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Annual Report on Seabird Interactions and Mitigation Efforts
in the Hawaii-based Longline Fishery for
Calendar Year 2003

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

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Annual Report on Seabird Interactions and Mitigation Efforts in the Hawaii based Longline fishery for Calendar Year 2003

for

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1. Introduction

In the western Pacific region, the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NOAA Fisheries), through its Pacific Islands Regional Office (PIRO) has the lead responsibility 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. Together PIRO, PIFSC, and U.S. Fish and Wildlife Service (FWS) work cooperatively with the WPFMC to prevent and mitigate the bycatch of protected species, including seabirds, by U.S. domestic fisheries governed under the fishery management plans[2].

Seabird mitigation measures, authorized under the Magnuson-Stevens Fishery Conservation and Management Act, are prescribed in fishery management plans governing fisheries operating in the U.S. exclusive economic zone (EEZ) and international waters of the U.S. Pacific Islands region. To assess possible impacts of the Hawaii-based pelagic longline fishery to the endangered Short-tailed albatross (*Phoebastria albatrus*) population, a "Biological Opinion (BiOp) on the effects of the Hawaiian Longline Fishery on the Short-tailed Albatross" was finalized November 28, 2000 [FWS 1-2-1999-F-02; Service, 2000] with one revision submitted November 18, 2002 [FWS 1-2-1999-F-02R; Service, 2002].

As per the requirements of the BiOps (Service, 2000; 2002), NMFS/PIRO must annually report any observed interactions of Short-tailed albatross with the Hawaii-based pelagic longline fishery, and any observed and estimated total number of interactions with Laysan (*Phoebastria immutabilis*) and black-footed (*Phoebastria nigripes*) albatross by set type[3]. In addition, NOAA Fisheries must report on the status of observer coverage, provide assessments of the effectiveness of required seabird deterrents, and summarize the results of the Protected Species Workshops. This report includes the reporting

[1] American Samoa, Guam, Hawaii, Northern Mariana Islands, and the U.S. Pacific remote island area consisting of Howland Island, Baker Island, Jarvis Island, Johnston Atoll, Midway Island, Kingman Reef, Palmyra Atoll, and Wake Island as well as the high seas.

[2] Fishery management plans are developed by the WPFMC and if approved by the Secretary of Commerce; implemented as final regulations by NOAA Fisheries/PIRO. At present there are five fishery management plans governing western Pacific fisheries: pelagics, bottomfish/seamount groundfish, crustaceans, precious corals, and coral reef ecosystems.

[3] NOAA Fisheries described tuna and/or swordfish set type.

requirement for the Hawaii-based pelagic longline fishery operating during calendar year 2003.

2. Species of Concern: Short-tailed Albatross

The short-tailed albatross (STAL) is the largest of the Northern Hemisphere albatross species. They are long-lived, slow to mature, acquire adult plumage with maturity, and may be identified by distinctive pink bills. Short-tailed albatross 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, King 1981). During the beginning of the 20th century, the species declined in numbers to near extinction, resulting primarily from direct harvest at breeding colonies in Japan. They began recovering during the 1950's and since then, due to habitat management and stringent protection, the population has gradually increased approximately 6% per year (Service, 2000). Today the only known, currently active breeding colonies of short-tailed albatross are on Torishima and Minami-kojima islands, Japan. The current worldwide STAL population is approximately 1,990 individuals (P. Siebert, 2004).

3. The Hawaii-based Pelagic Longline Fishery

The Hawaii-based pelagic longline fishery is the largest commercial fishery managed under the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region (FMP) (NMFS 2001a). Prior to 1999, broadbill swordfish was one of the major target species and important component of the Hawaii longline fishery. Beginning in late 1999 and into 2001, the fishery, especially the swordfish component, was restricted by Federal Court orders that were intended to protect threatened and endangered sea turtles taken accidentally in the fishery.

The Hawaii-based pelagic longline fishery of 2003 operated under the turtle and seabird mitigation measures that were promulgated as emergency rules (67 FR 40232, June 12, 2001) that subsequently became final June 12, 2002. The fishery operating during calendar year 2003 was exclusively a deep-set longline, “tuna-targeting” fishery. Key conservation measures (67 FR 40232, June 12, 2002) include:

- Seasonal longline area closures during April and May (from the equator to 15^{o}N and 145^{o}W to 180^o);
- A prohibition on swordfish-targeted longline fishing north of the equator;
- A trip-limit of 10 on the number of swordfish that can be taken by a Hawaii-based longline vessel fishing north of the equator;
- A ban on the possession of light sticks or other light emitting devices used as lures to attract swordfish on boats operating north of the equator;
- Gear restrictions and gear configurations:
    a) deploy longline gear such that the “sag” (deepest point) between any two floats is at least 100 m (328 ft) below the surface of the water at its deepest point;

b) a minimum of 15 branch lines deployed between any two floats; and
c) each float line (one length) must be at least 20 m (65.6 ft) long;

- Sea turtle handling measures; and
- Annual attendance at mandatory protected species workshops for vessel operators.

With respect to albatross, the most important change to the fishery resulting from the sea turtle mitigation measures, is the suspension of all swordfish-target or shallow-set longline operations by Hawaii-based longline vessels. In addition to sea turtles, the historic (pre-2000) swordfish fishery accounted for a majority of the accidental take of seabirds. The fishery employed a shallow-set longline gear configuration with baited hooks typically deployed at dusk and retrieved at dawn. In general, these are the times when albatrosses are actively engaged in foraging and feeding (Service 2000). This characteristic (in combination with other factors, Appendix 3) may have led to higher levels of interactions with longline gear.

4. *Hawaii-based Pelagic Longline Fishery Activity in 2003*

In 2003, the fishery yielded pelagic landings of 17.5 million pounds and generated ex-vessel revenues estimated at $38.7 million with tuna (*Thunnus* spp.) the dominant components of longline landings (Table 1).

Table 1. Hawaii-based Longline Fishery during 2003, catch per unit effort (CPUE), number of species caught per 1,000 hooks. Source: PIFSC unpublished data.

Year	# Tuna	# Sharks	# Billfish	# PMUS*
1999	9.21	4.59	3.90	4.80
2000	8.18	3.91	2.88	4.80
2001	8.64	2.10	1.61	4.21
2002	7.48	1.87	0.98	4.27
2003	6.33	2.32	1.77	4.58

* Pelagic Management Unit Species: mahimahi, moonfish, oilfish, pomfret, wahoo

In 2003, there were 110 active Hawaii-based longline vessels which made 1,215 trips (Table 2); almost all of which targeted tunas (Bigeye, Albacore and Yellowfin tuna). Of these trips, 404 trips occurred above 23 degrees N. Latitude (PIRO unpublished data).

Table 2. Hawaii-based Longline Fishery 1999 to 2002. Source: PIFSC unpublished data.

Year	No. Vessels	No. Trips	No. Sets	No Hooks	No. 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

5. Seabird Deterrent Methods

Numerous seabird deterrent mitigation methods have been tested and found to reduce interaction rates and/or incidental mortality of seabirds with longline fisheries (Brothers 1995; Brothers *et al.* 1999; McNamara *et al.* 1999). Although limited information exists about the effectiveness of seabird deterrents, research by McNamara *et al.*, (1999), Boggs (2001) and the PIFSC tested the deterrents in Table 3 and found them to be effective mitigation measures for use by the fishery. These deterrents were required by the Terms and Conditions in the 2000 STAL BiOp, and were initially required by the *emergency rule*s of June 2001 (Service, 2000; 66 FR 31561) and were finalized on May 12, 2002 (67 FR 34408).

Table 3. Summary of seabird deterrent methods (Service, 2000).

Seabird Deterrent Measure:	Tuna (deep) Set:
Thawed Bait	Required
Blue Dyed Baits	Required for all baits except control sets in accordance with design of experiment described under "Description of Proposed Action"
Strategic Offal Discharge	Required
Line Setting Machine with weighted branch lines (= 45gm) within one meter of the hook, or use of tarred mainline, basket-style gear deployed slack	Required
Night Sets	Optional
Towed Deterrent	Optional

The *final rules,* recommended by the WPFMC and promulgated by NOAA Fisheries, required all Hawaii longline vessels fishing north of 23^{o} N. latitude to comply with the following seabird mitigation measures (WPFMC, 2002):

- Use of thawed, blue dyed bait;
- Discard offal strategically;
- Use at least 45g weights within one meter of each hook;
- Use a line shooter or basket gear;
- Attend annual Protected Species Workshops (vessel owners and operators);
- Handle **all** seabirds in a manner that maximizes the probability of their long-term survival;
- Notify NOAA Fisheries immediately if a STAL is hooked or entangled; and
- Retain all dead STAL and submit the carcass upon return to port.

6. Observer Coverage

The two major sources of information regarding albatross interactions with the Hawaii-based pelagic longline fishery are mandatory logbooks and observer data collection programs administered by NOAA Fisheries. The longline logbook program requires longline vessel operators to complete and submit to NOAA Fisheries a daily log sheet containing detailed catch and effort data on each set, including information on interactions with protected species (50 CFR §660.14). Although the information is extensive, it does not compare to the completeness of the data collected by fishery observers placed onboard the longline fishing vessels.

NOAA Fisheries observers have been deployed aboard Hawaii-based longline fishing vessels since 1994 primarily to document protected species interactions, collect fishery-related information, and collect other information as requested by the Pacific Islands Fishery Science Center (PIFSC). A March 30, 2001, court order (taking the cue from a biological opinion issued by NMFS) required increased observer coverage to 20% of all Hawaii longline vessels. The Court's order dated 8/4/00 required 100% observer coverage north of 28° N., and gradual increase to 10% then 20% between Equator and 28° N.

Until 2001, NMFS Hawaii Longline Observer Program Field 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 not record general seabird sightings **except for** sightings of Short-tailed albatrosses although interactions with other species were to be recorded (NMFS 2001b). As of October 22, 2002, observers on vessels operating north of 23EN. latitude are required to document the setting and haulback of longline gear and record **all** seabird species present, behavior towards fishing gear and interactions (if any) with gear. In order to focus on seabird observations, observers are instructed to discontinue any other duties if seabirds are present during the haulback of the longline gear (PIRO Circular Update 55, Oct. 22, 2002).

During 2003, the observer program maintained average observer coverage of 22.2% (Table 4), and exceeded the required 5% coverage (i.e., 24%) for vessels operating north of 23˚ N. latitude (Table 5).

Table 4: Selected Performance Measures for the Hawaii Longline Observer Program, 1994-2003 (NMFS unpublished data)

Year	Number of Trips	Observed Number of Trips	Average % coverage
1994	1031	55	5.3%
1995	937	42	4.5%
1996	1062	52	4.9%
1997	1123	40	3.6%
1998	1180	48	4.1%
1999	1136	38	3.3%
2000	1134	118	10.4%
2001	1035	233	22.5%
2002	1,193	294	24.6%
2003	1,215	266	22.2%

Table 5. Observer coverage of vessels operating North of 23˚ North latitude. Source: Logbook data (NMFS/PIRO).

Year	**2000**	**2001**	**2002**	**2003**
Sets	4,265	2,856	3,594	3,776
Sets Observed (% observed)	356 (8.3)	567 (19.8)	970 (26.9)	834 (22%)
Trips	393	352	510	404
Trips Observed (% observed)	30 (7.6)	66 (18.8)	106 (20.8)	98 (24%)

7. Seabird Interactions: 2003

The following information provides the Laysan (LAAL) and black-footed albatross (BFAL), observed and estimated fleet-wide interactions with the Hawaii-based pelagic longline fishery based on observer data for calendar year 2003. In this report, as per the 2000 BiOp, a seabird interaction is any contact between a seabird and fishing activity, implying that the seabird became entangled in the line or was caught on a hook (Service, 2000). Seabird "takes" are recorded at the end of a set, during retrieval or "haul-in."

Observed

During calendar year 2003, there were 24 BFAL and 44 LAAL total observed takes during all 266 observed sets. There were no observed or recorded Short-tailed albatross interactions in the Hawaii-based pelagic longline fishery. No sightings were reported in 2003.

Table 6. Total observed black-footed (BFAL) and Laysan (LAAL) albatross takes for calendar year 2003 in the Hawaii-based pelagic longline fishery. Source: NMFS/PIRO observer data.

Species	Condition	Swordfish Sets	Tuna Sets
BFAL:	Dead	N/A	23
	Injured*	N/A	1
LAAL:	Dead	N/A	44
	Injured	N/A	0

* Injured birds released alive

Estimated

The following results on incidental takes of BFAL and LAAL are summarized from unpublished results provided by the PISFC (M. McCracken). See Appendix 1 for a complete description of the methods and applied statistical techniques. During 2003, the Hawaii-based pelagic longline fleet was estimated to have accidentally interacted with 111 BFAL and 146 LAAL (Table 7) [4]. Confidence intervals for the quarterly estimates

[4] During the first and second quarter there were a total of six research trips taking part in a NMFS research project. An observer recorded the incidental takes of BFAL and LAAL on all of these trips. Since these trips were not selected using the sampling protocol above, they are not part of the random sample. However, since the crew for three of these trips was given instructions to fish as normal the bycatch from these trips should be representative of the fleet. Therefore, these three trips were included as if they were part of the random sample. For the other three trips, the crew altered their gear as instructed and fished in close proximity to the previously mention trips. Hence, these trips were not considered part of the random sample. Instead, their incidental take was added to the estimated take in order to derive the total take. For

were computed using the approximated sampling probabilities and assuming that a species' takes per trip were independent Poisson variates 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 (unpublished, PIFSC 2003).

Table 7. Estimates of the total incidental take of black-footed (BFAL) and Laysan albatross (LAAL) in the Hawaii-based longline fishery during the four Quarters of 2003 and corresponding 95% confidence interval.
Source: PIFSC, Unpublished Data.

	Takes per Quarter				
Species	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total Takes
BFAL	28	76	7	0	111
(c.i.)	(6,58)	(36, 114)	(1, 27)	(0, 12)	
LAAL	28	118	0	0	146
(c.i.)	(6, 58)	(71, 161)	(0, 16)	(0, 12)	

The fleet-wide estimated seabird takes by the Hawaii-based pelagic longline fishery during years 1999 (included for comparison purposes) through 2003 is depicted in Figure 1. Management regulations are similar for periods 2000b and 2001a (see Appendix 2 for a summary of regulatory restrictions). The regulatory period 2001b demarcates the closure of the swordfish component and the beginning of *emergency regulations* for the Hawaii-based pelagic longline fishery. Regulations in 2003 remained unchanged.

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reference, one bottlenose take was recorded during the trips that were fished as normal, and five black-footed and eighteen Laysan albatross takes were recorded on the trips that altered their gear.

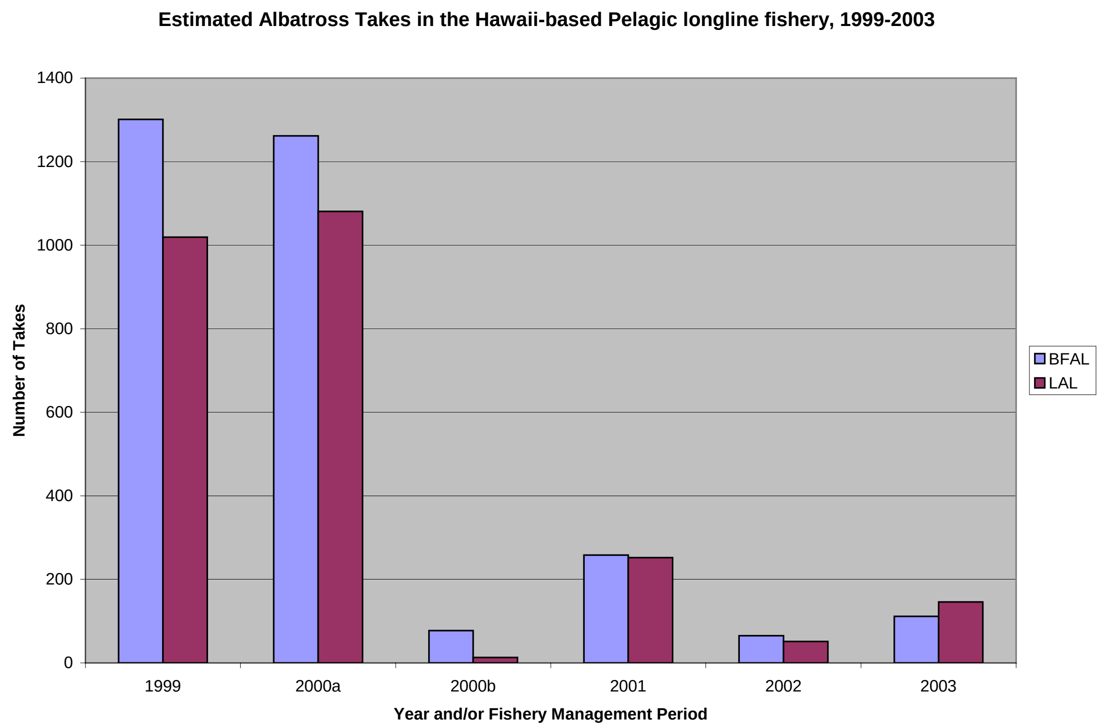

Figure 1: Estimated fleet-wide incidental take of black-footed (BFAL) and Laysan Albatross (LAAL) in the Hawaii based longline fishery during 1999-2003. 2000a=regime period 1/1-8/24 2000; 2000b = regime period 8/25-12/31 2000.

8. Protected Species Workshops

The Protected Species Workshops have been conducted by PIRO every year since 2000 and are expected to continue into the future. Workshops are mandatory for all longline vessel operators and owners with a Hawaii limited entry permit, and for all vessel operators operating with a general longline permit. Participants receive a certification card upon attendance and completion of the workshop. The card must be carried on board the vessel during fishing operations. PIRO makes a strong effort to collaborate with other agencies and groups involved with the Hawaii-based longline fishery. This collaborative effort between the agencies has led to informative and successful Protected Species Workshops.

In general, workshops consist of presentations on seabird and sea turtle identification and life history, albatross and sea turtle handling techniques, marine mammal identifications, current regulations, and current sea turtle research including satellite tagging and gear modification experiments. Workbooks containing all current regulations, copies of presentations, and informational placards are provided to all participants. Written materials and video presentations have also been translated in Vietnamese, Korean, and Samoan. In addition, some materials have been translated into Tagalog, the predominant language of some of the crews of Hawaii-based longline vessels.

180 Hawaii-based longline vessel operators and owners received certification in 2003 (Table 8). In 2003, Protected Species Workshops were also conducted in America Samoa where 100 American Samoa-based longline fishermen received certification.

Table 8. Protected Species Workshops Certifications.

Year	No. Fishers Certified
2000	101 Hawaii-based
2001	113 Hawaii-based
2002	• 158 Am. Samoa-based • 139 Hawaii-based
2003	• 158 Am. Samoa based • 180 Hawaii-based

9. Effectiveness of Mitigation Measures

Studies by McNamara *et. al.* (1999), Boggs (2001) and the PIFSC on the effectiveness of sea bird mitigation measures suggest that numerous measures have the potential to significantly reduce the incidental catch of albatrosses in the Hawaii-based pelagic longline fishery (see, Table 3). On the other hand, no mitigation measure is exclusively effective on its own (NMFS 2001a). Combining the use of mitigation measures is necessary if any single measure significantly loses its effectiveness under certain circumstances (e.g., night setting during a full moon or use of tori line in rough seas) or gradually loses its effectiveness (e.g., if seabirds become habituated to a particular towed deterrent or blue-dyed bait). Combining the use of two or more measures is likely to improve overall mitigation effectiveness, although it is uncertain by how much (NMFS 2001a).

The Hawaii-based longline fishery has been required to employ seabird mitigation measures since June 2001. These measures are part of a suite of mitigation techniques which include the use of a line shooter (or basket style gear), weighted branch lines, thawed and dyed blue bait, and strategic offal discard. Although research indicates that use of these seabird deterrents may reduce the incidental catch of albatrosses, the relative effects of these measures on the reduction in bycatch observed in the Hawaii-based longline fishery since 2000 cannot be quantified (e.g. blue-dyed bait and line shooters). Fishery operations were not designed to experimentally test deterrents. Deterrents were not utilized independently of other measures, there were no "control" sets, nor were they tested independently of changing fishery management strategies.

In general, the suspension of swordfish targeting for vessels operating north of the equator and/or other characteristics associated with swordfish style fishing (Appendix 3) may be the primary influence(s) on the low interaction rates of albatrosses with the Hawaii-based pelagic longline fishery, and not the required deterrent measures.

Another confounding factor in assessing the effects of seabird deterrents is the seasonal movements of albatross at sea. Rates cannot be directly extrapolated on an annual basis because seabird interaction rates change throughout the year as a function of their breeding biology and behavior. The low takes observed during the third and fourth Quarter of 2003 (Table 7) may be reflective of seabirds migrating northwest during post-nesting season, rather than due to implemented deterrent measures or fishery management regimes. Despite 22.2 % observer coverage, seabird interaction rates were too low for statistical significance because there were not enough observed takes to model seasonal and/or spatial trends corresponding to the nesting season and distribution of seabirds with the distribution of fishery effort.

10. Seabird Mitigation Methods and Research

A number of seabird deterrent methods have the capacity to nearly eliminate bird captures when employed effectively. However, to resolve the problem of seabird mortality in longline 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 for use, and provide crew with an incentive to employ them consistently and effectively (Gilman *et al.*, 2002).

Two research fishing trips were conducted between April 1 and May 17, 2003 on the Hawaii-based longline vessel, F.V. *Katy Mary* at grounds south of Laysan Island, Northwestern Hawaiian Islands (Gilman *et al*., 2003). The study area was selected to ensure sufficient albatross abundance to demonstrate statistically significant differences between seabird deterrent treatments' effectiveness at avoiding seabird interactions[5]. Assessments were made of each deterrent method's effectiveness at avoiding seabird interactions, practicability and convenience, effect on fishing efficiency, cost to employ, and enforceability when limited resources for enforcement are available.

In four experiments, three deterrent methods were tested in swordfish and tuna sets. They include side setting, underwater bait setting chutes (both 9m and 6.5m in length), and blue-dyed bait. See Appendix 4 for a summary of research activities (Table 15) and summary of results (Table 16). The following information is summarized from the executive summary of the most recent seabird mitigation experiments (Gilman *et al*., 2003, in review). For full description of the methods, results and analysis of these experiments please refer to the complete paper.

Side Setting

Side setting is a seabird deterrent method which entails setting gear from the side of the vessel, with other gear design the same as conventional approaches when setting from the stern. The hypothesis is that when side setting, baited hooks will be set close to the side of the vessel hull where seabirds will be unable or unwilling to attempt to pursue the hooks alongside the vessel, and by the time the hooks reach the stern, they will have sunk to a depth where seabirds cannot locate it or cannot dive to the depth needed to reach it.

This deterrent showed the highest promise of the four tested deterrent treatments. Side setting had the lowest mean seabird contact and capture rates of the deterrents tested when used with both Hawaii-based longline tuna and swordfish gear. Side setting provided a large operational benefit for certain types of vessels, and was perceived to be practicable for use by crew. Side setting resulted in high fishing efficiency relative to the other treatments, based on bait retention and hook setting rates. Side setting requires a nominal amount of initial expense to employ and can be effectively enforced via simple dockside inspections. Assessment of the feasibility of adjusting the gear to side set from various deck positions, the location of deployment of baited hooks from various side setting positions, sink rates of a range of types of baited hooks, and aspects of vessel conversion to side setting, indicates that side setting would be both feasible and effective at reducing seabird interactions on a wide range of longline vessel deck designs.

As of August 2004, nine Hawaii-based longline vessels have voluntarily converted their vessels to side setting.

[5] Breeding Laysan and black-footed albatrosses were in the latter half of their chick-rearing period during this period.

Underwater bait setting chute

Underwater setting chutes release baited hooks underwater, out of sight and reach of diving seabirds. Results from the 2002 preliminary trials conducted in Hawaii suggested that the chute showed great a deal of promise, eliminating seabird captures, reducing contacts by 95%, and reducing the birds' interest in the vessel by 39% (Gilman *et. al.*, 2002). In these recent experiments, two lengths of an underwater setting chute were tested, one 9m long and one 6.5m long, which deployed baited hooks 5.4m and 2.9m underwater, respectively.

The chutes were found to be relatively effective at reducing bird interactions but performed inconsistently and were inconvenient due to design problems. Design improvements are needed and are feasible through additional research. For instance, integrating the chute into the deck hull could address the design and consistency problems currently encountered with the chute. After side setting, the 9m chute had the next lowest mean seabird interaction rates when used with swordfish gear, while after side setting, the 6.5m chute had the next lowest mean seabird interaction rates when used with tuna gear. The underwater setting chute is a relatively expensive deterrent, costing U.S.$5,000 for the hardware, however, the chute is not commercially available for pelagic longline fisheries. Use of the underwater setting chute may be effectively enforced if combined with relevant technology such as hook counters. The chute is not yet suitable for broad commercial use, but holds high promise to minimize seabird mortality in longline fisheries.

Blue-dyed Fish Bait

A part of the proposed action described in the 2002 revised BiOp is an experiment to test the efficacy of blue-dyed saury and other fish bait as a seabird deterrent in the Hawaii-based longline fishery (Service, 2002). The fishery presently incorporates the use of line shooters and weighted branch lines in its standard gear configuration. The recent experiments were designed to quantify any added benefits of using blue-dyed bait. The two previous blue-dyed bait studies (McNamara *et. al.*, 1999; Boggs, 2001) were controls for these experiments.

Thawing and dying bait blue is an attempt to reduce a seabirds ability to see the bait by reducing the bait's contrast with the sea surface. The bait is thawed, separated, and soaked in a mixture of blue food coloring additive and sea water in an attempt to make the bait the same hue as the sea surface. It was found that blue-dyed bait was generally less effective at preventing seabird interactions than side setting and the underwater chute. Dyeing bait was impractical and inconvenient for crew, and is not employed consistently by different crew. Blue-dyed bait resulted in a relatively low fishing efficiency based on bait retention and hook setting rates. Blue-dyed bait is a relatively inexpensive deterrent method, costing about U.S.$14 per set, but does not facilitate effective enforcement. Most of the practicality, convenience, and enforceability problems could be addressed if pre-blue-dyed bait were commercially available. Currently this seabird deterrent method holds less promise of tested methods to minimize seabird mortality in longline fisheries.

11. Conclusion

In summary no Short-tailed albatross was reported taken in the Hawaii-based pelagic longline fishery (either swordfish or tuna sets) during calendar year 2003. However, during this period the fishery incidentally caught an estimated 111 black-footed and 146 Laysan albatross. Total observer coverage averaged 22.2% (3,204 of 14,560 sets), and 22 % of the longline vessels operating north of 23˚ N. latitude (834 of 3,776 sets). Gilman *et al*. (2003) found that approximately 28% fewer seabirds are hauled aboard than caught during gear deployment. Therefore estimated mortality rates for this annual report are considered conservative, since they are based on observing the haul.

NOAA Fisheries observer and logbook data reflect that the fleet was in compliance with required seabird mitigation regulations, however, a definitive statement regarding the effectiveness of the required seabird deterrents cannot be made at this time. Numerous regulatory regimes influenced the Hawaii-based pelagic longline fishery during years 2000 and 2001. However, the suspension of the swordfish component of the fishery appears to have had the most impact in reducing seabird interaction rates. These regulatory changes significantly changed the fleet's effort, spatial distribution of effort, and the amount and composition of incidental bycatch.

APPENDICIES

12.1 APPENDIX 1: The following information was supplied by the PIFSC (M. McCraken) and provides a detail description of how year 2003 seabird interaction estimates were obtained and the analyses supporting subsequent results.

This report provides the estimates of the incidental takes of protected species in the Hawaii longline fishery for the year 2003. For the purpose of this report, an incidental take refers to an animal that was hooked or entangled. A trip's incidental take was assigned to the quarter that the vessel arrived back into port after completing the trip.

During the year 2003, trips were selected using a systematic design with additional trips being selected when needed. This design has proven to be practical as the level of coverage can fluctuate since the number of observers available and the level of fishing activity fluctuates. Although a coverage level around 20% is the objective, experience has shown that a systematic sample designed for 15% coverage is typically achievable (few systematic samples missed). A new systematic sample was drawn each quarter. The additional trips necessary to achieve 20% coverage were selected when an observer needed to be employed and all the systematic samples were covered. These trips were selected with equal probability from a pool of vessels that had recently called into NMFS, as required, to report their intended departure. This additional sampling does depart from a traditional probability sample since the day when additional samples are drawn is not randomly selected but determined by the need to draw additional samples. The sampling probabilities during the periods when additional samples were drawn were computed by enumerating the number of trips calling in during the period of higher coverage and assuming 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 is below that of the anticipated systematic sample and the trips drawn by the systematic sample are not sampled and no additional trips are sampled during the time period, the sampling probabilities were computed by enumerating all trips that called in during this period and assuming that the trips sampled were selected with equal probability. Because of the additional sampling and periods of lower coverage, trips were not selected with equal probability. To estimate total take the Horvitz-Thompson was used as it takes into account unequal sampling probabilities. Confidence intervals for the quarterly estimates were computed using the approximated sampling probabilities and assuming that a species' takes per trip were independent Poisson variates 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.

During the first and second quarter there were a total of six research trips taking part in a NMFS research project. An observer recorded the incidental takes on all of these trips. Since these trips were not selected using the sampling protocol above, they are not part of the random sample. However, since the crew for three of these trips was given instructions to fish as normal the bycatch from these trips should be representative of the fleet. Therefore, these three trips were included as if they were part of the random sample. For the other three trips, the crew altered their gear as instructed and fished in close proximity to the previously mention trips. Hence, these trips were not considered part of the random sample. Instead, their incidental take was added to the estimated take in order to derive the total take. For reference, one bottlenose take was recorded during the trips that were fished as normal, and five black-footed and eighteen Laysan albatross takes were recorded on the trips that altered their gear.

12.2 **APPENDIX 2:** Summary of regulatory changes for years 2000 and 2001. For a complete analysis of results for these years, please refer to the *Annual Report on Seabird Interactions and Mitigation Efforts in the Hawaii-based Longline Fishery for Calendar Year 2000 – 2001* (Kinan, 2003 unpublished technical report).

Calendar Year 2000

During 2000, fishery data were separated into two periods, which reflect changes in fishery regulations that took place in August 2000. The actual and estimated black-footed and Laysan albatross takes in the Hawaii longline fishery are reported separately for these periods.

- Period One - January 1 to August 24, 2000 - the fleet was prohibited from fishing within the area bounded by 28E N and 44E N, 150E W and 168E W (termed "Area A"; see Figure 1).

Period Two - August 25 to December 31, 2000 - the fleet continued to be prohibited from fishing within Area A, but was also limited to no more than 154 sets (with 100% observer coverage) within the area on either side of Area A and bounded by 28E N and 44E N and 173E E to 168E W (termed “Area B”, see Figure 1). And targeting of swordfish (i.e., shallow setting) was prohibited in waters between the equator and 28E N, from 173E E to 137E W (“Area C”).

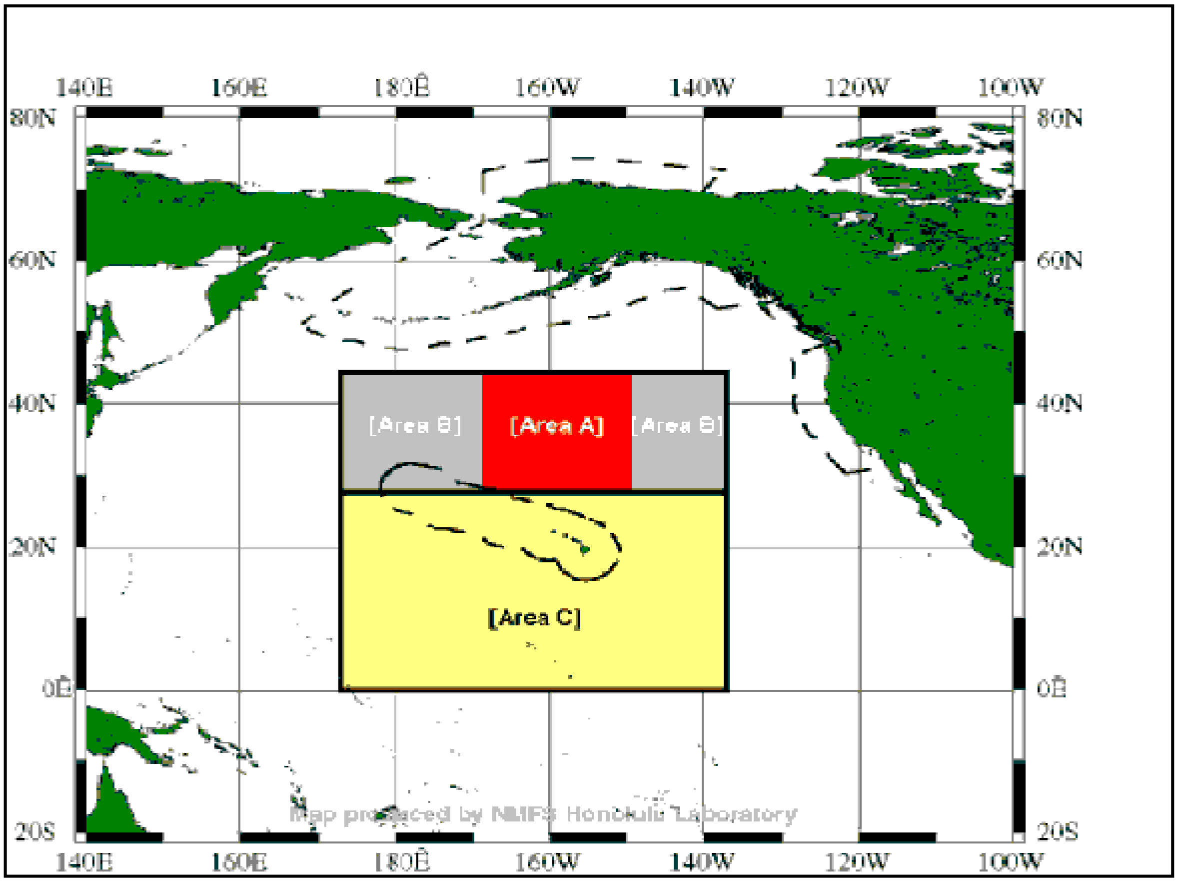

Figure 2. Map of area fishing restrictions applied to the Hawaii-based longline fishery during calendar year 2000.

Calendar Year 2001

Further fishery regulatory changes occurred in calendar year 2001. Of most relevance to seabird interactions was a prohibition on shallow-setting (i.e., targeting swordfish) for all Hawaii-based longline vessels fishing north of the equator. In addition, requirements were implemented that any vessel fishing above 23E North latitude must dye all bait blue, discard offal strategically, used weighted branch lines and either use a line setting machine or basket style longline gear to mitigate seabird interactions.

In 2001, the fishing grounds were divided into two regulatory regimes. The first regime governed the Hawaii-based longline fishery from August 25, 2000 - March 31, 2001 and therefore was applicable during the first quarter of 2001. The second regulatory regime beginning April 1, 2001 was applicable during the last three quarters of 2001 and has continued into the present.

- Regime One - The fishing grounds were split into the three management areas (A, B and C) such as during year 2000[6] (see Figure 2); each with different restrictions. All vessels operating in Area B were required to carry a NMFS observer (i.e., 100% observer coverage).

- Regime Two - Fishing was regulated by a NMFS final rule implementing the March 30, 2001 court order (66FR 18243). The fishery management areas (A, B & C) were no longer applicable. Instead, the rule implemented restrictions, closures and gear prohibitions/configurations listed in section "The Hawaii-based Pelagic Longline Fishery" (pg. 4, this document).

12.3 APPENDIX 3: Characteristics of swordfish versus tuna fishing

General characteristics of swordfish versus tuna fishing.

Characteristics	Swordfish targeting	Tuna targeting
Set depth	Shallow (~40m)	Deep (~100-300m)
Hook type	J hook	Circle hook
Bait	Squid	Saury
Lightsticks	Yes	No
Set deployment/retrieval	Dusk/Dawn	Morning/Night
General Location	North of 25^{o} N. lat.	South of 15^{o} N. lat.
No. hooks between floats	4 - 6	15 - 30
Approx. No. hooks per set	800	2,000 to 3,000

12.4 APPENDIX 4: Fishing Experiments

[6] Regime 1 was modified via emergency interim rule on November 3, 2000 (65 FR 66186), by adding management measures to expressly prohibit directed longline fishing for swordfish in Area C.

Table 15 provides a summary of the dates of the two research fishing trips, and the order of replicates by tote (also called snood bins, line boxes, or hook boxes) for each set. Four seabird deterrent experimental treatments were employed using Hawaii pelagic longline tuna and swordfish gear.

Table 15. Summary of research activities in the longline experiments.

Trip 1

Set	Date 2003	Treatment and fishing method per tote[a]				
		A	B	C	D	E
1	6 April	B sword	9 sword	S sword	S sword	S tuna
2	7 April	S sword	9 sword	B sword	9 sword	9 tuna
3	8 April	9 sword	B sword	9 sword	S sword	S tuna
4	9 April	S sword	S tuna	B sword	B tuna	B tuna
5	10 April	B sword	B tuna	S sword	S tuna	S tuna
6	11 April	S tuna	S sword	S tuna	B tuna	B sword
7	12 April	B tuna	B sword	B tuna	S sword	S tuna
8	13 April	S tuna	S sword	S tuna	B sword	B tuna
9	14 April	B tuna	B sword	B tuna	S sword	S tuna
10	15 April	B sword	B tuna	S tuna	S sword	S tuna
11	16 April	S tuna	S sword	S tuna	B sword	B tuna
12	17 April	S tuna	S tuna	S tuna	S tuna	S tuna

Trip 2

Set	Date 2003	Treatments per tote (all sets use tuna gear)[a]				
		A	B	C	D	E
1	1 May	B	9	6.5	S	6.5
2	2 May	B	6.5	9	B	9
3	3 May	6.5	S	B	S	9
4	4 May	9	Ss	6.5	S	B
5	5 May	9	B	S	S	6.5
6	6 May	6.5	S	B	S	[b]
7	7 May	6.5	9	B	S	B
8	9 May	S	B	9	6.5	S
9	10 May	9	6.5	S	B	S
10	11 May	S	S	S	B	S
11	13 May	S	B	S	S	S

[a] 6.5 = 6.5m long underwater setting chute (deploys baited hooks 2.9m underwater)
9 = 9m long underwater setting chute (deploys baited hooks 5.4m underwater)
B = Blue-dyed bait
S = side setting
"tuna" = tuna fishing gear
"sword" = swordfish fishing gear

[b] Only 4 totes deployed in this set

Table 16. Summary of average albatross abundance, total seabird contacts, total seabird captures on the set, and total seabirds hauled aboard, by deterrent treatment.

			Mean albatross abundance [a]		Total contacts		Total birds caught/set		Total birds hauled aboard			
Treatment	No.	Hooks	LA	BF	LA	BF	LA	BF	LA	BF	STS	SS
Blue-dyed bait sword gear	11	3896	19.5	8.3	223	30	15	6	6	1	0	0
Blue-dyed bait tuna gear	23	11754	27.4	7.0	265	15	19	3	12	0	1	1
Side set swordfish gear	11	4322	17.1	8.4	8	0	1	0	1	0	0	0
Side set tuna gear	32	20133	21.4	5.7	3	0	0	0	1	0	0	0
9m chute swordfish gear	5	1805	7.4	8.4	8	1	0	1	0	1	0	0
9m chute tuna gear	10	4092	22.5	6.7	42	0	0	0	7	0	0	0
6.5m chute tuna gear	10	4263	24.4	6.4	24	0	1	0	2	0	0	0

[a] LA = Laysan albatross; BF = black-footed albatross, STS = short-tailed shearwater, SS = sooty shearwater

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