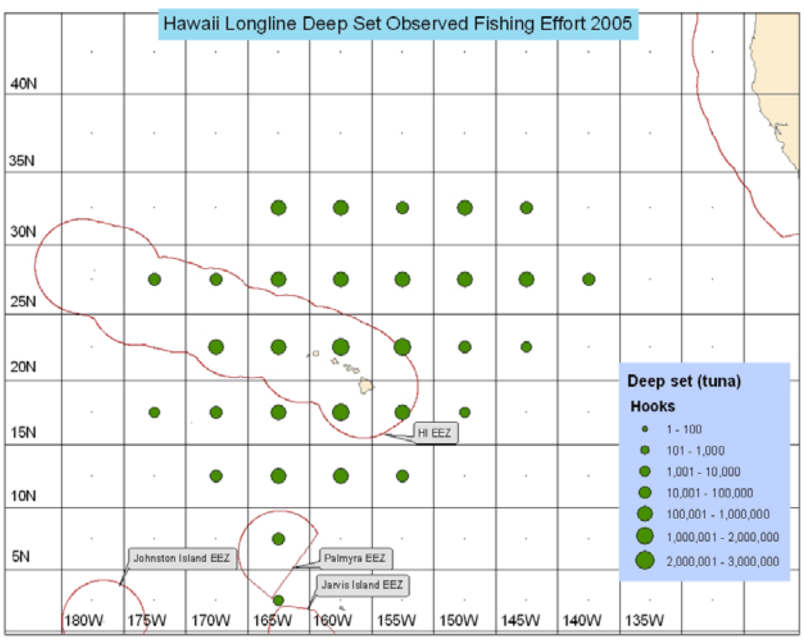

Figure 3. Observed fishing effort in the deep-set fishery, 2005.
(Source: NMFS PIRO)

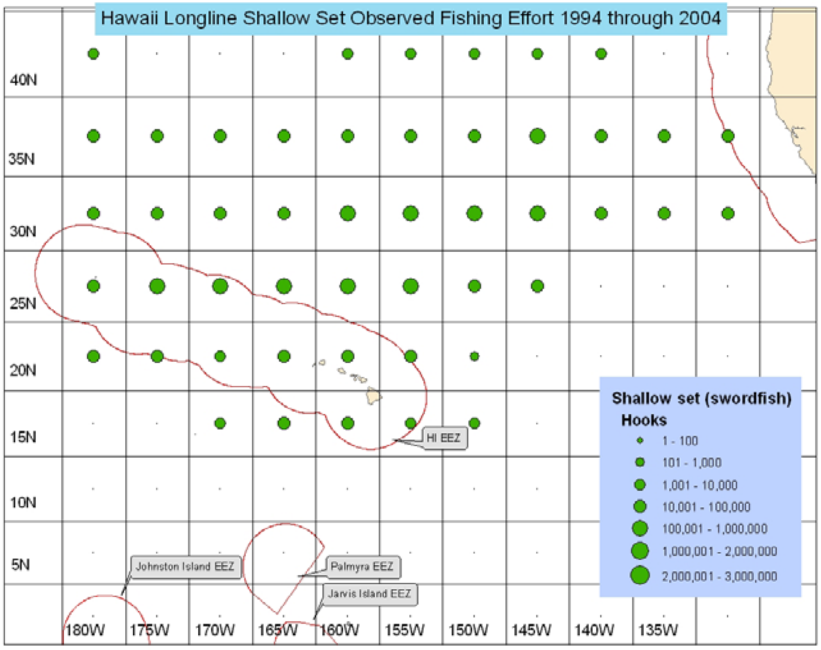

Figure 4. Observed fishing effort in the shallow-set fishery, 1994-2004.
(Source: NMFS PIRO)

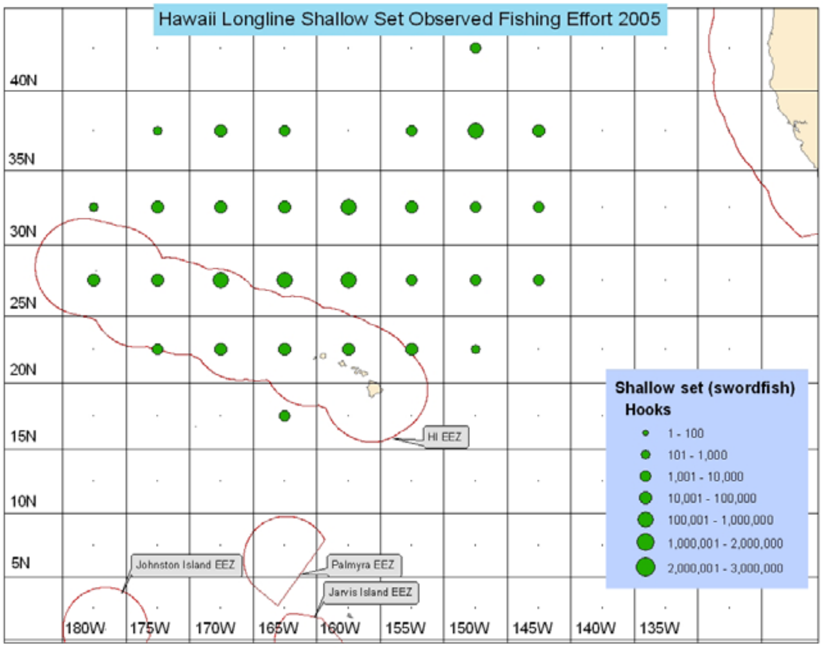

Figure 5. Observed fishing effort in the shallow-set fishery, 2005.
(Source: NMFS PIRO)

7.0 Observer Coverage in 2005

The two major sources of information regarding albatross interactions with the Hawaii longline fishery are mandatory logbooks and observer data collection programs, both administered by NMFS. The longline logbook program requires longline vessel operators to complete and submit to NMFS a daily log sheet containing detailed catch and effort information about each set, including interactions with protected species (50 CFR 660.14).

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

Until 2001, the NMFS Hawaii Longline Observer Program Field Manual (Manual) specifically instructed observers not to record seabird sightings unless birds interacted with the fishing gear (NMFS 1999). In the June 2001 revised Manual, observers were instructed to record sightings of STALs only, and fishing interactions with all seabird species (NMFS 2001b). From October 2002 to November 2004, observers on vessels operating north of 23° N. latitude were required to identify, record behaviors toward fishing gear, and any interactions with all seabird species during the setting and hauling of longline gear. In November 2004, observers were redirected to focus their seabird observations only to STAL, LAAL, and BFALs north of 23° N. latitude to comply with the USFWS 2004 BiOp. Observers are now instructed to record details and take photographs when STALs are sighted (USFWS 2004). Observers are also now asked to observe the first hour of setting operations for any seabirds by conducting 5-minute scan counts at the beginning of the hour and after the first half hour. Scan counts include surveying the area around the vessel in a 360 degree radius out to 200 m. During the retrieval of longline gear, observers are directed to conduct scan counts for any seabirds every two hours, at the beginning of each hour. Sightings and interactions with STAL, LAAL, and BFALs are to be recorded during the setting and hauling of longline gear (PIRO Circular Update 55B, November 2, 2004). Scan counts provide a way to estimate the relative abundance of seabirds which can be compared over the years.

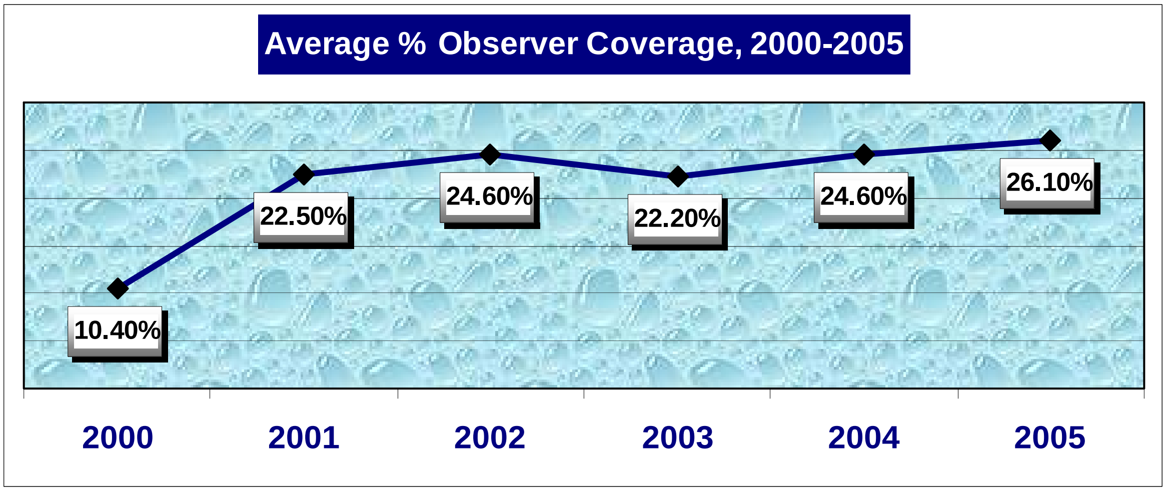

Figure 6. Observer coverage on deep-setting vessels, 2000-2005.
(Source: NMFS PIRO)

The observer program exceeded the required 5% coverage for deep-setting vessels operating north of 23° N. latitude. Deep-setting vessels that fished north of 23° N. latitude maintained an average of 32.1% observer coverage (Fig. 7), while shallow-setting vessels maintained 100% observer coverage.

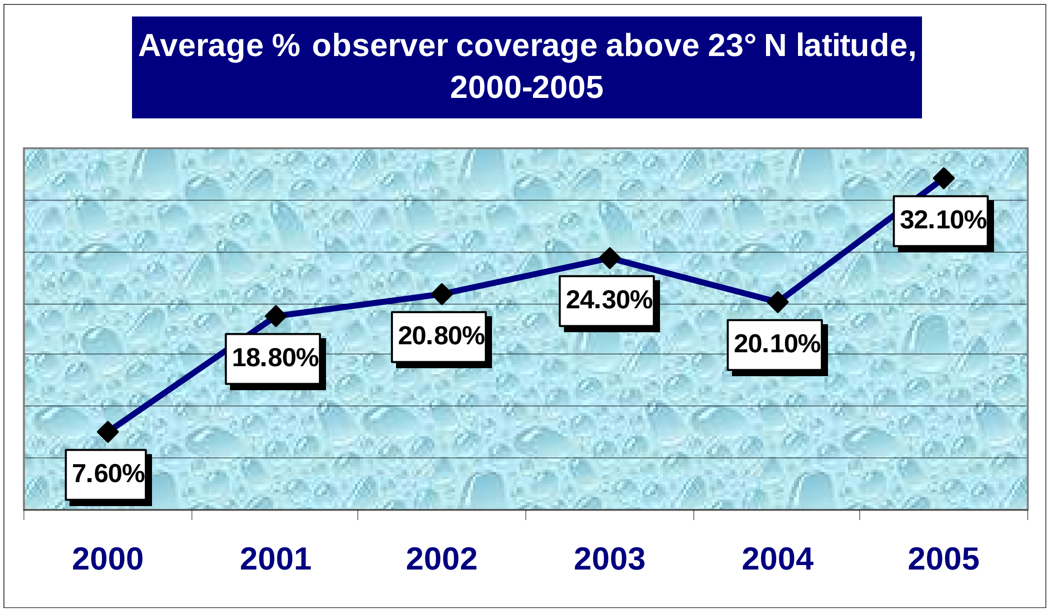

Figure 7. Observer coverage on deep-setting vessels north of 23° N latitude, 2000-2005.
(Source: NMFS PIRO)

8.0 Seabird Interactions in 2005

In this report, a seabird interaction is any contact between a seabird and fishing gear, implying that the seabird became hooked or entangled. Seabird "takes" or "captures" are usually recorded during the haulback of longline gear, but on rare occasions, they may be recorded by observers during the setting of gear. 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 allowed per year for the shallow-set fishery under the 2004 BiOp (USFWS 2004).

Observed Interactions

There were no sightings, nor were there any observed interactions of STALs in either the deep-set or shallow-set components of the Hawaii longline fishery during 2005. However, the deep-set fishery interacted with 12 BFAL and 6 LAAL out of 4,585 observed sets (approx. 0.002 albatross per 1,000 hooks, Fig. 8). The shallow-set fishery interacted with 7 BFAL and 62 LAAL out of 1,641 observed sets (approx. 0.04 albatross per 1,000 hooks, Fig. 8).

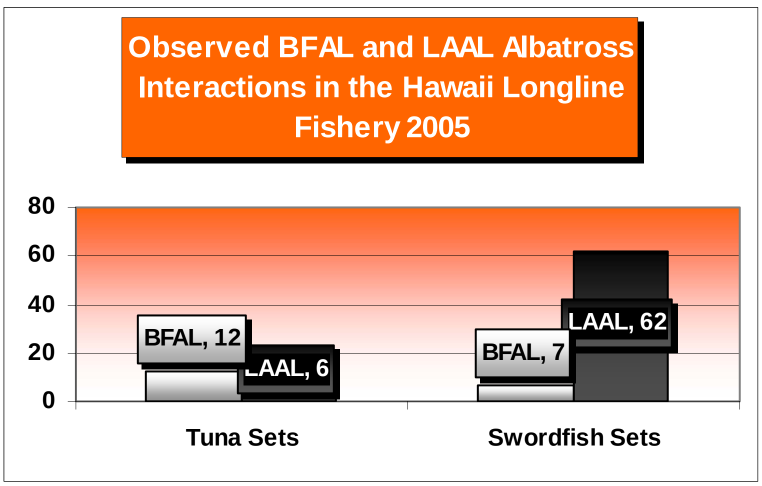

Figure 8. Total observed black-footed and Laysan albatross interactions in the Hawaii pelagic longline fishery, 2005.
(Source: NMFS/PIRO)

Estimated Interactions

Interaction estimates are calculated for the deep-set fishery, in which an average of 20% observer coverage annually is generally maintained (NMFS 2005), however, interaction estimates are not calculated for the shallow-set fishery, in which 100% observer coverage is required. During 2005, the Hawaii pelagic tuna longline fleet (deep-set component) was estimated to have incidentally interacted with 82 BFAL and 43 LAAL out of 16,442 sets (approx. 0.004 albatross per 1,000 hooks, See Appendix 2: Table 1). These estimates may appear high considering there were 12 BFAL and 6 LAAL observed caught in 2005 with 26.1% observer coverage, but the observer coverage rate during the first quarter of 2005 was 16.3% and this coverage rate varied significantly even within the first quarter. The estimator used takes into account the non-constant observer coverage and adjusts for periods of low and high coverage levels; therefore the first quarter observations were raised by a higher number reflecting the periods of lower coverage. During a period when observer coverage was very low in March there was one observation of a BFAL and this one observation is therefore very influential in the computation of the first quarter interaction estimate, but because observer coverage was low the uncertainty in the estimate is high for this period. The confidence intervals in the first quarter reflect the uncertainty in the estimates of 82 BFAL and 43 LAAL and are wide due to the variability of observer coverage rates during the first quarter. Confidence intervals for the quarterly estimates were computed using the approximated sampling probabilities and assuming that the takes of seabirds per trip were independent Poisson variants with a constant mean value. The assumption that the average take rate is constant throughout a quarter is questionable, but necessary to compute confidence intervals. Confidence intervals for the yearly total were not computed because it seemed unreasonable to assume the take rates were constant throughout the year (McCracken 2006).

Table 4. Interaction estimates with incidentally caught albatrosses and corresponding 95% confidence intervals (C.I.) for the Hawaii deep-set longline fishery in 2005.
Source: PIFSC, unpublished data.

	Quarter 1	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Annual Total**
Species	Point Estimate, C.I.	Point Estimate, C.I.	Point Estimate, C.I.	Point Estimate, C.I.	
Black-footed Albatross	68, [25,115]	11, [2,37]	0, [0,10]	3, [1,18]	82
Laysan Albatross	43, [11,85]	0, [0,19]	0,[0,10]	0, [0,15]	43

The fleet-wide seabird takes by the Hawaii longline fishery (estimated deep-set and observed shallow-set) during years 1999 through 2005 are depicted in Fig. 9[9], taking into account that the shallow-set fishery closed in April 2001, and re-opened in April 2004.

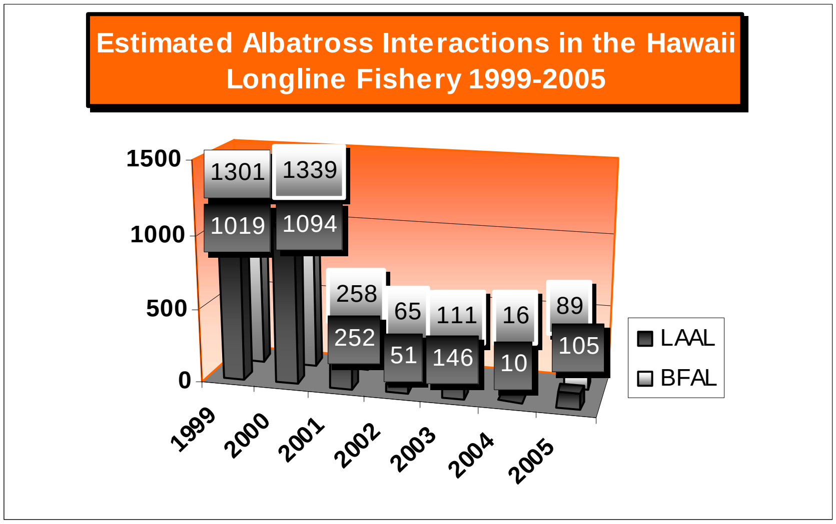

Figure 9. Estimated fleet-wide incidental interactions of black-footed and Laysan albatrosses in the Hawaii longline fishery during, 1999-2005.
(Source: NMFS PIRO)

[9] The deep-set and shallow-set components of the Hawaii longline fishery are combined in this figure because seabird interaction numbers were calculated in terms of one fishery until April 2004, when the swordfish fishery reopened. At this time the fishery was separated into two components and seabird interaction rates were calculated separately as well.

9.0 Protected Species Workshops in 2005

The Protected Species Workshops have been conducted by PIRO, Sustainable Fisheries Division (PIRO SFD) annually since 2000. Workshops are mandatory for all longline vessel operators and owners with a Hawaii or American Samoa longline limited entry permit, and recommended for all vessel operators with a general longline permit. 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 other agencies, including USFWS, PIFSC, and NMFS Office for Law Enforcement (OLE), and other PIRO divisions involved with the Hawaii longline fishery, including the Observer Program and the Protected Resources Division. This collaborative effort between the agencies has led to informative and successful Protected Species Workshops.

The workshops present information on seabird, sea turtle, and marine mammal identification and life history, mitigation techniques, and current regulations; and any advancements in sea turtle research, including gear modification experiments. Participants receive workbooks containing current regulations, copies of presentations, and information placards. Written materials and video presentations are translated into Vietnamese, Korean, Samoan, and Tagalog, which are the predominant languages of captains and crews of Hawaii longline vessels.

In 2005, NMFS presented the Protected Species Workshops to 287 longline vessel operators and owners in Hawaii and American Samoa (Fig. 10).

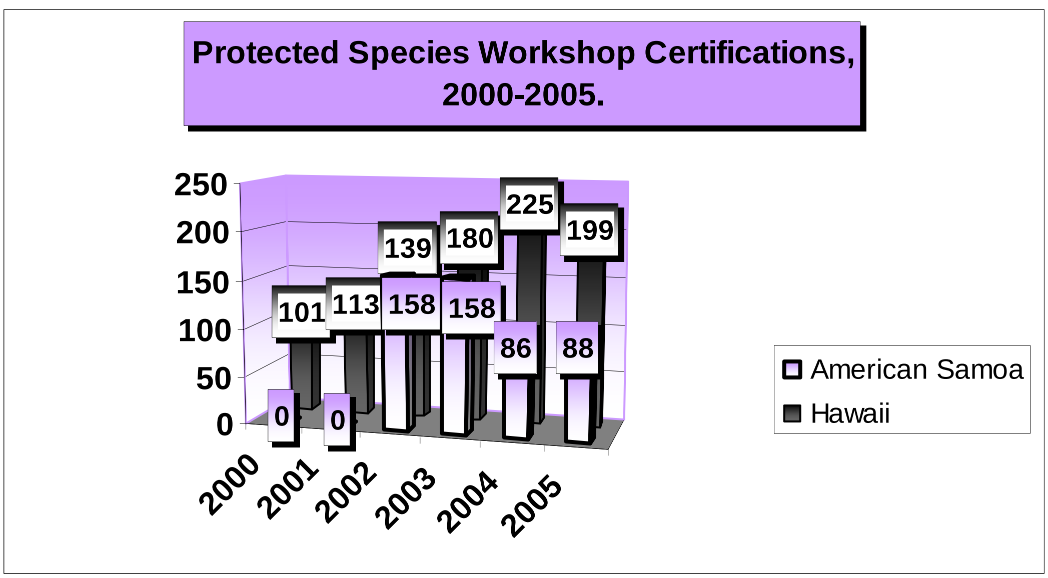

Figure 10. Protected Species Workshop certifications for Hawaii-based and American Samoa longline fishermen, 2000-2005.
(Source: NMFS/PIRO)

10.0 Summary

In 2005, total observer coverage averaged 34.4% (26.1% for deep-setting vessels and 100% for shallow-setting vessels; 4,585 of 18,083 total sets), and 41.9% coverage for longline vessels operating north of 23° N. latitude (32.1% for deep-setting vessels and 100% for shallow-setting vessels; 3,847 of 6,081 total sets).

No interaction was observed or reported with a STAL in the Hawaii longline fishery, either by deep-setting or shallow-setting vessels, during 2005. However, in 2005, the shallow-set fishery was observed to interact with seven BFALs and 62 LAALs. In the deep-set fishery it was estimated that there were 82 BFAL and 43 LAAL interactions. The interaction estimates for the 2005 deep-set fishery were high in part due to fluctuations in observer coverage per quarter throughout the year. Interaction estimates are computed on a quarterly basis, and observer coverage can skew the estimated seabird bycatch rate if one quarter has low observer coverage. Therefore, in 2005, an increase in swordfish effort (shallow-setting vessels, which require 100% observer coverage) and low observer coverage on deep-setting vessels in the first quarter, most likely accounted for the increase in seabird bycatch numbers from 2004.

NMFS observer and logbook data indicate that for the most part the fleet was in compliance with required seabird mitigation regulations in 2005. Regulatory changes appear to have significantly changed the fleet’s effort, spatial distribution of fishing effort, and the amount and composition of incidental seabird bycatch. Accordingly new seabird regulations that became effective as of January 18, 2006, are expected to result in a decrease in seabird bycatch rates in 2006. Also, as of March 20, 2006, the shallow-set component of the Hawaii longline fishery closed for the remainder of the calendar year, due to reaching the authorized interaction limit of 17 loggerhead sea turtles, under the 2004 BiOp (NMFS 2004). Therefore, the closure of the swordfish fishery and the new seabird deterrence measures in place will most likely have an effect on seabird bycatch rates in 2006.

11.0 Literature Cited

Boggs, C.H. 2001. Deterring albatrosses from contacting baits during swordfish longline sets. Proceedings of the Symposium on Seabird Bycatch: Trends, Roadblocks and Solutions. Pacific Seabird Group, University of Alaska Sea Grant Program. AK-SG-01-01.

Brothers, N. 1995. Catching fish not birds: A guide to improving your longline fishing efficiency. Australian Longline Version. Hobard, Australia: Australia Parks and Wildlife Service. 70 pp.

_____. 1996. Longline fishing dollars and sense: Catching fish not birds using bottom set or mid-water set longlines. Tasmanian Parks and Wildlife Service, Hobart.

Brothers, N. and Gilman E. 2005. Technical assistance for Hawaii pelagic longline vessels to change deck design and fishing practices to side-set. Prepared for the Hawaii Longline Association and U.S. NOAA Fisheries Pacific Islands Fisheries Science Center. 20 October 2005, p12.

Brothers, N.P., Cooper, J., and Lokkebord, S. 1999. The incidental catch of seabirds by longline fisheries: Worldwide review and technical guidelines for mitigation. FAO Fisheries Circular No. 937. Food and agriculture Organization of the United Nations: Rome. 100p.

Flint, Beth. 2005. Hawaiian Islands National Wildlife Refuge and Midway Atoll National Wildlife Refuge – Annual Nest Counts through Hatch Year 2005. USFWS, Pacific Remote Islands National Wildlife Refuge Complex, 20pp.

Gilman E., Brothers N., Kobayashi D. In Press. Comparison of the efficacy of three seabird bycatch avoidance methods in Hawaii pelagic longline fisheries. *Fisheries Science*.

Gilman, E., Brothers, N., Kobayashi, D. 2005. Principles and approaches to abate seabird bycatch in longline fisheries. *Fish and Fisheries* 6(1): 35-49.

Gilman, E. 2004. Assessment of data collection protocols by the Hawaii pelagic longline onboard Observer program to assess effectiveness of strategies to reduce seabird bycatch and comparison of seabird bycatch rates for the Hawaii pelagic longline tuna vessels side-setting, stern-setting, and using blue-dyed bait, and stern-setting with no seabird avoidance methods for the period 15 August 2003-26 October 2004. Prep. for the Western Pacific Regional Fishery Management Council. Honolulu.

Gilman, E., Boggs, C., and Brothers, N. 2003. Performance assessment of an underwater setting chute to mitigate seabird bycatch in the Hawaii pelagic longline tuna fishery. *Ocean and Coastal Management* 46(11-12): 985-1010.

Hasegawa, H. 1979. Status of the STAL of Torishima and in the Senkaku Retto in 1978/79. *Pacific Seabird Group Bull*. 6(1): 806-814.

McCracken, Marti L. 2006. Estimation of incidental interactions with sea turtles, seabirds, and marine mammals in the 2005 Hawaii deep-set fishery. Pacific Islands Fisheries Science Center, NMFS, NOAA, Honolulu, HI.

McNamara, B., Torre, L., and Morgan, K.H. 1999. Final report: Hawaii longline seabird mortality mitigation project. Report prepared by Garcia and Associates for the Western Pacific Fishery Management Council. 93 pp + appendixes.

National Marine Fisheries Service. 1999. *Biological Assessment: Effects of the Hawaii domestic longline fishery on the STAL around the Hawaiian Islands*. Pacific Islands Area Office, National Marine Fisheries Service, February 1999. 40p.

_____. 2001a. Final Environmental Statement: Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region. March 30, 2001.

_____. 2001b. Hawaii Longline Observer Program Field Manual. Southwest Region, Pacific Islands Area Office, Honolulu, Hawaii.

_____. 2004. Biological Opinion on the Western Pacific Pelagics FMP. NMFS Pacific Islands Regional Office, February 23, 2004. 252pp.

_____. 2005a. Biological Opinion on the Hawaii-based pelagic, deep-set longline fishery. NMFS Pacific Islands Regional Office, October 4, 2005. 187pp.

_____. 2005b. Final Environmental Impact Statement: Seabird Interaction and Avoidance Methods under the Fishery Management Plan on Pelagics Fisheries of the Western Pacific Region and Pelagic Squid Fishery Management under the Fishery Management Compliance Act. NMFS Pacific Islands Regional Office, April 2005. 602pp.

U.S. Fish and Wildlife Service (USFWS). 2000. BiOp of the U.S. Fish and Wildlife Service for the effects of the Hawaii Domestic Longline Fleet on the STAL (*Phoebastria albatrus*), November 2000. Honolulu, HI. 96 pp. FWS 1-2-1999-F-02.

_____. 2002. Birds of Conservation Concern 2002. US Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region, Portland, Oregon.

_____. 2002. Revised BiOp of the U.S. Fish and Wildlife Service for the effects of the Hawaii Domestic Longline Fleet on the STAL (*Phoebastria albatrus*), November 2002. Honolulu, HI. 30 pp. FWS 1-2-1999-F-02R.

_____. 2004. BiOp on the Effects of the Reopened Shallow-Set Sector of the Hawaii Longline Fishery on the STAL (*Phoebastria albatrus*), October 2004. Honolulu, HI. 129 pp. FWS 1-2-1999-F-02.2.

Western Pacific Regional Fishery Management Council (WPRFMC). April 2003. Pelagic fisheries of the Western Pacific region, 2001 Annual report. Honolulu, HI.

12.0 Acknowledgements

Dr. Marti McCracken of the Pacific Islands Fisheries Science Center provided the 2005 interaction estimates for protected species incidentally caught in the Hawaii longline fishery. Eric Gilman of the Blue Ocean Institute provided input on the effectiveness of seabird deterrence measures. Tom Swenarton of the Pacific Islands Region Hawaii Longline Observer Program provided the Hawaii longline effort plots. Dr. Holly Freifeld of the U.S. Fish and Wildlife Service provided the current status of albatross populations. Kim Rivera, National Seabird Coordinator, NOAA Fisheries, provided input on albatross life history trends.

13.0 Appendices

Appendix 1: Characteristics of the swordfish fishery versus the tuna fishery.

Table 5. Characteristics of the shallow-set (swordfish-targeting) and deep-set (tuna-targeting) components of the Hawaii longline fishery.

Characteristics	Swordfish-targeting	Tuna-targeting
Set depth	Shallow (~ 40 m)	Deep (~100-300 m)
Hook type	18/0 Circle hook with a 10° offset	Tuna "J" hook (3.6 or 3.8 mm)
Bait	Mackerel type (e.g. saury)	Saury
Lightsticks used?	Yes	No
Set deployment/retrieval	Night/Morning	Morning/Night
No. hooks between floats	4 - 6	15 - 30
Approx. no. hooks per set	800	2,000 to 3,000

Appendix 2: Interactions estimates with incidentally caught sea turtles, seabirds, and marine mammals in the Hawaii longline deep-set fishery.

Estimation of Incidental Interactions with Sea Turtles, Seabirds, and Marine Mammals in the 2005 Hawaii Longline Deep Set Fishery[1]

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 by the Hawaii longline deep set fishery in the year 2005 (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 a certificate for swordfishing.

The interaction estimates are based on a random sample of longline trips on which scientific observers were deployed. In 2005, observed trips were selected using two sampling schemes. 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 did not leave within a reasonable amount of time, the observer was usually reassigned to a different trip. When the selected vessel was ready to depart an observer was assigned to it.

Because the number of observers was limited, it was impractical to achieve the full targeted coverage under the systematic design. The sample selected under the systematic design was slightly under the targeted coverage, typically 5% under. The additional trips needed to reach the targeted level were then 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 needed to be assigned to a trip. 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 accommodate observers. The additional samples drawn under the secondary sampling scheme depart from traditional probability samples, however, because the days when additional samples were drawn were not randomly selected but determined by the need to sample additional trips.

---

[1] PIFSC Internal Report IR-06-006
Issued 19 April 2006

Because the systematic sample was selected quarterly, point estimates of incidental interactions were computed on a quarterly basis and then summed for the year's total estimate. All observed incidental interactions on a trip were assigned to the quarter when the vessel returned to port after completing the trip. The contractor's sampling records were used to approximate sampling probabilities. The sampling probabilities during the periods when additional (secondary) samples were drawn were computed by enumerating the number of call-ins during consecutive periods of comparable coverage. It was then assumed that the additional trips 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, 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 4 April 2006.

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.

During the third and fourth quarter of year 2005, several vessels participated in an experiment that involved alternating, within a set, between circle hooks and the hook type the vessel normally used. All trips involved in this experiment had an observer onboard. Because the protocol for this experiment fell under the current legal practices for this fishery, these trips were considered to be part of the Hawaii Longline Deep Set Longline Fishery activity. Because these trips had 100% coverage they were not part of the random sampling scheme. To estimate the total incidental interactions for all deep set longline fishing activity, the total observed interactions from these experimental trips were added to the total estimated number of interactions for trips subject to the random sampling scheme; i.e., all trips not participating in the experiment.

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 2005.

	Quarter 1		Quarter 2		Quarter 3		Quarter 4		Annual Total
	Number of Incidental Interactions								
Species	**Point Estimate**	**C.I.**	**Point Estimate**	**C.I.**	**Point Estimate**	**C.I.**	**Point Estimate**	**C.I.**	**Point Estimate**
Turtles									
Loggerhead	0	[0,16]	0	[0,19]	0	[0,10]	0	[0,15]	0
Leatherback	0	[0,16]	0	[0,19]	0	[0,10]	4	[1,19]	4
Olive Ridley	0	[0,16]	0	[0,19]	1	[1,11]	15	[3,35]	16
Green	0	[0,16]	0	[0,19]	0	[0,10]	0	[0,15]	0
Albatrosses									
Black-footed	68	[25,115]	11	[2,37]	0	[0,10]	3	[1,18]	82
Laysan	43	[11,85]	0	[0,19]	0	[0,10]	0	[0,15]	43
Dolphins									
Spotter	0	[0,16]	0	[0,19]	0	[0,10]	0	[0,15]	0
Spinner	0	[0,16]	0	[0,19]	0	[0,10]	0	[0,15]	0
Bottlenose	0	[0,16]	0	[0,19]	0	[0,10]	0	[0,15]	0
Risso	0	[0,16]	0	[0,19]	3	[1,14]	0	[0,15]	3
Whales									
Pilot	6	[1,24]	0	[1,19]	0	[0,11]	0	[0,15]	6
Humpback	0	[0,16]	0	[0,19]	0	[0,11]	0	[0,15]	0
False	0	[0,16]	0	[0,19]	3	[1,14]	3	[1,18]	6
Sperm	0	[0,16]	0	[0,19]	0	[0,10]	0	[0,15]	0
Beaked	0	[0,16]	0	[0,19]	0	[0,10]	6	[1,23]	6