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June, 2005

Regulatory Amendment 5 to the Pelagics Fishery Management Plan was transmitted to NMFS on April 7, 2005 and as of June 2005 is awaiting approval and implementation.

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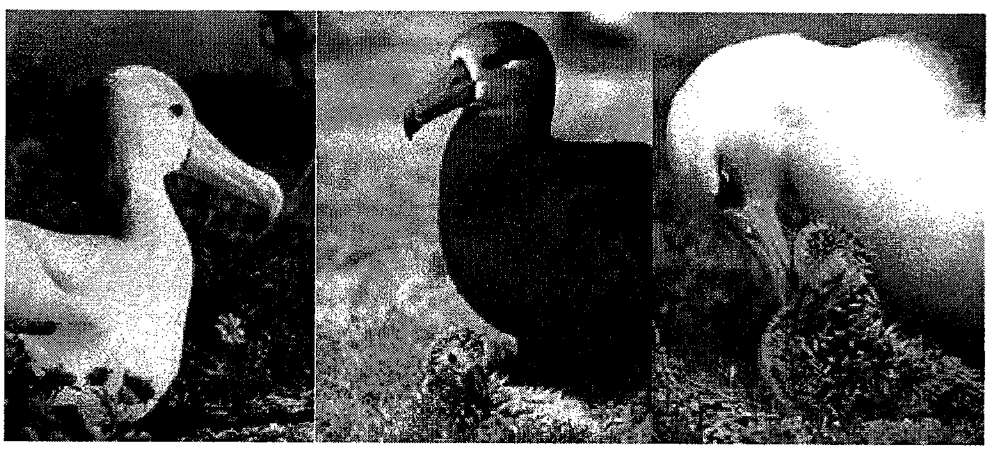
Additional Measures to Reduce the Incidental Catch of Seabirds in the Hawaii-Based Longline Fishery

A Regulatory Amendment to the Fisheries Management Plan for the Pelagic Fisheries of the Western Pacific Region



April 6, 2005
Western Pacific Regional Fishery Management Council
1164 Bishop St., Suite 1400
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2.0 Summary

Hawaii-based pelagic longline fishing vessels inadvertently hook, entangle and kill black-footed albatrosses (*Phoebastria nigripes*) and Laysan albatrosses (*Phoebastria immutabilis*) that nest in the Northwestern Hawaiian Islands (NWHI). On rare occasions wedge-tailed and sooty shearwaters are also incidentally caught by these vessels. However, there are no observations or reports of interactions between the fishery and the endangered short-tailed albatross (*Phoebastria albatrus*). The number of fishery interactions with all seabirds has been significantly reduced since 2000, due to the closure of the swordfish segment of the Hawaii-based longline fishery, and the implementation of new seabird mitigation measures based on research conducted cooperatively by fishery participants, environmental organizations, and the National Marine Fisheries Service (NMFS, also known as NOAA Fisheries).

In October 1999, the Western Pacific Fishery Management Council (Council, also known as the Western Pacific Regional Fishery Management Council) recommended three measures to mitigate the harmful effects of fishing by vessels registered for use under Hawaii longline limited access permits (Hawaii-based longline vessels) on seabirds. The first measure required vessel operators fishing with longline gear north of 25° N. latitude to employ two or more of the following seabird deterrent techniques: 1) maintain adequate quantities of blue dye on board and use only completely thawed, blue-dyed bait; 2) discard offal while setting and hauling the line in a manner that distracts seabirds from hooks; 3) tow a NMFS-approved deterrent (such as a tori line or a buoy) while setting and hauling the line; 4) deploy line with line-setting machine so that the line is set faster than the vessel's speed and attach weights equal to or greater than 45 grams to branch lines within one meter of each hook; 5) attach weights equal to or greater than 45 grams to branch lines within one meter of each hook; 6) begin setting the longline at least one hour after sunset and complete the setting process at least one hour before sunrise, using only the minimum vessel's lights necessary for safety. The second measure directed vessel operators to make every reasonable effort to ensure that birds brought onboard alive are handled and released in a manner that maximizes the probability their long-term survival as directed by seabird handling guidelines. The final measure required all vessel owners and operators to annually complete a protected species educational workshop conducted by NMFS.

On July 5, 2000, NMFS published a proposed rule for the Hawaii-based longline fishery based on the Council's recommended measures. However, the agency did not proceed with the publication of a final rule, as the USFWS had indicated it was developing a Biological Opinion (BiOp) for the fishery action under section 7 of the Endangered Species Act (ESA) for the short-tail albatross. This endangered species has been documented in small numbers in the NWHI, and the USFWS BiOp, published on November 28, 2000, concluded that the Hawaii-based longline fishery as proposed was not likely to jeopardize the continued existence of the short-tailed albatross. Nevertheless, it included several non-discretionary measures to be employed by the Hawaii-based longline fishery and implemented by NMFS. In contrast to the Council's recommendation requiring the use of any two of the six approved deterrents when fishing north of 25° N., the 2000 USFWS BiOp required that all Hawaii-based vessels operating with longline gear north of 23° N. latitude use thawed blue-dyed bait and discard offal strategically to distract birds during setting and hauling of longline gear. In addition, when making deep sets (targeting

tuna) north of 23° N. latitude, Hawaii-based vessel operators were required to employ a line-setting machine with weighted branch lines (a weight of at least 45 g placed within one meter of each hook). All longline vessel operators and crew were also required to follow certain handling techniques to ensure that all seabirds would be handled and released in a manner that maximizes the probability of their long-term survival, and vessel operators were required to annually complete a protected species educational workshop conducted by NMFS. Optional mitigation measures include towed deterrents, or the use of weighted branch lines without a line-setting machine (in the case of swordfish or mixed target sets). In addition, operators of Hawaii-based vessels making shallow sets (targeting swordfish) north of 23° N. were required to begin the setting process at least one hour after sunset and complete the setting process by sunrise.

Emergency and final regulations implementing seabird mitigation measures for the Hawaii-based longline fishery were promulgated on June 12, 2001 and May 14, 2002, respectively. However, the requirements regarding shallow-set longlining north of 23° N. latitude were not implemented by NMFS as, for the purpose of minimizing effects of the fishery on threatened and endangered sea turtle species, on March 31, 2001, by order of the court NMFS prohibited all shallow-set pelagic longline fishing for swordfish north of the equator by Hawaii-based vessels.

The March, 2001 closure of the shallow set longline component of the fishery led NMFS to reinitiate consultation with the USFWS to examine the impacts of the reduced fishery on short-tailed albatrosses. The subsequent USFWS 2002 BiOp was released November 18, 2002, and again concluded that the Hawaii-based longline fishery was not likely to jeopardize the continued existence of the short-tailed albatross.

In 2003 new information, experimental results and technological advances in longline gear design that concern interactions between the fishery and sea turtles prompted the Council recommend new measures for the Hawaii-based fishery. As a result current regulations allow a limited amount (2,120 sets annually) of shallow-set longline effort by Hawaii-based swordfish vessels using circle hooks with mackerel-type bait. Because this action allowed limited shallow-setting, it also implemented the USFWS 2000 BiOp requirement that any shallow-setting occurring north of 23° N. latitude be done at night. Final regulations implementing these recommendations were promulgated on April 2, 2004

Based on NMFS' extrapolations from observer data during 1999 the fleet is estimated to have brought onboard 2,320 hooked or entangled albatrosses (1,301 black-footed and 1,019 Laysan), while in 2002 the fleet is estimated to have brought onboard 113 hooked or entangled albatrosses (65 black-footed and 51 Laysan), and 257 albatrosses (111 black-footed and 146 Laysan) in 2003.Although vessel and observer records indicate that some birds are released alive it is unknown how long they actually survive and a worst-case scenario would assume that all albatrosses brought onboard represent mortalities. The increase between 2002 and 2003 may be related to the increase in nesting populations of black-footed and Laysan albatrosses in the Northwestern Hawaiian Islands (NWHI) (a 7.2% increase in active black-footed albatross nests on Midway Atoll as compared to 2001 and a 53.9% increase in Laysan albatross nests on Midway as compared to 2001). In addition, the USFWS has reported that worldwide populations of short-tailed albatrosses are increasing at more than 7% per year. The most recent information indicates that NWHI nesting numbers for both species have remained stable since 1991 (USFWS 2005).

A series of cooperative research trials with new mitigation methods were conducted between 2002 and 2003 on Hawaii-based longline vessels. The trials found that underwater setting chutes (which deploy baited hooks underwater and out of the reach of seabirds) and side setting (which deploys the longline laterally from amidships, rather than directly over the stern), were both effective in reducing interactions with seabirds. This document examines a range of alternatives that would allow or require the use of one or more of these techniques to cost-effectively further reduce seabird interactions with the Hawaii-based fishery. Also examined is the use of tori lines (also known as streamer or bird scaring lines) which have been found to be effective in reducing seabird interactions in the Alaska demersal longline fishery.

Two assumptions were made in crafting the alternatives, which are summarized in Table I. First, that the 'no action' alternative means maintaining the suite of measures currently required (by FMP regulations and by the requirements of the US Fish and Wildlife Service's 2000 and 2002 BiOps which were in effect during the time this amendment was being developed). Second, that these current measures are an option in those alternatives offering a choice of mitigation measures (e.g. fishermen can elect to maintain operating under the current suite of measures or use side setting).

Table I. Seabird mitigation measures included in each alternative. (Current requirements for annual protected species workshop attendance and seabird handling protocols would remain in place under all alternatives.)

Alt.	Description
1	CURRENT MEASURES **All Hawaii-based longline vessels** fishing north of 23° N. must: Discharge offal and spent bait on the opposite side from setting or hauling Use blue-dyed, thawed bait, and have a minimum of 2 cans of dye onboard **Vessels deep-setting** north of 23° N. must use a line setting machine (line shooter) and use minimum 45g weights within 1m of each hook, if using a monofilament main line[1] **Vessels shallow-setting** north of 23° N must begin setting at least 1 hour after local sunset and complete the setting process by local sunrise, using the minimum vessel lights necessary
2A	Use current mitigation measures **OR** use side setting, when fishing north of 23° N.
2B	Use above current mitigation measures **OR** use side setting, in all areas
3A	Use current mitigation measures **OR** use an underwater setting chute, when fishing north of 23° N.
3B	Use current mitigation measures **OR** use an underwater setting chute, in all areas
4A	Use current mitigation measures **OR** use a tori line (e.g. paired streamer lines), when fishing north of 23° N.
4B	Use current mitigation measures **OR** use a tori line (e.g. paired streamer lines), in all areas
5A	Use current mitigation measures **OR** use side setting **OR** use an underwater setting chute, when fishing north of 23° N.
5B	Use current mitigation measures **OR** use side setting **OR** use an underwater setting chute, in all areas
6A	Use current mitigation measures **OR** use side setting **OR** use an underwater setting chute **OR** use a tori line (e.g. paired streamer lines), when fishing north of 23° N.
6B	Use above current mitigation measures **OR** use side setting **OR** use an underwater setting chute **OR** use a tori line (e.g. paired streamer lines), in all areas

Table I. Seabird mitigation measures included in each alternative. (Current requirements for annual protected species workshop attendance and seabird handling protocols would remain in place under all alternatives.)

7A	Use current mitigation measures **OR** use side setting **OR** use a tori line (e.g. paired streamer lines), when fishing north of 23° N.
7B	Use current mitigation measures **OR** use side setting **OR** use a tori line (e.g. paired streamer lines), in all areas
7C	a. In all areas, shallow setting boats use current mitigation measures, excluding the requirement to use blue-dyed bait, OR use side setting **OR** use an underwater setting chute **OR** use a tori line (e.g. paired streamer lines). b. North of 23° N. deep setting boats use current mitigation measures, excluding the requirement to use blue-dyed bait, **OR** use side setting **OR** use an underwater setting chute **OR** use a tori line (e.g. paired streamer lines), in conjunction with a line shooter and weighted branchlines.
7D	a. All deep setting vessels must either side-set, or use a tori line plus the currently required measures (line shooter with weighted branch lines, blue dyed thawed bait and strategic offal discards) when fishing north of 23 ° - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present; AND b. All shallow setting vessels must either side-set, or use a tori line plus the currently required measures (night setting, blue dyed thawed bait and strategic offal discards) wherever they fish - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present.
8A	Use current mitigation measures **PLUS** side setting, when fishing north of 23° N.
8B	Use current mitigation measures **PLUS** side setting, in all areas
9A	Use side setting when fishing north of 23° N.
9B	Use side setting in all areas
10A	Use side setting **UNLESS** technically infeasible in which case use current mitigation measures, when fishing north of 23° N.
10B	Use side setting **UNLESS** technically infeasible in which case use above current mitigation measures, in all areas
11A	Use side setting **UNLESS** technically infeasible, in which case use an underwater setting chute **OR** a tori line **OR** current mitigation measures without blue bait or strategic offal discards (shallow-setting vessels set at night, deep-setting vessels use line shooters with weighted branch lines), when fishing north of 23° N.

Table I. Seabird mitigation measures included in each alternative. (Current requirements for annual protected species workshop attendance and seabird handling protocols would remain in place under all alternatives.)

11B	Use side setting **UNLESS** technically infeasible, in which case use an underwater setting chute **OR** a tori line **OR** above current mitigation measures without blue bait or strategic offal discards (shallow-setting vessels set at night, deep-setting vessels use a line shooter with weighted branch lines), in all areas
12	Voluntarily use side setting, **OR** night setting, **OR** an underwater setting chute, **OR** a tori line, **OR** a line shooter with weighted branch lines, when fishing south of 23° N.

1. Basket gear may also be used if deep set longline fishing above 23° N., with a requirement that the mainline be set slack to maximize the sinking of baited hooks

Table II presents a summary evaluation of the various mitigation measures considered here. Most methods are very effective at reducing contacts with gear and capture of seabirds, achieving 80% reductions or greater, as compared to fishing without any seabird mitigation measures. Caution should be exercised in comparing between different techniques, since they were tested under a variety of different conditions and seabird densities on different fishing platforms, and under different experimental protocols. As such, the ranking of deterrent measures in Table II is somewhat subjective. Moreover the variances about the point estimates are very wide and overlapping in many cases (Christofer Boggs, PIFSC, personal communication), and thus other factors as discussed below also need to be considered when deciding on the preferred alternative.

The ideal measure or technique for mitigating interactions with seabirds should minimize seabird capture, achieve high compliance among the fishing fleet, , be perceived as cost-effective, not be overly dependent on crew behavior and work consistently across a range of variables such as time, location, weather, sea state, seabird density etc. Table II is summarized from a more detailed summary of the various mitigation research observations in Appendix 1, while the details of the evaluation of the estimated costs, operational, compliance and enforcement characteristics of the different measures is contained within Section 10.6.8.

A comparison of the alternatives requires examination of both the effectiveness of the required measures in reducing seabird interactions, and their impacts on other marine resources and fishery participants. None of the alternatives examined here are anticipated to have regionally significant impacts on fishing operations or catches and for that reason no impacts on other marine resources are expected. In general, alternatives which allow greater flexibility are preferred by fishery participants as they allow for a variety of techniques to be used based on vessel capabilities, operator experience, and local conditions. To the extent that this promotes voluntary compliance, such alternatives are preferable. In addition, fishery participants are aware that their cooperative research has already led to significant reductions in seabird interactions and maintaining this collaborative attitude through the implementation of cost-effective and flexible measures will also likely promote voluntary compliance.

Table II. Summary of Qualitative Appraisals and Costs of Deterrent Measures
(●= good; ●●= better; ●●●=best)

Mitigation Measure	Evaluation Parameters		
	Operational Characteristics	**Cost/Vessel**	**Compliance and Enforcement**
Thawed blue-dyed bait TBDB)	●●	$1,400 annual	●
Strategic offal discards (SOD)	●◖	$150 initial plus $150 annual	●
Line shooter with weighted branch lines (on tuna vessels)	●●●	already purchased	●●●
Tori line (TL)	●	$3,300 initial plus $4,600 annual (2 lines)	●
Night setting (on swordfish vessels) (NS)	●●	$0	●●
Underwater setting chute (USC)	●	$6,000 initial	●
Side setting (+ 60g swivels within 1m of the hook) (SS)	●●◖	$4,000 initial plus $50 annual	●●●

At its 123rd meeting in June, 2004, the Council reviewed a draft of the material presented here and took initial action by selecting alternative 7C as its preliminary preferred alternative. At its 124th meeting (October 12-15, 2004), the Council took final action and recommended the following action to NMFS:

All shallow-setting longline vessels, wherever they fish, be required to either use side setting, or to use all of the following measures simultaneously: night setting, blue bait, offal discards, and tori lines.

All deep-setting longline vessels, when fishing north of 23 deg N, be required to either use side setting, or to use all of the following measures simultaneously: a line shooter with weighted branch lines, blue bait, offal discards, and tori lines.

The Council will use the period of the regulatory process to collect supplementary data on bird behavior and coordinate with the USFWS to remove the requirement for blue dyed thawed bait and offal discards, if appropriate.

A letter received by the National Marine Fisheries Service (NMFS) from the US Department of the Interior (dated October 15, 2004, but delivered after the 124th Council meeting), stated that blue dyed bait and strategic offal discards should be retained as mitigation measures. However, the letter further suggested that strategic offal discards should be used by longline vessels only when seabirds were present.

Thus the Council's final preferred alternative (7D) is as follows:

A) All deep setting Hawaii-based longline vessels must either side-set, or use a tori line plus the currently required measures (line shooter with weighted branch lines, blue dyed thawed bait and strategic offal discards) when fishing north of 23 ° - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present;

AND

B) All shallow setting Hawaii-based longline vessels must either side-set, or use a tori line plus the currently required measures (night setting, blue dyed thawed bait and strategic offal discards) wherever they fish - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present.

3.0 Table of Contents

3.1 List of Tables

3.2 List of Figures

3.3 List of Acronyms

CFR	Code of Federal Regulations
CNMI	Commonwealth of the Northern Mariana Islands
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
FMP	Fishery Management Plan
HAPC	Habitat Areas of Particular Concern
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MUS	Management Unit Species
NAO	NOAA Administrative Order
NEPA	National Environment Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OY	Optimum Yield
PMUS	Pelagic Management Unit Species
PRA	Paperwork Reduction Act
RFA	Regulatory Flexibility Act

4.0 Introduction

4.1 Responsible Agencies

The Council was established by the Magnuson-Stevens Fishery and Conservation Management Act (MSA) to develop Fishery Management Plans (FMPs) for fisheries operating in the US Exclusive Economic Zone (EEZ) around American Samoa, Guam, Hawaii and Commonwealth of the Northern Mariana Islands and the US possessions in the Pacific.[1] Once an FMP is approved by the Secretary of Commerce, it is implemented by federal regulations which are enforced by the National Marine Fisheries Service and the US Coast Guard, in cooperation with state, territorial and commonwealth agencies. For further information contact:

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4.2 Public Review Process and Schedule

On May 14, 2002, a final rule was published implementing the terms and conditions of a November 28, 2000 Biological Opinion (BiOp) issued under section 7 of the Endangered Species Act by the U.S. Fish and Wildlife Service (USFWS). These measures apply to all Hawaii-based longline vessels and consist of the following requirements:

When fishing above 23° N., vessel operators must:

Completely thaw and dye all bait blue before using it.

Discharge spent bait and fish parts to distract seabirds while setting or hauling the gear (strategic offal discards).

Use a line shooter or line setting machine with weighted branch lines to set the gear when deep setting (an October 18, 2001 amendment allows the use of basket gear instead of a line shooter with weighted branch lines).

In addition, all Hawaii-based longline vessel operators are required to follow seabird handling requirements wherever they fish, and vessel operators and owners must annually attend a protected species workshop conducted by the National Marine Fisheries Service (NMFS, also known as NOAA Fisheries or NOAA Fisheries Service).

[1] Howland, Baker, Jarvis, Wake and Johnston Islands, Palmyra and Midway Atolls and Kingman Reef.

A second final rule was published in the Federal Register on April 2, 2004 which requires night setting (begin setting an hour after sunset and complete the setting process by dawn) by Hawaii-based longline vessels making shallow sets above 23° N.

New research results were communicated to the Council and its Scientific and Statistical Committee (SSC) during regular public meetings convened in 2002 and 2003. A series of research trials with new mitigation methods were conducted between 2002 and 2003 using Hawaii-based longline vessels. The trials found that underwater setting chutes and side setting, (where the longline is deployed laterally from amidships rather than directly over the stern), were also effective in reducing interactions with seabirds.

At its 85th meeting (February 25, 2004) the SSC considered a range of possible seabird mitigation measures for the Hawaii-based longline fishery. The SSC suggested the addition of an additional alternative to provide fishermen with the flexibility of using the mitigation measures currently required, using an underwater setting chute, or side setting. At its122nd meeting (March 24, 2004) the Council heard a similar presentation and also considered the above recommendation from the SSC. Following a public hearing, the Council directed staff to prepare a draft Pelagics FMP amendment that examines a range of alternatives for seabird mitigation, including that suggested by the SSC. At its 123rd meeting on June 23, 2004, the Council took initial action by selecting a preliminarily preferred alternative. As described in Section 7.0, at its 124th meeting (October 12-15, 2004) the Council took final action, and following the late-receipt of a comment letter from the Department of the Interior to NMFS, subsequently recommended the following action to NMFS:

A) All deep setting Hawaii-based longline vessels must either side-set, or use a tori line plus the currently required measures (line shooter with weighted branch lines, blue dyed thawed bait and strategic offal discards) when fishing north of 23° - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present;

AND

B) All shallow setting Hawaii-based longline vessels must either side-set, or use a tori line plus the currently required measures (night setting, blue dyed thawed bait and strategic offal discards) wherever they fish - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present.

4.3 List of Preparers

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5.0 Purpose and Need for Action

The primary objective of the proposed action is the cost-effective further reduction of the potentially harmful effects of fishing by Hawaii-bsed longline vessels on the short-tailed albatross, but the overarching goal is to reduce the potentially harmful effects of fishing by Hawaii-based longline vessels on all seabirds in a cost-effective manner. Hawaii-based pelagic longline fishing vessels inadvertently hook, entangle and kill black-footed albatrosses (*Phoebastria nigripes*) and Laysan albatrosses (*Phoebastria immutabilis*) that nest in the Northwestern Hawaiian Islands (NWHI). On rare occasions Wedge-tailed and sooty shearwaters are also incidentally caught by these vessels. However, there are no observations or reports of interactions between the fishery and the endangered short-tailed albatross (*Phoebastria albatrus*). Fishery interactions may impact individual seabirds and, if large enough, in turn impact seabird populations so as to alter their trajectory (e.g. from positive to negative).

The number of Hawaii-based longline fishery interactions with all seabirds has been significantly reduced since 2000, due to the closure of the swordfish segment of the Hawaii-based longline fishery, and the implementation of new seabird mitigation measures based on research conducted cooperatively by the fishery participants, environmental organizations, and NMFS.

Based on NMFS' extrapolations from observer data, during 1999 the fleet is estimated to have brought onboard 2,320 hooked or entangled, and presumed drowned albatrosses (1,301 black-footed and 1,019 Laysan), while in 2002 the fleet is estimated to have brought onboard 113 hooked or entangled, and presumed drowned albatrosses (65 black-footed and 51 Laysan), and 257 albatrosses (111 black-footed and 146 Laysan) in 2003. The increase between 2002 and 2003 may be partially related to the increase in nesting populations of black-footed and Laysan albatrosses in the Northwestern Hawaiian Islands (NWHI) (a 7.2% increase in active black-footed albatross nests on Midway Atoll as compared to 2001 and a 53.9% increase in Laysan albatrosses on Midway breeding pairs as compared to 2001). However there are likely other factors involved as well that are not wholly exclusive of the fishery's activities.

A series of cooperative research trials with new seabird deterrent methods were conducted between 2002 and 2003 on Hawaii-based longline vessels. The trials found that underwater setting chutes (which deploy baited hooks underwater and out of the reach of seabirds) and side setting (which deploys the longline laterally from amidships, rather than directly over the stern), were both effective in further reducing interactions with seabirds. Also examined was the use of tori lines (also known as streamer or bird scaring lines) which have been found to be effective in reducing seabird interactions in the Alaska demersal longline fishery. The Council is now considering including these new mitigation measures to aid the fishery in cost-effectively further reducing seabird interactions.

6.0 Management Objectives

The objectives of the Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region (Pelagics FMP), as amended in Amendment 1, are as follows:

1. To manage fisheries for management unit species (MUS) in the Western Pacific Region to achieve optimum yield (OY).

2. To promote, within the limits of managing at OY, domestic harvest of the MUS in the Western Pacific Region EEZ and domestic fishery values associated with these species, for example, by enhancing the opportunities for:

a. satisfying recreational fishing experiences;
b. continuation of traditional fishing practice for non-market personal consumption and cultural benefits; and
c. domestic commercial fishermen, including charter boat operations, to engage in profitable fishing operations.

3. To diminish gear conflicts in the EEZ, particularly in areas of concentrated domestic fishing.

4. To improve the statistical base for conducting better stock assessments and fishery evaluations, thus supporting fishery management and resource conservation in the EEZ and throughout the range of the MUS.

5. To promote the formation of a regional or international arrangement for assessing and conserving the MUS and tunas throughout their range.

6. To preclude waste of MUS associated with longline, purse seine, pole-and-line or other fishing operations.

7. To promote, within the limits of managing at OY, domestic marketing of the MUS in American Samoa, CNMI, Guam and Hawaii.

The primary objective of this management action is the cost-effective further reduction of the potentially harmful effects of fishing by Hawaii-based longline vessels on the short-tailed albatross, but the overarching goal is to reduce the potentially harmful effects of fishing by Hawaii-based longline vessels on all seabirds in a cost-effective manner. This action is consistent with Objectives 1, 2 and 7 above; to achieve optimum yield and promote domestic marketing of MUS on a long-term basis from the region's pelagic fishery, without likely jeopardizing the continued existence of any threatened or endangered species.

7.0 Initial Actions

Measures taken by the Council in the early 1990s to manage the pelagic species fishery reduced the incidental catch of seabirds by Hawaii-based longline vessels. These measures include limiting the size of the longline fleet to 164 permits, and prohibiting longline fishing in a 50 nautical mile area (protected species zone) around the Northwestern Hawaiian Islands (NWHI). Specific actions by the Council to reduce the incidental catch of seabirds began in 1996, when the Council and the USFWS conducted a workshop in September of that year in Honolulu to inform longline fishermen of the problem and various mitigation measures. The book *Catching Fish, Not Birds* by Nigel Brothers (1995) was translated into Vietnamese and Korean and copies were sent to all holders of a NMFS Hawaii longline limited access permit. A second workshop informing fishermen of the problem was held in January 1997. At that time, the USFWS also distributed a laminated card showing various species of albatross and describing possible mitigation methods. The card was issued in both English and Vietnamese.

Assessments of the level of voluntarily adoption of mitigation measures by Hawaii longline fishermen indicated that the education program described above was only partially successful. Two dockside visits by Council and USFWS staff in mid-1997, to examine what mitigation measures, if any, were being employed revealed that, of the 12 longline vessels surveyed, five used weighted branch lines, one used bait dyed blue to camouflage it in the water, three towed a trash bag or buoy, one scared birds with a horn, one distracted the birds by strategically discarding offal and two vessels took no measures. A mail survey of 128 Hawaii-based longline vessels was conducted by the Environmental Defense Fund during the same period. Ten of the 18 fishermen that responded to a question regarding mitigation measures employed indicated that they were actively using some type of measure, such as reducing the use of deck lights at night, adding weights to increase the sink rate of the fishing line during setting, strategically discarding offal to distract birds, using a line-setting machine or setting the line under-water.

In October 1997, NMFS observers deployed on Hawaii-based longline vessels began recording which mitigation measures, if any, were being used voluntarily by fishermen. Information from the observer program for 1998 showed that nearly all vessels used some measure, the most common being to avoid setting the line in the vessel wake. About 55% of the vessels thawed the bait before baiting hooks, 29% of the vessels set at night and 11% avoided discarding unused bait while setting the fishing line. Only two percent of the vessels used a towed deterrent or blue-dyed bait.

In October 1998, a seabird population biology workshop was convened at the Council office in Honolulu to make a preliminary assessment of the impact of fishing by the Hawaii-based longline fleet on the black-footed albatross population in the NWHI (WPRFMC, 2000). The incidental catch of seabirds by fishing vessels was identified as a source of chronic or long term mortality. It was noted that the impact of the interactions would be more serious if the albatrosses killed were predominantly adult birds because this would result not only in the loss of chicks, but also the loss of many breeding seasons as the surviving mate must find another mate and establish a pair bond. However, banding data analyzed at the workshop suggested that it was predominantly immature juvenile birds that were interacting with longline boats. This finding is consistent with that of Brothers (1991), who observed that about four times as many juvenile as adult albatrosses are caught in the Southern Bluefin tuna (*Thunnus maccoyii*) longline fisheries.

In anticipation that regulatory measures would be required to further reduce the incidental catch of seabirds in the Hawaii longline fishery, the Council in 1998, contracted Garcia and Associates to assess which mitigation methods would be most effective for local vessels under actual commercial fishing conditions. As reported in McNamara *et al.* (1999), the study assessed the effectiveness of various mitigation methods aboard Hawaii-based longline vessels under actual fishing conditions. The mitigation techniques evaluated included several of those identified by Alexander, Robertson and Gales (1997) as being effective in other fisheries, such as night setting, towed deterrents, modified offal discharge practices and thawed bait. In addition, Garcia and Associates evaluated blue-dyed squid bait, the effectiveness of which appeared promising based on limited use by Hawaii-based longline vessels, but which had not been scientifically assessed. Because data collected by NMFS observers showed that Hawaii-based longline vessels targeting swordfish had higher incidental catches of seabirds than did vessels targeting tuna, Garcia and Associates tested the effectiveness of mitigation measures primarily during swordfish trips. The criteria used by Garcia and Associates to evaluate the effectiveness of mitigation measures included the number of attempts on (chases, landings and dives) and interactions (physical contact) with fishing gear as well as actual hookings and mortalities.

In early 1999, NMFS' Honolulu Laboratory assessed the effectiveness of several seabird mitigation methods during a cruise on a NOAA research vessel in the waters around the NWHI (Boggs 2001). This study was designed to supplement the field test of towed deterrents and blue-dyed bait conducted by Garcia and Associates, and to evaluate an additional measure: weighted branch lines. The advantage of using a research vessel to test the effectiveness of mitigation measures was that fishing operations could be controlled to improve the opportunities for observation, comparison and statistical analysis. For example, by setting gear in daylight researchers greatly increased the number of bird interactions with the gear in the presence and absence of each mitigation method. Easily regurgitated net pins were substituted for hooks in the research to avoid injuring seabirds.

Based on observer records from 1994 to 1998, the Honolulu Laboratory also assessed the efficacy of a line-setting machine used in combination with weighted branch lines in reducing seabird interactions.

In October 1999, the Western Pacific Fishery Management Council (Council) recommended three measures to mitigate the harmful effects of fishing by vessels registered for use under Hawaii longline limited access permits (Hawaii-based longline vessels) on seabirds. The first measure required vessel operators fishing with longline gear north of 25° N. latitude to employ two or more of the following seabird deterrent techniques: 1) maintain adequate quantities of blue dye on board and use only completely thawed, blue-dyed bait; 2) discard offal while setting and hauling the line in a manner that distracts seabirds from hooks; 3) tow a NMFS-approved deterrent (such as a tori line or a buoy) while setting and hauling the line; 4) deploy line with line-setting machine so that the line is set faster than the vessel's speed and attach weights equal to or greater than 45 grams to branch lines within one meter of each hook; 5) attach weights equal to or greater than 45 grams to branch lines within one meter of each hook; 6) begin setting the longline at least one hour after sunset and complete the setting process at least one hour before sunrise, using only the minimum vessel's lights necessary for safety. The second measure directed vessel operators to make every reasonable effort to ensure that birds brought onboard alive are handled and released in a manner that maximizes the probability their long-term survival as directed by seabird handling guidelines. The final measure required all vessel owners and operators to annually complete a protected species educational workshop conducted by NMFS.

On July 5, 2000, NMFS published a proposed rule for the Hawaii-based longline fishery based on the Council's recommended measures. However, the agency did not proceed with the publication of a final rule, as the USFWS had indicated it was developing a Biological Opinion for the fishery action under section 7 of the Endangered Species Act (ESA) for the short-tail albatross. This endangered species has been documented in small numbers in the NWHI, and the USFWS BiOp, published on November 28, 2000, concluded that the Hawaii-based longline fishery as proposed was not likely to jeopardize the continued existence of the short-tailed albatross.

Nevertheless, it included several non-discretionary measures to be employed by the Hawaii-based longline fishery and implemented by NMFS. In contrast to the Council's recommendation requiring the use of any two of the six approved deterrents, the 2000 USFWS BiOp required that all Hawaii-based vessels operating with longline gear north of 23° N. latitude use thawed blue-dyed bait and discard offal strategically to distract birds during setting and hauling of longline gear. In addition, when making deep sets (targeting tuna) north of 23 ° N. latitude, Hawaii-based vessel operators were required to employ a line-setting machine with weighted branch lines (minimum weight = 45 g). All longline vessel operators and crew were also required to follow certain handling techniques to ensure that all seabirds (not just short-tailed albatrosses) would be handled and released in a manner that maximizes the probability of their long-term survival, and vessel operators were required to annually complete a protected species educational workshop conducted by NMFS. Optional mitigation measures include towed deterrents, or the use of weighted branch lines without a line-setting machine (in the case of swordfish or mixed target sets). In addition, operators of Hawaii-based vessels making shallow sets (targeting swordfish) north of 23 ° N. were required to begin the setting process at least one hour after sunset and complete the setting process by sunrise.

The USFWS 2000 BiOp was based on the operations of the Hawaii-based longline fishery prior to December 1999, and anticipated that the fishery would take 15 short-tailed albatrosses during the seven year period addressed in the consultation (2.2 short-tailed albatrosses annually from 2000-2006). This BiOp considered a "take" to include not only injury or mortality to a short-tail albatross caused by longline gear, but also any short-tail albatross striking at the baited hooks or mainline gear during longline setting or haulback.

Emergency and final regulations implementing seabird mitigation measures for the Hawaii-based longline fishery were promulgated on June 12, 2001 and May 14, 2002, respectively. However, the requirements regarding shallow-set longlining north of 23° N. latitude were not implemented by NMFS as, for the purpose of minimizing effects of the fishery on threatened and endangered sea turtle species, on March 31, 2001, by order of the court NMFS prohibited all shallow-set pelagic longline fishing for swordfish north of the equator by Hawaii-based vessels.

The March 31, 2001 closure of the shallow set longline component of the fishery led NMFS to reinitiate consultation under the Endangered Species Act (ESA) with the USFWS on August 15, 2001 to examine the impacts of the reduced fishery on short-tailed albatross. The subsequent 2002 USFWS BiOp was released November 18, 2002, and again concluded that the Hawaii-based longline fishery as proposed was not likely to jeopardize the continued existence of the short-tailed albatross.

In 2003 new information, experimental results and technological advances in longline gear design that concern interactions between the fishery and sea turtles prompted the Council recommend new measures for the Hawaii-based fishery. As a result current regulations allow a limited amount (2,120 sets annually) of shallow set longline effort by Hawaii-based swordfish vessels using circle hooks with mackerel-type bait. Because this action allowed limited shallow setting, the Council also recommended implementation of the 2000 USFWS BiOp requirement that any shallow-setting occurring north of 23° N. latitude be done at night. Final regulations implementing these recommendations were promulgated on April 2, 2004

A series of cooperative research trials with new mitigation methods were conducted between 2002 and 2003 on Hawaii-based longline vessels. The trials found that underwater setting chutes (which deploy baited hooks underwater and out of the reach of seabirds) and side setting (which deploys the longline laterally from amidships, rather than directly over the stern), were both effective in further reducing interactions with seabirds. This document examines a range of alternatives that would allow or require the use of one or more of these techniques to cost-effectively further reduce seabird interactions with the Hawaii-based fishery. Also examined is the use of tori lines (also known as streamer or bird scaring lines) which have been found to be effective in reducing seabird interactions in the Alaska demersal longline fishery.

In October 2004, USFWS published a new BiOp on the reopening of the swordfish segment of the Hawaii-based longline fishery. Although the consultation was concerned primarily with the introduction of circle hooks and mackerel bait in the fishery, and its likely potential impact on the short-tailed albatross, the BiOp also took into consideration the development of new mitigation techniques such as side setting. Consequently, although the BiOP concluded that the fishery was not likely to jeopardize the continued existence of the short-tailed albatross, the reasonable and prudent measures in the USFWS' October 2004 BiOp required NMFS to implement side setting, or other equally more effective measures to minimize the risk of incidental take of short tailed albatrosses by August 30, 2005. In addition to introducing promising new seabird deterrent measures, the Council believes that this regulatory amendment will bring the Pelagics FMP into compliance with the USFWS October 2004 BiOp.

At its 123rd meeting on June 23, 2004, the Council took initial action and selected a preliminary preferred alternative. At its 124th meeting (October 12-15, 2004) the Council took final action and recommended the following action to NMFS:

All shallow-setting longline vessels, wherever they fish, be required to either use side setting, or to use all of the following measures simultaneously: night setting, blue bait, offal discards, and tori lines.

All deep-setting longline vessels, when fishing north of 23 deg N, be required to either use side setting, or to use all of the following measures simultaneously: a line shooter with weighted branch lines, blue bait, offal discards, and tori lines.

The Council will use the period of the regulatory process to collect supplementary data on bird behavior and coordinate with the USFWS to remove the requirement for blue dyed thawed bait and offal discards, if appropriate.

A comment letter on the Draft Environmental Impact Statement prepared by NMFS for this action from the US Department of the Interior (dated October 15, 2004, but delivered after the 124th Council meeting), stated that blue dyed bait and strategic offal discards should be retained as mitigation measures. However, the letter further suggested that strategic offal discards should be used by longline vessels only when seabirds were present. A second letter received from the USFWS on February 24, 2005 in response to a direct request for clarification from the Council, reiterated this position.

Thus the Council's final preferred alternative (7D) recommended to NMFS for approval and implementation is as follows:

A) All deep setting Hawaii-based longline vessels must either side-set, or use a tori line plus the currently required measures (line shooter with weighted branch lines, blue dyed thawed bait and strategic offal discards) when fishing north of 23 ° - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present;

AND

B) All shallow setting Hawaii-based longline vessels must either side-set, or use a tori line plus the currently required measures (night setting, blue dyed thawed bait and strategic offal discards) wherever they fish - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present.

8.0 Management Alternatives

The primary objective of this management action is the cost-effective further reduction of the potentially harmful effects of fishing by Hawaii-based longline vessels on the short-tailed albatross, but the overarching goal is to reduce the potentially harmful effects of fishing by Hawaii-based longline vessels on all seabirds in a cost-effective manner. Fishery interactions may impact individual seabirds and, if large enough, in turn impact seabird populations so as to alter their trajectory (e.g. from positive to negative).

Mitigation of seabird fishery interactions can be accomplished in a number of ways. One approach is to reduce the physical impacts on seabirds of interactions (e.g. hookings) that do occur, another is to support seabird nesting areas to compensate for fishery impacts, a third is to reduce the size of fisheries operating around seabirds, and a fourth is to reduce the interaction (e.g. hooking) rate by active fisheries. The first approach has been implemented through the design and distribution of seabird handling guidelines to all vessel owners and operators during annual protected species workshops. Attendees review the guidelines and watch a video demonstrating how to safely handle and release hooked or entangled seabirds. To date the Council has not undertaken the conservation of seabird nesting habitat although this could be considered. Reductions in the size of the Hawaii-based longline fishery (e.g. reductions in permits or effort limits) are not being considered at this time as they would not be cost-effective given the low fishery interaction rates, the status of affected seabird populations, and the availability of other mitigation measures. The action proposed here is the result of an examination of a range of new and old seabird deterrent techniques which have been found to reduce the interaction rates between seabirds and the Hawaii-based longline fishery.

There are numerous seabird mitigation techniques developed by fishermen and scientists that are aimed at deterring albatrosses from reaching baited longline hooks. A summary of experimental data on mitigation techniques tested in the North Pacific by Hawaii-based longline vessels is shown in Appendix I. In 1991, Brothers had a fishing master deploy a diversion streamer line and found that it reduced bait loss to birds by 69% (Brothers 1991). Prior to 1991, fishing masters had tried towing buoys, throwing explosives, towing artificial lures and adding weights to sink baits faster (Brothers 1991). Since then additional deterrent measures have been invented (Alexander et al. 1997, Brothers et al. 1999, McNamara et al. 1999, Boggs 2001, Melvin et al. 2001, Gilman et al. 2002, 2003 a, b). All measures, regardless of the details of their design or implementation methodologies, attempt to do one of the following in order to keep albatrosses away from baits:

- Make baits difficult for birds to detect;
- Make baits difficult for birds to reach;
- Frighten, physically deter or draw birds away from baits; or
- Reduce the number of birds congregating around the fishing vessel

The following sections review the characteristics of individual seabird measures considered in formulating a new management regime. The potential measures include those that have been previously considered by the Council or specified by the USFWS in its 2000 BiOp on effects of the fishery (thawed blue-dyed bait, strategic offal discards, line shooter with weighted branch lines, night-setting), as well as a deterrent that has proven effective elsewhere in other fisheries (tori line), and two additional techniques (underwater setting chute and side-setting) which have been found effective in experimental testing.

In evaluating how well the individual seabird interaction avoidance measures and the alternatives, most of which contain more than one such measure, accomplish the action objective, both qualitative and quantitative criteria were used.

Qualitative criteria identified as critical to the successful implementation of seabird interaction avoidance measures are operational characteristics and compliance. Operational characteristics include such things as ease of implementation by crew, consistency of performance across a range of variables including time of day, location, weather, sea state, and seabird density, and effect on target species CPUE. Compliance is a measure of the likelihood of a measure's proper use, the likelihood of its use in the absence of observers, and the relative ease with which it may be enforced.

Two quantitative criteria were also evaluated: efficacy of a measure or combination of measures to deter seabirds from baited hooks and the cost of implementation. All of the measures evaluated here have a high level of efficacy in deterring seabirds from baited hooks, but there are some notable differences among measures. The cost criterion includes both initial costs to fishermen to purchase and install gear and also recurring costs for supplies or maintenance.

This section describes the strategies available to achieve this action's objective. It then evaluates and compares seabird interaction avoidance and deterrent measures and combinations of measures that might be assembled into action alternatives. Finally, it describes the 24 alternatives considered for the fishery and discusses other alternatives not considered in detail.

8.1 Potential Deterrent Measures to Reduce Longline-Seabird Interactions

Blue-dyed and Thawed Bait

Operational characteristics

Blue-dyed bait and thawed bait are actually two deterrent measures that could be evaluated or implemented independently. Blue dye makes bait more difficult for birds to detect, and thawed bait sinks faster, thus more rapidly removing it from the reach of seabirds. In practice it is necessary to thaw or at least partially thaw bait for it to take up the blue dye, and current regulations require the use of thawed and blue-dyed bait when longlining north of 23 °N. Thawed blue-dyed squid and fish bait were used in deterrent efficacy experiments conducted in Hawaii using longline gear and methods typical of the fleet. For these reasons these two measures are combined here. In practice, blue-dying bait has its operational drawbacks. Pre-dyed blue bait is not commercially available, requiring fishermen to dye the bait blue as it is thawed before each set. The use of blue dye is messy, dyeing the hands and clothes of the crew and the deck of the vessel. The use of blue dye also requires the crew to deploy the baited hooks away from the propeller wash, where the white water makes the blue-dyed bait more apparent to seabirds. Crews untrained or unfamiliar with the use of blue-dyed bait may reduce its effectiveness by not deploying baited hooks away from the propeller wash. Thawed bait falls off the hook more readily than firmer, partially frozen bait. Gilman et al. (2003) found that "blue-dyed bait resulted in a relatively low fishing efficiency based on bait retention and hook setting rates."

Compliance

Monitoring compliance with the use of blue-dyed bait is very difficult in the absence of an observer. Vessels can be checked for tins of blue bait by being boarded at sea or during dockside inspections, but this does not ensure that the dye is being used, or used properly. However, Gilman (2004) found, in analyzing PIRO observer data from sets made in 2003 and 2004, that the compliance rate on observed trips was 99%. The compliance rate on unobserved trips is unknown, but Gilman also found that some vessels were voluntarily using thawed blue-dyed bait on sets south of 23 °N.

Efficacy

Blue dye has been shown to be effective at mitigating seabird interactions when used with squid bait, which readily absorbs the dye, and thus disguises the bait on immersion in the sea. For example, McNamara et al. (1999) in tests using Hawaii longline shallow-set (swordfish) gear reported a 77% reduction in gear contacts and a 95% reduction in bird capture rates using blue-dyed squid bait. The shallow-set component of the Hawaii longline fleet formerly used squid for bait, but is now required to use mackerel-type bait, as has been used by the deep-set (tuna) sector of the fishery. As compared to squid, blue dye is taken up less readily by fish baits such as sanma or sardines, and fishermen report difficulty in achieving the desired intensity of blue color as specified in the regulations, due to the shedding of the deciduous scales of the commonly used bait fish. Gilman et al. (2003) tested thawed blue-dyed fish bait with Hawaii tuna longline gear and found a 63% reduction in bird capture. While not as good a deterrent as blue-dyed squid, blue-dyed fish still has substantial deterrent properties. Research on the use of blue dye to minimize interactions with seabirds has been conducted in New Zealand, and Japan (Eric Gilman, Blue Ocean Institute, personal communication). Information on the performance of blue dyed bait in the New Zealand tuna fishery (Greg Lydon, New Zealand Seafood Industry, personal communication to Holly Friefeld, USFWS Honolulu) suggests that sanma is better at absorbing blue dye than sardines, but at sea trials with blue bait have only included squid bait). Results from Japanese fishing trials with blue dyed mackerel bait (Minami & Kiyota 2002) indicated that blue dyed bait eliminated seabird captures entirely when used on longliners targeting southern bluefin tuna.

Cost

There is a cost of about $14.00/set (Gilman et al. 2003) associated with dyeing bait blue in the Hawaii longline fishery. Over the period of a year, a vessel might be expected to make 100 sets, amounting to an annual blue dye cost of $1,400 per vessel.

<u>Strategic Offal Discard</u>

Operational characteristics

Operationally, offal discards are more appropriate for vessels targeting swordfish than tuna, because the carcasses of swordfish are routinely headed and gutted before being packed on ice in the vessel's hold. A supply of offal is therefore routinely generated for the next set. Historically, tuna were not dressed, with only the fins and tails removed before icing. Accumulating offal for the next set on tuna-targeting vessels was thus more problematic. Tunas are now beginning to be dressed at sea on some Hawaii longline tuna vessels so a supply of offal is less problematic for these vessels.

Compliance

Monitoring of compliance with a requirement for strategic offal discards on longline sets is difficult in the absence of an observer. Fishermen may voluntarily use this measure as it has been shown to be effective and has no cost associated with it, particularly for swordfish-targeting vessels which routinely generate quantities of offal. For tuna-targeting vessels, bycatch may have to be butchered for offal. Gilman (2004), in his analysis of recent Hawaii longline observer data, found that only 18% of tuna-targeting sets employed strategic offal discard.

Efficacy
Offal discards have been shown to be effective in reducing interactions with longlines during the period when lines are set. Offal discards were shown to reduce gear contacts by 51% and captures by 88% in tests by McNamara et al. (1999) with Hawaii longline swordfish gear.

However, there are also mixed evaluations of the effectiveness of strategic offal discharge (Cherel et al. 1996, Brothers 1995 and 1996, McNamara et al. 1999). Although discharging offal and fish bycatch during setting can distract birds from baited hooks (Cherel and Weimerskirch 1995, Cherel et al. 1996, McNamara et al. 1999), this practice is believed to have the disadvantage of attracting birds to the vessel, increasing bird abundance, searching intensity, and capture (Brothers et al. 1999). In the long-term, strategic offal discharge 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 discharge offal and fish bycatch will have higher seabird abundance and capture rates than vessels that do not discharge offal and fish waste. Nevertheless, in the Hawaii-based fleet the swordfish vessels at least have a supply of offal and routinely discard it.

Cost
There are no financial costs associated with strategic offal discards other than the need to purchase containers in which to store the offal. The cost for containers is estimated at $150 per vessel.

Line-shooter with Weighted Branch Lines
Operational characteristics
Line-shooters and weighted branch lines are two separate seabird interaction avoidance measures that could be (and have been) evaluated independently. Because they are linked in current regulations applicable to the deep-setting sector of the fleet, they are considered together here. Although line-shooters and weighted branch lines (minimum 45g) are required to be used to target deep swimming tuna by Hawaii-based longline vessels, they would likely be used routinely anyway to get the baits deep quickly. Line-shooters function to deploy the longline at a rate faster than that of the vessel, thus creating slack in the line, allowing it to sink without tension. Weighted branch lines serve to sink the baits themselves, which could otherwise linger near the surface until slack is taken up by the sinking main line. Weighted branch lines, however, can be dangerous to crew. When attempting to haul in a live fish, the hook can pull loose or the leader can break, slinging the weight and/or the hook directly towards the fisherman's face. The heavier the weight, the greater the danger. There is anecdotal evidence of serious injuries from 60g weights, although many operators do prefer the heavier weights. As much as 70% of the Hawaii-based fleet now uses the heavier weights (Sean Martin, Hawaii Longline Association [HLA], personal communication). Many operators also now fasten the hook to a section of steel leader to minimize cutting of the monofilament branch line, especially common with hooked

sharks (Sean Martin, HLA, personal communication). Vessels targeting tuna in the Hawaii-based fleet universally employ line-shooters, except for one vessel which used traditional tarred rope basket gear, but which has since left the fleet. Line-shooters are not needed when setting shallow for swordfish, however, many vessels in the fleet re-rigged from swordfish fishing to tuna fishing after the 2001 ban on shallow-setting in the fleet. These vessels now have line-shooters, and may continue to use them, albeit somewhat differently than deep-setting vessels. Whereas deep-setting vessels deploy the main line at a speed faster than that of the vessel to allow it to rapidly sink, shallow-setting vessels may deploy the line at the same speed as the vessel, intending that it remain relatively shallow. As noted above, a line shooter with weighted branch lines is standard gear for targeting tuna in the Hawaii-based fleet, and therefore vessels targeting tuna north of 23 °N are automatically complying with this aspect of current regulations. Swordfish-targeting vessels are not required to employ line setters and weighted branch lines , and these measures, which facilitate rapid sinking of the branch lines by removing line tension during the set and adding weights within one meter of each hook, would be inappropriate for their intended shallow sets. A requirement for the swordfish vessels to place weighted swivels within 1 m of the hook would probably not alter the final depth of deployment of the gear, as is stated in this section. This would increase the initial sink rate of the baited hook near the surface and could affect swordfish CPUE. Although a line shooter can be set to run such that it does not set the line slack and thus does not allow the mainline to sink faster than the typical method of mainline deployment for swordfish fishing, fishery participants that did so without shallow set certificates would be fishing illegally and prohibited from possessing or landing more than 10 swordfish per trip.

Compliance

As noted above, a line-shooter and weighted branch lines are standard gear for targeting tuna in the Hawaii-based fleet, and therefore vessels targeting tuna north of 23 °N are automatically complying with this aspect of current regulations. Swordfish-targeting vessels are not required by current regulations to employ line setters or weighted branch lines, but many do.

Efficacy

Boggs (2001) found that adding 60 g of weight to branch lines reduced albatross interactions by 92%. Albatross are surface feeders and do not dive as deeply as plunge divers such as boobies. Baits deeper than a few meters are out of reach of albatrosses. According to Brothers et al. (1995), a frozen bait weighted with about 50 g of lead should sink to three m depth approximately 30 m behind a longline vessel setting at eight knots. The efficacy of a combination of weighted branch lines and a line-shooter at reducing bird capture was estimated to be 97-98% (NMFS, SWFSC Honolulu Laboratory, cited in WPRFMC 2001).

Cost

The cost of a hydraulic line-shooter of the type employed by the Hawaii-based longline fleet and its installation amounts to about $5,700 (Jim Cook, Pacific Ocean Producers, personal communication). Weighted branch lines are estimated to be a recurring annual cost of $2,400 per vessel.

Tori line

Operational characteristics

Tori lines are a type of towed deterrent. Other towed deterrents, including such things as inflated trash bags, have been tried by fishermen, but no data are available on their effectiveness. In general, a tori line is a line suspended from a high pole on the stern of the vessel and extending astern to a buoy or float that keeps the line taught. Streamer lines are attached at intervals along the main line and extend down to the water's surface. Tori lines protect baited hooks which are accessible to seabirds at the water's surface, and force birds to forage further behind the fishing vessel, giving the baits a chance to sink. The effectiveness of tori lines is reduced under conditions where the tori line is not over the baits, such as when winds and currents are in very different directions. In such situations, the effectiveness of a tori line may be improved by rigging a boom and bridal system that allows the line to be shifted laterally to afford better coverage of the main line. Rough seas and high winds may reduce the effectiveness of tori lines and increase the risk of entanglements between the tori line and the main line or branch lines. In addition, McNamara et al. (1999) noted that seabirds themselves occasionally contact branchlines and carry these over the tori line, leading to entanglements. Further, when a longline vessel stops during hauls, the streamers attached to the tori line may cause the tori line to sink, increasing the risk of entanglement with the fishing gear or the vessel's propeller. This and the constant attention needed to ensure the proper functioning of the tori line may increase the risk of accidents or injury to fishermen during setting operations.

Compliance

If vessels elect to use this measure, they can be checked at dockside to ensure that appropriate gear is on board. The deployment of a tori line is also highly visible, allowing at-sea monitoring of compliance from an aircraft or cutter. However, as with blue bait and offal discards, monitoring of compliance at-sea would be problematic in the absence of on-board observers. . Further, monitoring may be problematic even with observers on the vessel. It is not always possible to ensure that the method is being used effectively, resulting in a tori line being deployed but not over the area of baited hooks. This may result in compliance with the regulations, but negate its effect in avoiding bird capture.

Efficacy

McNamara et al. (1999) and Boggs (2001) evaluated the effectiveness of towed deterrents, including tori lines on Hawaii-based longline vessels and using a research vessel, respectively. The observations conducted by those investigators were on longline gear rigged to fish shallow for swordfish. In the McNamara study, tori lines reduced seabird captures by 79% and towed buoys reduced captures by 88%. In the Boggs study, tori lines reduced contacts with the line by 76%.

Cost

The equipment for a tori line amounts to about $2,000 for the fiberglass pole and $300 for the line and streamers. Installation of a mount for the tori line is estimated to cost about $1,000. Total initial costs associated with a single tori line are thus likely to be about $3,300. Assuming that vessel operators replace one to two units per year and keep a spare unit on board at all times, annual costs would be $4,600.

Night-setting

Operational characteristics

This measure is predicated on birds' inability to see gear and bait in the dark, so its effectiveness likely is influenced by cloud cover, moon phase, vessel lighting and use of light sticks. Hooks set at or before dusk, however, are a threat to crepuscular feeders such as albatross. Setting longlines at night has historically been part of the standard operating procedures for Hawaii-based longline vessels making shallow-sets targeting swordfish. However, some operators in the Hawaii-based fleet historically set their hooks according to a lunar calendar and that sometimes resulted in pre-dusk setting. Consequently, the observer data (and estimated seabird interactions) for the period 1994-1999 (prior to implementation of the current definition of and requirement for nighttime shallow sets) represents a mixture of pre-dusk and true night-setting. There is a common belief among some fishermen that the hooks deployed before dark are generally more effective than those set after dusk (Brian MacNamara, personal communication).

Compliance

Vessels opting to target swordfish in the shallow-set sector of the fishery reauthorized in 2004 will have to declare their intent to make shallow-sets prior to departure. They will be required to carry an observer, who will note the start and finish times of sets as part of their duties, and therefore establish a record of compliance with the requirements for the timing of the start and termination of sets. Should observer coverage be reduced in the future, data collected via the VMS system could be used to verify the start and finish of setting and hauling. VMS position checks can be made at intervals well under an hour and as frequently as every five minutes (Sean Martin, Hawaii Longline Association, personal communication.)

Efficacy

Unlike the other measures considered here, which tend to work similarly on Laysan and black-footed albatross, night-setting is more effective at minimizing interactions with black-footed albatross than with Laysan albatross, which may continue to feed after dark and therefore may dive on baited hooks being deployed after dusk. McNamara et al. (1999) found that black-footed albatross captures were reduced by 95%, but Laysan albatross captures were only reduced by 40%. Boggs (2003) found that shallow-setting at night reduced overall captures by 98% and contacts by 93%.

Cost

There are no additional financial costs known to be specifically associated with night-setting, however, when fishing at high latitudes in summer, nights are short, night-setting gives fishermen less time to set gear.

Underwater Setting Chute

Operational characteristics

Two lengths of chutes (9m and 6.5m) used by Gilman et al. (2003) in experiments in Hawaii using deep-set gear were found to have design flaws that affected their performance. The 9m chute fractured and bent on one fishing trip, and even when repaired had a markedly reduced performance operationally and in terms of mitigating seabird interactions. Even the shorter chute, however, requires a lot of deck space to stow when not fishing and in transit to and from fishing grounds, which may be a problem on smaller vessels. An additional problem noted by Gilman et al. (2003) is that the chutes tested caused delays in setting the branch lines that could reduce the number of hooks deployed per set by 12.5% for the 9m long chute and 28.8% for the 6.5m long chute. However, the reduced hook setting rate when using the chute would only be a problem for longline tuna vessels, and not for longline swordfish vessels, due to their conventional hook setting speeds.

Compliance
The deployment of an underwater setting chute could be monitored from an aircraft or cutter. However, as with several other potential measures, monitoring of compliance at-sea would be problematic in the absence of on-board observers. The presence of a setting chute on-board a vessel at the dock does not insure its use at sea, although an electronic hook counter could be fixed to the chute to monitor the deployed through the setting chute.

Efficacy
Trials with underwater setting chutes on Hawaii-based longline vessels have been conducted by Gilman et al. (2002, 2003). Initial trials with a 9m chute in the longline tuna fishery, where the chute deployed baited hooks 5.4m underwater, eliminated bird captures.

Cost
The acquisition of an underwater setting chute is a significant expense, currently estimated to be about $5,000, with additional costs estimated at $1,000 for installation of mounts and hardware.

<u>Side-setting</u>
Operational characteristics
Side setting under experimental conditions has been shown to virtually eliminate bird capture (Gilman 2003b). In trials conducted by Gilman et al. (2003b) during 22 deep-sets, side setting was also shown to perform significantly better at reducing interactions and mortalities than sets with two lengths of underwater setting chutes or with blue-dyed bait (Table1). More recently, observer data (August 2003 – October 2004) analyzed by Gilman (2004) indicates that 21 sets where side setting was employed did not record a single seabird capture. However caution must be exercised when looking at observer data which, unlike experimental data, merely record the presence or absence of seabirds and do not normalize the data for bird abundance. Side-setting minimizes bait theft and bird capture, thus increasing fishing efficiency. Vessels with the wheel house positioned amidships or aft of the vessel conventionally set their lines from the aft deck, and retrieve the line from the foredeck. All the retrieved gear is then carried manually to the aft deck for baiting and setting, reducing the work load for fishermen.

As noted in the discussion of line-shooters above, some fishermen have safety concerns about the 60 g weights as recommended for use with side-setting by Gilman et al. (2003). Nevertheless, it is estimated that about 70% of the vessels currently fishing in Hawaii already use 60g weighted swivels (Sean Martin, HLA, personal communication), while other vessels are still using the currently required (minimum) 45g weights when deep-set fishing north of 23 °N.

Promising as side setting appears to be there are compelling reasons to take a more cautious approach and maintain an element of flexibility in the methods available to operators in the Hawaii-based longline fishery. Experience in the Alaska demersal longline fishery has shown that a stepwise approach may be more "prudent" (Kim Rivera, NMFS, North Pacific Region, personal communication). Although mitigation measures can be shown to be effective under experimental conditions, their performance characteristics need to be evaluated under operational conditions during routine fishing operations through the use of on-board observations (Kim Rivera, NMFS, North Pacific Region, personal communication). A wholesale conversion to side setting by one or more fishery sectors would effectively remove the "control" portion of the sector and the information to be gained from a "with and without" comparison would be lost and further systematic evaluation of this technique would be difficult (Christofer Boggs, PIFSC, personal communication). In addition, should seabirds prove to become habituated to side setting, its effectiveness would be lost and vessels would have undergone reconfigurations for little purpose.

Compliance
Side-setting is relatively easy to enforce as the orientation of the gear on deck can be checked through dockside inspection, and vessel operations can be readily observed at sea. It would be relatively easy to reconfigure a vessel from side-setting to stern-setting while at sea, especially for shallow setting vessels which do not employ a mainline shooter. However, because of the operational benefits described above there would seem little motivation to do so. Moreover, vessels must notify NMFS and carry observers when shallow setting. If NMFS is not notified and no observer is carried, regulations prohibit the possession or landing of more than 10 swordfish per trip. Thus there would be little opportunity or incentive for vessel operators to reconfigure their vessel while at sea. To date approximately 15 vessels (more than 12% of the fleet) have voluntarily made the conversion to side-setting (Sean Martin, HLA, personal communication), presumably due to the operational benefits noted above.

Efficacy
Side-setting has been shown to virtually eliminate bird capture. In shallow set and deep-set trials conducted by Gilman et al. (2003), side-setting was shown to perform significantly better at reducing interactions and mortalities than sets with the two lengths of underwater setting chutes or with blue-dyed bait.

Cost
Conversion to side-setting means that all operations can be conducted from the foredeck with the elimination of the gear transfer between sets. The initial expense of adjusting the vessel deck design, fabricating or purchasing a bird curtain, and switching from 45g to 60g weighted swivels is estimated to be about $4,000, with an annual cost of $50 to replace the bird curtain.

Summary Comparison of Potential Seabird Deterrent Measures

Table 1 grades the seabird interaction avoidance measures on the basis of the qualitative criteria described above. Due to the qualitative nature of the criteria, these grades are necessarily subjective. Table 2 summarizes the costs per fishing vessel associated with each measure.

Table 1 Summary of Qualitative Appraisals of Deterrent Measures
(●= good; ●●= better; ●●●=best)

Deterrent Measure	Evaluation Criteria	
	Operational Characteristics	Compliance
Thawed blue-dyed bait	●●	●
Strategic offal discards	●◖	●
Line-shooter with weighted branch lines (on tuna vessels)	●●●	●●●
Tori line	●	●
Night-setting (on swordfish vessels)	●●	●●
Underwater setting chute	●	●
Side-setting (+ 60g swivels within 1m of the hook)	●●◖	●●●

Table 2 Summary of Costs per Vessel for Deterrent Measures

Deterrent Measure	Cost per Vessel
Thawed blue-dyed bait	$1,400 annual
Strategic offal discards	$150 initial plus $150 annual
Line-shooter with weighted branch lines (on tuna vessels)	already purchased and being used ($5,700 initial plus $2,400 annual)
Tori line	$3,300 initial plus $4,600 annual (2 lines)
Night-setting (on swordfish vessels)	$0
Underwater setting chute	$6,000 initial
Side-setting (+ 60g swivels within 1m of the hook)	$4,000 initial plus $50 annual

The results of seabird mitigation experiments conducted in the North Pacific aboard Hawaii-based longline vessels are shown in Appendix I and summarized in Table 3. Table 3 includes the reduction in seabird capture rates for measures discussed above and included in the alternatives presented later in this chapter. The percent reductions are relative to a no-mitigation measure baseline, however in the case of deep setting tuna vessels the baseline includes a line shooter with weighted branch lines as this is the norm for these vessels. The bolded values in Table 3 were used in estimating the efficacy or percent reduction in seabird interactions (compared to no-mitigation conditions) of combined measures and potential seabird takes under each alternative. Most experiments used shallow sets and those values are likely conservative for deep sets in which line shooters are used and the weights are closer to the baited hook, causing them to sink more rapidly out of the reach of seabirds (Boggs 2001) and most of which are made to the south of the Hawaiian Islands beyond the normal range of Laysan and blackfooted albatrosses. References for the experiments are provided and rationales for the values are provided in the comments columns. All of these data and results of experiments with other deterrents are summarized in Gilman et al. (2003a). Data is presented in terms of percent changes from the baseline in order to provide an easy comparison of the efficacy of each measure.

Table 3 Deterrent Measure Efficacy Values From Experiments Conducted in the Hawaii-based Longline Fishery

Measure	Tuna (Deep) Set	Reference	Comments	Swordfish (Shallow) Set	Reference	Comments
Thawed Blue-Dyed Bait (Squid) (TBDB)	Not applicable	---	Squid bait not used for tuna	95%	McNamara 1999	Squid bait no longer permitted.
Thawed Blue-Dyed Bait (Fish) (TBDB)	**(63%)**	---	Use SF efficiency for tuna. Appears conservative for deep sets.	**63%**	Gilman et al. 2003	
Strategic Offal Discharge (SOD)	**(86%)**	---	Use SF efficiency for tuna. Appears conservative for deep sets.	**86%**	McNamara 1999	
Night-setting (NS)	Not applicable	---	Night-setting not used for tuna.	73% 98% Mean = **85.5%**	McNamara 1999 Boggs 2003	Mean value of two studies used in calculations.
Night-setting + Thawed Blue-Dyed Squid	Not applicable	---	Neither night-setting nor squid bait used for tuna.	100%	Boggs 2003	Squid bait no longer permitted.
Underwater Setting Chute (USC)	88% (6.5m) 100% (9m) Mean = **94%**	Gilman et al. 2003	Assumes fully functional chutes.	**(94%)**	---	Assumes chute functionality equal to deep sets.
Single Tori Line (TL)	**(79 %)**	---	Use SF efficiency for tuna. Appears conservative for deep sets.	**79%**	McNamara 1999	
Paired Tori Lines	No data	---		No data	---	
Side Setting (SS)	**(99.8%)**	---	Use SF efficiency for tuna. Appears conservative for deep sets.	99.6-100% Mean = **99.8%**	Gilman et al. 2003	

It can be seen that most measures are very effective at reducing capture of seabirds, achieving 63% reductions or greater, as compared to fishing without any seabird mitigation measures. Caution should be exercised in comparing the quantitative results of different techniques, however, as they were tested under a variety of conditions, seabird densities, on different fishing platforms, and under different experimental protocols. Moreover, the variances about the point estimates are very wide and overlapping in many cases (Christofer Boggs, PIFSC, personal communication). Nevertheless, these are the best estimates we have of both absolute and relative efficacies of the measures under consideration, and these values are used later in this chapter to estimate seabird captures under the various alternatives.

Any discussion of the efficacy of seabird mitigation measures should also acknowledge the impact of captured bird drop-offs, and the need to normalize capture rates of seabirds relative to the abundance of seabirds around a fishing vessel. The absolute number of birds counted in experimental observations is subject to error from drop-offs or loss by predation of hooked and drowned birds from the longline. However, assuming that bird drop-off and loss rates are constant, this will not affect the relative comparison between different methods and controls. Estimates of drop-offs and loss in the Hawaii longline fishery have been made by Gilman et al. (2003) who found that 28% fewer birds were hauled aboard than were observed being caught during setting. This is consistent with observations by Brothers (1991) who observed 27% fewer birds on hauls than observed on sets in the Japanese tuna longline fishery in the Southern Ocean. Ward et al. (2004) analyzing observer data from a number of longline fisheries showed that the drop-off and loss of seabirds may be as high as 45% and is related to the length of longline soak time.

The results in Table 3 are from experiments conducted on a NMFS research vessel and on a commercial longline vessel, with detailed information recorded on interactions. In both instances the number of seabirds around the vessel was recorded along with the number of attempts and contacts with bait and/or the fishing line, and captures of seabirds. In contrast, observers deployed by NMFS on Hawaii-based longline vessels record seabird abundance within about 150 m of the vessel or around the gear at variable times during a fishing trip. However, most observations of seabird abundance were made by the observers during the haul, which typically occur during the afternoon and at night in the Hawaii longline tuna fleet. Albatross abundance is generally lower at night than during the day. It is also very difficult to accurately estimate bird abundance around the vessel in the dark (McNamara et al., 1999). As such, historical observer data collected by NMFS cannot be treated in the same way as experimental data when looking at the efficacy of different methods.

8.2 Potential Combinations of Deterrent Measures

This section qualitatively examines combinations of the available deterrent measures to see if any combinations would be an obvious improvement over single deterrent measures. Table 4 is a matrix for combining individual seabird deterrent measures for evaluation of all possible pairs of measures. Combinations are discussed by number in the paragraphs below as is the issue of whether individual measures would be anticipated to perform independently of each other (and thus tend to have an additive or cumulative effective) or whether they would interact with each other (either positively or negatively). Quantitative estimates of the efficacies of combinations of measures appearing in the alternatives are made in the next section.

Table 4 Seabird deterrent matrix

Deterrent Measure	Thawed Blue Bait	Strategic Offal Discard	Line-shooter	Tori line	Night-setting	Setting Chute	Side Setting
Thawed Blue Bait	Individual deterrent characteristics	1	2	3	4	5	6
Strategic Offal Discard		Individual deterrent characteristics	7	8	9	10	11
Line-shooter			Individual deterrent characteristics	12	13	14	15
Tori line				Individual deterrent characteristics	16	17	18
Night-setting					Individual deterrent characteristics	19	20
Setting Chute						Individual deterrent characteristics	21
Side Setting							Individual deterrent characteristics

Combination 1: Blue-dyed and thawed bait with strategic offal discard
These measures are independent of each other, and would tend to be additive in their deterrent effects. Both measures have merits, however each has intrinsic limitations in the current fishery, as described above. Blue dye is not as effective for coloring fish as it is for squid. Tests in New Zealand showed that dye uptake in bait fish was poorest for pilchards, most like mackerel of the baits tested (Holly Freifeld, USFWS, personal communication). Strategic offal discards may condition birds to associate longline vessels with food, thereby attracting more birds to the vessel and increasing the risk of interactions.

Combination 2: Blue-dyed and thawed bait with line-shooter and weighted branchlines (minimum 45g)
The measures are independent, and would tend to be additive in their deterrent effects. However, line-shooters previously have not been required for shallow-setting in the Hawaii longline fishery, and blue dye is not as effective with the mackerel-type bait now required for shallow-sets as it was with the squid formerly used as bait for swordfish.

Combination 3: Blue-dyed and thawed bait with tori line
There is anecdotal evidence that some Hawaii-based longline vessels employ tori lines in some circumstances, although this measure may have reduced effectiveness in the rough waters fished by this fleet. These two measures are independent, and would tend to be additive in their deterrent effects, however, blue dye is not as effective with the mackerel-type bait now required

for shallow-sets as it was with the squid formerly used as bait, and tori lines present a risk of entanglement with the main line or the propeller.

<u>*Combination 4:*</u> *Blue-dyed and thawed bait with night-setting*
The measures are independent of each other, and would tend to be additive in their deterrent effects, although blue bait may be unnecessary during darker moon phases or periods of high cloud cover, and blue dye is not as effective with the mackerel-type bait now required for shallow sets as it was with the squid formerly used as bait.

<u>*Combination 5:*</u> *Blue-dyed and thawed bait with setting chute*
The measures are independent of each other, and would tend to be additive in their deterrent effects. Blue dye is not as effective with the mackerel-type bait now required for shallow-sets as it was with the squid formerly used as bait. The setting chute, as tested to date, has design deficiencies that make it operationally problematic.

<u>*Combination 6:*</u> *Blue-dyed and thawed bait with side setting*
The measures are independent of each other, and would tend to be additive in their deterrent effects. Blue dye is not as effective with the mackerel-type bait now required for shallow-sets as it was with the squid formerly used as bait.

<u>*Combination 7:*</u> *Strategic offal discard with line shooter*
The measures are independent of each other, and would tend to be additive in their deterrent effects. Strategic offal discard is effective in luring birds away from the baits, but as noted above, may condition birds to approach longline vessels.

<u>*Combination 8:*</u> *Strategic offal discard with tori line*
There is anecdotal evidence that some Hawaii-based longline vessels employ tori lines in some circumstances. The measures are independent of each other, and would tend to be additive in their deterrent effects. Strategic offal discard is effective in luring birds away from the baits, but as noted above, may condition birds to approach longline vessels, and tori lines present a risk of entanglement with the main line or the propeller.

<u>*Combination 9:*</u> *Strategic offal discard with night-setting*
The measures are independent of each other, and would tend to be additive in their deterrent effects. However, to the extent birds discontinue feeding at night, strategic offal discard would presumably be less effective (although albatrosses have a well developed sense of smell) and, as noted above, may condition birds to approach longline vessels.

<u>*Combination 10:*</u> *Strategic offal discard with setting chute*
The measures are independent of each other, and would tend to be additive in their deterrent effects. Strategic offal discard is effective in luring birds away from the baits, but as noted above, may condition birds to approach longline vessels. The setting chute, as tested to date, has design deficiencies that make it operationally problematic.

Combination 11: Strategic offal discard with side setting
The measures are independent of each other, and would tend to be additive in their deterrent effects. Strategic offal discard is effective in luring birds away from the baits, but as noted above, may condition birds to approach longline vessels.

Combination 12: Line-shooter with tori line
The measures are independent of each other, and would tend to be additive in their deterrent effects. The slack put into the main line by the line shooter increases the risk of it tangling with the tori line under rough or windy conditions.

Combination 13: Line-shooter with night-setting
The measures are independent of each other, and would tend to be additive in their deterrent effects. Operationally however, line-shooters are used for deep, tuna sets which are done during daylight hours, and night-setting is done for shallow swordfish sets. The combination is not a practical one for either sector of the fleet, and does not appear in any of the alternatives.

Combination 14: Line-shooter with setting chute
The measures would not be independent, as the hook end of the branch line would be shot through the chute. Although tests of the setting chute were performed using a line shooter, the chute has design deficiencies that make it operationally problematic.

Combination 15: Line-shooter with side setting
The measures would not be independent, as the line-shooter would deploy line from the side of the vessel. This is how the line shooter was tested by Gilman, et al. (2003b), and it worked very well.

Combination 16: Tori line with night-setting
The measures are independent of each other, and would tend to be additive in their deterrent effects. Towing a deterrent at night when visibility is limited, however, would exacerbate the problems associated with keeping it clear of the main line or fouling with the propeller. The incremental improvement in deterrence over night-setting alone is likely to be small.

Combination 17: Tori line with setting chute
The measures are independent of each other, and would tend to be additive in their deterrent effects. However, the setting chute, as tested to date, has design deficiencies that make it operationally problematic.

Combination 18: Tori line with side setting
The measures are independent of each other, but it's unclear what would be the additive product of the deterrent effects. The tori line would have to be mounted from the bow or side of the vessel where the main line is being set. Such a deployment of a tori line on Hawaii-based longline vessels has not been tested.

Combination 19: *Night-setting with setting chute*
The measures are independent of each other, and would tend to be additive in their deterrent effects. The setting chute, as tested to date, has design deficiencies that make it operationally problematic.

Combination 20: *Night-setting with side setting*
The measures are independent of each other, and would tend to be additive in their deterrent effects.

Combination 21: *Setting chute with side setting*
In combination, these measures would not be independent, and this is an unlikely combination operationally as the chute would have to be mounted from the side in a manner so that it faces towards the stern. Limited testing of chutes in the Hawaii-based longline fishery resulted in structural failures however this may have been due to poor chute construction. Chute performance with side setting is untested and unknown.

Summary of Potential Combinations of Deterrent Measures

Considering the above assessments, an attempt was made to qualitatively rank the combinations relative to one another. Combination 21 (setting chute with side setting) was discarded as mechanically unworkable. Combination 18 (tori line with side setting) was discarded as not providing added deterrence over side setting alone. In general, combinations involving side setting faired best, but every combination had liabilities of one sort or another. Specifically, combinations employing blue bait suffered from the decreased performance of the dye on fish as compared with squid. Strategic offal discards may ultimately serve to attract more birds to the vicinity of the longline vessels. Line shooters work well for deep-sets, but are inappropriate for shallow-sets. Tori lines can be problematic operationally. Night-setting is appropriate for shallow-sets but not for deep-sets. For the setting chute to be a reliable, convenient measure, additional design development is required to resolve the difficulties encountered in testing of the prototypes.

In consideration of the above, a wide variety of alternatives are presented below. These alternatives are generally of the form where vessels may use the current suite of measures or one of the individual measures above, but alternatives are offered which also consider requiring side setting and dropping blue-dyed bait and strategic offal discard from the default suite of measures. I would not recommend that all vessels be required to side set at this point. It might be argued that since side setting effectively reduces seabird interactions to zero, that the Council should simply require all vessels to convert to side setting. Promising as side setting appears to be, however, there are compelling reasons to take a more cautious approach and maintain an element of flexibility in the methods available to operators in the Hawaii-based longline fishery. Experience in the Alaska demersal longline fishery has shown that a stepwise approach may be more "prudent "(Kim Rivera, NMFS, North Pacific Region, personal communication). Although mitigation measures can be shown to be effective under experimental conditions, their performance characteristics need to be evaluated under operational conditions during routine fishing operations, through the use of on-board observations. Such information has already been collected in the Hawaii fishery for measures such as blue dyed bait and strategic offal discards (Gilman 2004).

8.3 Alternatives for Reduction of Seabird Interactions in the Hawaii-based Longline Fishery

In this section a range of alternatives for mitigating seabird interactions in the Hawaii longline fishery are presented. The "no action" alternative means maintaining the current suite of measures implemented by current regulations. The action alternatives consist of a range of combinations of seabird deterrent measures as discussed above, and all alternatives would maintain the current requirements for Hawaii-based longline vessel owners and operators to follow seabird handling regulations and to annually attend a NMFS protected species workshop. As described in Section 7, at its 124th meeting (October 12-15, 2004) the Council took under advisement the possibility of deleting the thawed blue-dyed bait and strategic offal discard requirements from the preferred alternative, however this issue was resolved by receipt of a letter dated October 15, 2004 from the Department of the Interior to NMFS which clarified the USFWS position on these measures and the Council's final preferred alternative is described below as Alternative 7D.

<u>Alternative 1 No Action:</u> *Use current mitigation measures when fishing north of 23 °N.*

The current measures appear in Section 660 of Title 50 of the Code of Federal Regulations as follows:

(a) Seabird mitigation techniques. Owners and operators of vessels registered for use under a Hawaii longline limited access permit must ensure that the following actions are taken when fishing north of 23° N. lat.:

(1) Employ a line setting machine or line shooter to set the main longline when making deep sets using monofilament main longline;

(2) Attach a weight of at least 45 g to each branch line within 1 m of the hook when making deep sets using monofilament main longline;

(3) When using basket-style longline gear, ensure that the main longline is deployed slack to maximize its sink rate;

(4) Use completely thawed bait that has been dyed blue to an intensity level specified by a color quality control card issued by NMFS;

(5) Maintain a minimum of two cans (each sold as 0.45 kg or 1 lb size) containing blue dye on board the vessel;

(6) Discharge fish, fish parts (offal), or spent bait while setting or hauling longline gear, on the opposite side of the vessel from where the longline gear is being set or hauled;

(7) Retain sufficient quantities of fish, fish parts, or spent bait, between the setting of longline gear for the purpose of strategically discharging it in accordance with paragraph (a)(6) of this section;

(8) Remove all hooks from fish, fish parts, or spent bait prior to its discharge in accordance with paragraph (a)(6) of this section; and

(9) Remove the bill and liver of any swordfish that is caught, sever its head from the trunk and cut it in half vertically, and periodically discharge the butchered heads and livers in accordance with paragraph (a)(6) of this section.

(10) When shallow-setting north of 23° N. lat., begin the deployment of longline gear at least one hour after local sunset and complete the deployment no later than local sunrise, using only the minimum vessel lights necessary for safety.

(b) *Short-tailed albatross handling techniques.* If a short-tailed albatross is hooked or entangled by a vessel registered for use under a Hawaii longline limited access permit, owners and operators must ensure that the following actions are taken:

(1) Stop the vessel to reduce the tension on the line and bring the bird on board the vessel using a dip net;

(2) Cover the bird with a towel to protect its feathers from oils or damage while being handled;

(3) Remove any entangled lines from the bird;

(4) Determine if the bird is alive or dead.

(i) If dead, freeze the bird immediately with an identification tag attached directly to the specimen listing the species, location and date of mortality, and band number if the bird has a leg band. Attach a duplicate identification tag to the bag or container holding the bird. Any leg bands present must remain on the bird. Contact NMFS, the Coast Guard, or the U.S. Fish and Wildlife Service at the numbers listed on the Short-tailed Albatross Handling Placard distributed at the NMFS protected species workshop, inform them that you have a dead short-tailed albatross on board, and submit the bird to NMFS within 72 hours following completion of the fishing trip.

(ii) If alive, handle the bird in accordance with paragraphs (b)(5) through (b)(10) of this section.

(5) Place the bird in a safe enclosed place;

(6) Immediately contact NMFS, the Coast Guard, or the U.S. Fish and Wildlife Service at the numbers listed on the Short-tailed Albatross Handling Placard distributed at the NMFS protected species workshop and request veterinary guidance;

(7) Follow the veterinary guidance regarding the handling and release of the bird.

(8) Complete the short-tailed albatross recovery data form issued by NMFS.

(9) If the bird is externally hooked and no veterinary guidance is received within 24–48 hours, handle the bird in accordance with paragraphs (c)(4) and (c)(5) of this section, and release the bird only if it meets the following criteria:

(i) Able to hold its head erect and respond to noise and motion stimuli;

(ii) Able to breathe without noise;

(iii) Capable of flapping and retracting both wings to normal folded position on its back;

(iv) Able to stand on both feet with toes pointed forward; and

(v) Feathers are dry.

(10) If released under paragraph (a)(8) of this section or under the guidance of a veterinarian, all released birds must be placed on the sea surface.

(11) If the hook has been ingested or is inaccessible, keep the bird in a safe, enclosed place and submit it to NMFS immediately upon the vessel's return to port. Do not give the bird food or water.

(12) Complete the short-tailed albatross recovery data form issued by NMFS.

(c) *Non-short-tailed albatross seabird handling techniques.* If a seabird other than a short-tailed albatross is hooked or entangled by a vessel registered for use under a Hawaii longline limited access permit owners and operators must ensure that the following actions are taken:

(1) Stop the vessel to reduce the tension on the line and bring the seabird on board the vessel using a dip net;

(2) Cover the seabird with a towel to protect its feathers from oils or damage while being handled;

(3) Remove any entangled lines from the seabird;

(4) Remove any external hooks by cutting the line as close as possible to the hook, pushing the hook barb out point first, cutting off the hook barb using bolt cutters, and then removing the hook shank;

(5) Cut the fishing line as close as possible to ingested or inaccessible hooks;

(6) Leave the bird in a safe enclosed space to recover until its feathers are dry; and

(7) After recovered, release seabirds by placing them on the sea surface.

In addition all Hawaii-based longline vessel owners and operators must attend an annual NMFS protected species workshop.

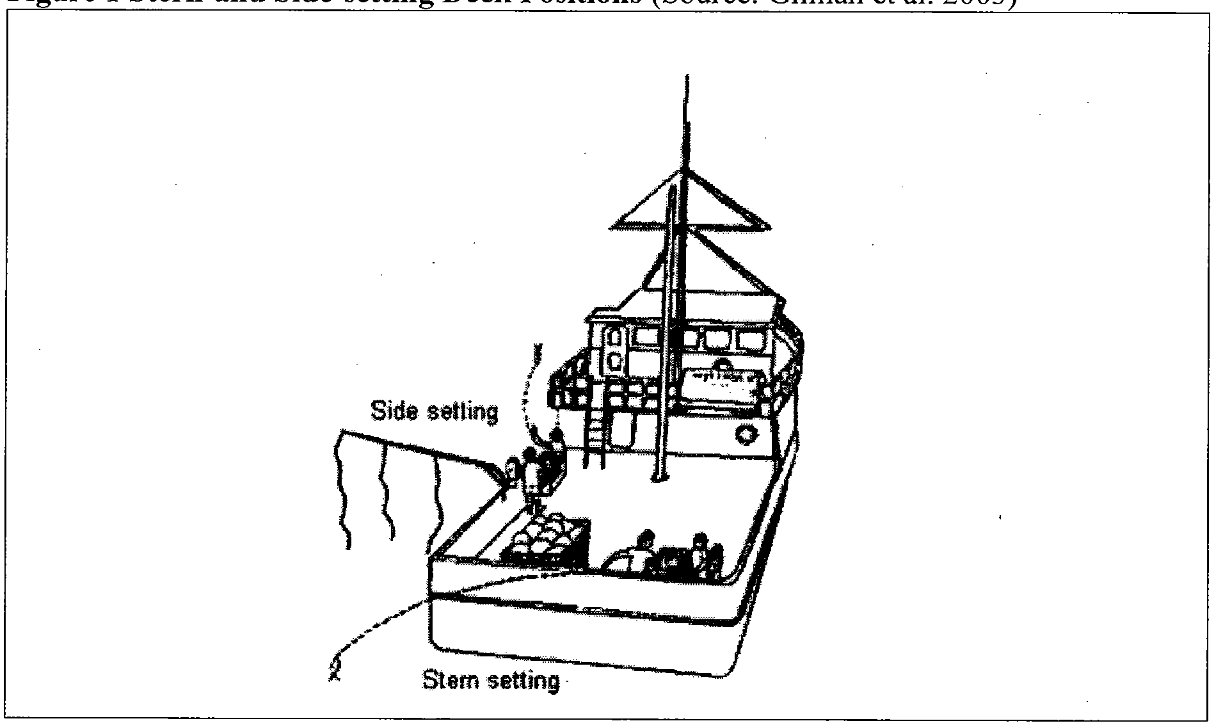
Alternative 2A: *Use current mitigation measures or use side setting, when fishing north of 23 °N.*

Under this alternative, operators of Hawaii-based longline vessels could elect to either (a) continue to use the current measures described above, or (b) employ side setting with 60g swivels within 1m of the hook according to the specifications below, when fishing north of 23 °N. Allowing vessel operators to choose between the current measures or side setting would increase flexibility and address safety concerns by offering the choice of current measures for those vessel operators unwilling to switch to 60 g weights. It also allows for the possibility that not all vessels can be configured for side setting.

For the purposes of this document and analysis, when side setting vessel operators would be required to comply with the following specifications:

Side set as far forward from the stern as possible
Deploy a bird curtain between the setting position and the stern
Throw baited hooks forward as close to the vessel hull as possible
Clip deployed branchlines to the mainline the moment that the vessel passes the baited hook to minimize tension in the branch line, which could cause the baited hook to be pulled towards the sea surface

Figure 1 Stern-and Side-setting Deck Positions (Source: Gilman et al. 2003)



Alternative 2B: Use current mitigation measures or use side setting, in all areas.

Under this alternative, operators of Hawaii-based longline vessels could elect to either (a) continue to use the current measures described above, or (b) employ side setting with 60g swivels within 1m of the hook according to the specifications above, in all areas.

Alternative 3A: Use current mitigation measures or use an underwater setting chute, when fishing north of 23 °N.

Under this alternative, operators of Hawaii-based longline vessels could elect to either (a) continue to use the current measures described above, or (b) use an underwater setting chute that has a minimum of 2.9m of its shaft underwater, when fishing north of 23 °N.

Alternative 3B: Use current mitigation measures or use an underwater setting chute, in all areas.

Under this alternative, operators of Hawaii-based longline vessels could elect to either (a) continue to use the current measures described above, or (b) use an underwater setting chute that has a minimum of 2.9m of its shaft underwater, in all areas.

Alternative 4A: Use current mitigation measures or use a tori line (e.g., paired streamer lines), when fishing north of 23 °N.

Under this alternative, operators of Hawaii-based longline vessels could elect to either (a) continue to use the current measures described above, or (b) employ one or more tori lines according to the general design used by McNamara et al. (1999) and Boggs (2001), when fishing north of 23 °N. Boggs (2001) and McNamara et al (1999) both provided specifications for single tori lines that were effective in reducing interactions with seabirds in their studies. In the study conducted by Boggs, a 150 m tori line comprised a 10 m attachment made of 6 mm yellow twisted polypropylene; a 40 m aerial streamer segment made of the same material with seven forked branch streamers, an 85 m x 3 mm red twisted nylon trailing segment with 8 small streamers on the first 40 m and a 15 m x 12 mm yellow twisted polypropylene drogue segment. The streamer line was flown from a commercially manufactured fiberglass pole mounted 4 m forward of the stern, extending 10 m above the water and 2 m outboard. The streamer line was about 8 m high at the stern and the ends of the first forked streamer dangled just above the water, 10 m behind the stern, about 5 m directly aft of the bait entry point. It is important to note, however, that Boggs' study was conducted aboard a NMFS research vessel, thus the mounting of the tori line is higher than would be possible onboard a commercial longline vessel.

In McNamara et al.'s (1999) study, the tori line varied from 140 -175 m in length depending on the zone of opportunity established for individual vessels. The line consisted of ¼ inch three strand polypropylene line, and six detachable aerial streamers. The aerial streamers were made of flexible material that moved just above the water's surface. The portion of the tori line that trailed in the water had short (10-25 cm) plastic streamers. The tori line that trailed in the water had short (10-25 cm) plastic streamers. The tori line incorporated a ½ inch hollow braid polypropylene drogue section at the terminal end. The tori line was positioned directly above the area where baited hooks were deployed. The height of the attachment point, length of the tori line, and weight of the aerial streamers determined the distance that the aerial streamer portion of the line remained aloft behind the vessel. A tori line of similar length specifications (140 -175m) was also deployed with a buoy at the end of the line, and with 1 m long plastic aerial streamers, and 10 inch water streamers.

Both Boggs (2001) and McNamara et al (1999) based the design of the tori lines used in their respective studies on tori lines used aboard pelagic longliners in the southern bluefin tuna fishery (Brothers et al (1994).

Figure 2 provides an example of a vessel using a tori line.

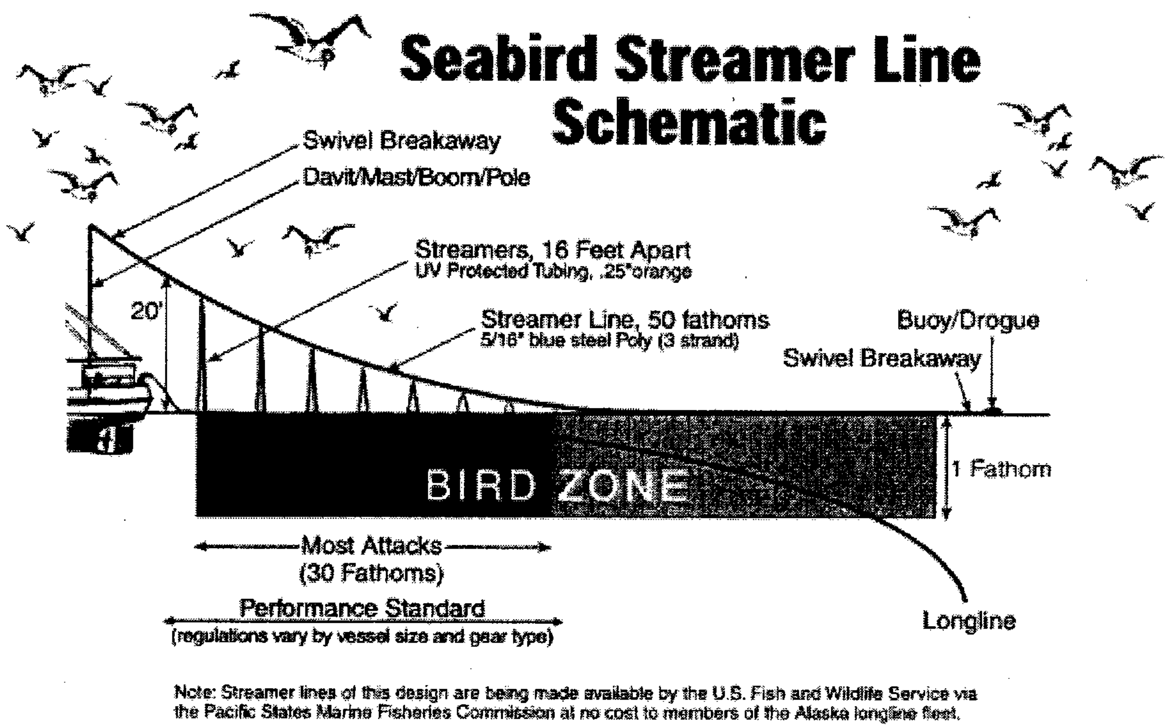


Figure 2 Schematic of a Tori Line Used in the Alaska Demersal Longline Fishery (Source: Melvin 2000)

<u>Alternative 4B:</u> Use current mitigation measures <u>or</u> use a tori line (e.g., paired streamer lines), in all areas.

Under this alternative, operators of Hawaii-based longline vessels could elect to either (a) continue to use the current measures described above, or (b) employ one or more tori lines according to the general design used by McNamara et al. (1999) and Boggs (2001), in all areas.

<u>Alternative 5A:</u> Use current mitigation measures <u>or</u> use side setting <u>or</u> use an underwater setting chute, when fishing north of 23 °N.

Under this alternative, operators of Hawaii-based longline vessels could elect to either (a) continue to use the current measures described above, or (b) employ side setting with 60g swivels within 1m of the hook according to the specifications above, or (c) employ an underwater setting chute that has a minimum of 2.9m of its shaft underwater, when fishing north of 23 °N.

<u>Alternative 5B:</u> Use current mitigation measures <u>or</u> use side setting <u>or</u> use an underwater setting chute, in all areas.

Under this alternative, operators of Hawaii-based longline vessels could elect to either (a) continue to use the current measures described above, or (b) employ side setting with 60g swivels within 1m of the hook according to the specifications above, or (c) employ an underwater setting chute that has a minimum of 2.9m of its shaft underwater, in all areas.

<u>Alternative 6A:</u> Use current mitigation measures <u>or</u> use side setting <u>or</u> use an underwater setting chute <u>or</u> use a tori line (e.g., paired streamer lines), when fishing north of 23 °N.

Under this alternative, operators of Hawaii-based longline vessels could elect to either (a) continue to use the current measures described above, or (b) employ side setting with 60g swivels within 1m of the hook according to the specifications above, or (c) employ an underwater setting chute that has a minimum of 2.9m of its shaft underwater, or (d) employ one or more tori lines according to the general design used by McNamara et al. (1999) and Boggs (2001), when fishing north of 23 °N.

<u>Alternative 6B:</u> Use current mitigation measures <u>or</u> use side setting <u>or</u> use an underwater setting chute <u>or</u> use a tori line (e.g., paired streamer lines), in all areas.

Under this alternative, operators of Hawaii-based longline vessels could elect to either (a) continue to use the current measures described above, or (b) employ side setting with 60g swivels within 1m of the hook according to the specifications above, or (c) employ an underwater setting chute that has a minimum of 2.9m of its shaft underwater, or (d) employ one or more tori lines according to the general design used by McNamara et al. (1999) and Boggs (2001), in all areas.

<u>Alternative 7A:</u> Use current measures or use side setting or use a tori line (e.g., paired streamer lines), when fishing north of 23 °N.

Under this alternative, operators of Hawaii-based longline vessels could elect to (a) continue to use the current measures described above, or (b) employ side setting with 60g swivels within 1m of the hook according to the specifications above, or (c) employ one or more tori bird-scaring lines according to the general design used by McNamara et al. (1999) and Boggs (2001), when fishing north of 23 °N.

<u>Alternative 7B:</u> Use current measures or use side setting or use a tori line (e.g., paired streamer lines), in all areas.

Under this alternative, operators of Hawaii-based longline vessels could elect to (a) continue to use the current measures described above, or (b) employ side setting with 60g swivels within 1m of the hook according to the specifications above, or (c) employ one or more tori bird-scaring lines according to the general design used by McNamara et al. (1999) and Boggs (2001), in all areas.

<u>Alternative 7C:</u> Swordfish (shallow-setting) vessels use "current" mitigation measures except thawed blue-dyed bait, <u>or</u> use side setting, <u>or</u> use an underwater setting chute that has a minimum of 2.9m of its shaft underwater, <u>or</u> use a tori line (e.g., paired streamer lines), in all areas. Tuna (deep-setting) vessels use "current" mitigation measures except thawed blue-dyed bait, <u>or</u> use side setting in conjunction with a line shooter and weighted branch lines, <u>or</u> use an underwater setting chute that has a minimum of 2.9m of its shaft underwater, <u>or</u> use a tori line (e.g., paired streamer lines) in conjunction with a line shooter and weighted branch lines, when fishing north of 23 °N.

Under this alternative operators of Hawaii-based longline vessels targeting swordfish (shallow-setting) could elect to (a) use the measures currently required for vessels fishing north of 23 °N as described above except the requirement to use thawed blue-dyed bait, or (b) employ side setting with 60g swivels within 1m of the hook according to the specifications, below, or (c) use an underwater setting chute that has a minimum of 2.9m of its shaft underwater, or (d) employ one or more tori bird-scaring lines according to the general design used by McNamara et al. (1999) and Boggs (2001), in all areas.

Operators of Hawaii-based longline vessels targeting tuna (deep-setting) could elect to (a) use the measures currently required for vessels fishing north of 23 °N as described above except the requirement to use thawed blue-dyed bait, or (b) employ side setting with 60g swivels within 1m of the hook according to the specifications above in conjunction with a line shooter with weights of at least 45 g placed within one meter of each hook, or (c) use an underwater setting chute that has a minimum of 2.9m of its shaft underwater, or (d) employ one or more tori bird-scaring lines according to the general design used by McNamara et al. (1999) and Boggs (2001), when fishing north of 23 °N.

<u>Alternative 7D</u>:. All deep setting Hawaii-based longline vessels must either side-set, or use a tori line plus the currently required measures (line shooter with weighted branch lines, blue dyed thawed bait and strategic offal discards) when fishing north of 23 ° - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present. All shallow setting Hawaii-based longline vessels must either side-set, or use a tori line plus the currently required measures (night-setting, blue dyed thawed bait and strategic offal discards) wherever they fish - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present.

Under this alternative operators of Hawaii-based longline vessels targeting swordfish (shallow-setting) could elect to (a) use the modified current measures as described above with the addition of one or more tori bird-scaring lines according to the general design used by McNamara et al. (1999) and Boggs (2001), or (b) employ side setting with 60g swivels within 1m of the hook, in all areas.

Operators of Hawaii-based longline vessels targeting tuna (deep-setting) could elect to (a) use the modified current measures as described above with the addition of one or more tori bird-scaring lines according to the general design used by McNamara et al. (1999) and Boggs (2001), or (b) employ side setting with 60g swivels within 1m of the hook, when fishing north of 23 °N.

<u>Alternative 8A</u>: *Use current mitigation measures <u>plus</u> side setting, when fishing north of 23 °N.*

Under this alternative, operators of Hawaii-based longline vessels would be required to continue to use the current measures described above as well as to employ side setting with 60g swivels within 1m of the hook as described above, when fishing north of 23 °N.

<u>Alternative 8B</u>: *Use current mitigation measures <u>plus</u> side setting, in all areas.*

Under this alternative, operators of Hawaii-based longline vessels would be required to continue to use the current measures described above as well as to employ side setting with 60g swivels within 1m of the hook as described above, in all areas.

<u>Alternative 9A</u>: *Use side setting when fishing north of 23 °N.*

Under this alternative, operators of Hawaii-based longline vessels would be required to employ side setting with 60g swivels within 1m of the hook as described above, when fishing north of 23 °N.

<u>Alternative 9B</u>: *Use side setting in all areas.*

Under this alternative, operators of Hawaii-based longline vessels would be required to employ side setting with 60g swivels within 1m of the hook as described above, in all areas.

Alternative 10A: Use side setting unless technically infeasible[2]*, in which case use current mitigation measures, when fishing north of 23 °N.*

Under this alternative, operators of Hawaii-based longline vessels would be required to employ side setting with 60g swivels within 1m of the hook as described above unless technically infeasible in which case they would be required to use the current measures described above, when fishing north of 23 °N.

Alternative 10B: Use side setting unless technically infeasible, in which case use current mitigation measures, in all areas.

Under this alternative, operators of Hawaii-based longline vessels would be required to employ side setting with 60g swivels within 1m of the hook as described above unless technically infeasible in which case they would be required to use the current measures described above, in all areas.

Alternative 11A: Use side setting unless technically infeasible, in which case either use current mitigation measures without blue bait or strategic offal discards (shallow-setting vessels set at night, deep-setting vessels use line shooters with weighted branch lines), or an underwater setting chute or a tori line, when fishing north of 23 °N.

Under this alternative operators of Hawaii-based longline vessels would be required to use side-setting with 60g swivels within 1m of the hook as described above unless technically infeasible, in which case shallow-setting vessels would be required to either (a) begin the setting process at least one hour after local sunset and complete the setting process by local sunrise, or (b) employ an underwater setting chute that has a minimum of 2.9m of its shaft underwater, or (c) employ one or more tori lines according to the general design used by McNamara et al. (1999) and Boggs (2001), when fishing north of 23 °N. Deep-setting vessels unable to side-set would be required to either (a) use the measures currently required for vessels fishing north of 23 °N, as described above, or (b) employ an underwater setting chute that has a minimum of 2.9m of its shaft underwater, or (c) employ one or more tori lines according to the general design used by McNamara et al. (1999) and Boggs (2001), when setting north of 23 °N.

Alternative 11B: Use side setting unless technically infeasible, in which case: swordfish (shallow-setting) vessels set at night, or use an underwater setting chute, or use a tori line (e.g., paired streamer lines), and tuna (deep-setting) vessels use current measures, or use an underwater setting chute, or use a tori line (e.g., paired streamer lines), when fishing north of 23 °N.

Under this alternative operators of Hawaii-based longline vessels would be required to use side-setting with 60g swivels within 1m of the hook as described above unless technically infeasible, in which case shallow-setting vessels would be required to either (a) begin the setting process at least one hour after local sunset and complete the setting process by local sunrise, or (b) employ

[2] The criteria for side setting infeasibility would be formulated by NMFS, in consultation with the Council and fishing industry during the rulemaking process.

an underwater setting chute that has a minimum of 2.9m of its shaft underwater, or (c) employ one or more tori lines according to the general design used by McNamara et al. (1999) and Boggs (2001), in all areas. Deep-setting vessels unable to side-set would be required to either (a) use the measures currently required for vessels fishing north of 23 °N, as described above, or (b) employ an underwater setting chute that has a minimum of 2.9m of its shaft underwater, or (c) employ one or more tori lines according to the general design used by McNamara et al. (1999) and Boggs (2001), in all areas.

Alternative 12: Voluntarily use side setting, an underwater setting chute, a tori line (e.g., paired streamer lines), night-setting, or a line shooter with weighted branch lines, when fishing south of 23 °N.

Under this alternative, operators of Hawaii-based longline vessels would be asked to voluntarily either (a) use side-setting with 60g swivels within 1m of the hook as described above, or (b) employ an underwater setting chute that has a minimum of 2.9m of its shaft underwater, or (c) employ one or more tori lines according to the general design used by McNamara et al. (1999) and Boggs (2001), or (d) begin the setting process at least one hour after local sunset and complete the setting process by local sunrise, or (e) use a line shooter with weights of at least 45 g placed within one meter of each hook, when fishing south of 23 °N.

A summary of these alternatives is provided in Table 5.

Table 5. Seabird mitigation measures included in each alternative. (Current requirements for annual protected species workshop attendance and seabird handling protocols would remain in place under all under all alternatives.)

Alt.	Description
1	**CURRENT MEASURES** **All Hawaii-based longline vessels** fishing north of 23° N. must: Discharge offal and spent bait on the opposite side from setting or hauling Use blue-dyed, thawed bait, and have a minimum of 2 cans of dye onboard **Vessels deep-setting** north of 23° N. must use a line setting machine (line shooter) and use minimum 45g weights within 1m of each hook, if using a monofilament main line[1] **Vessels shallow-setting** north of 23° N must begin setting at least 1 hour after local sunset and complete the setting process by local sunrise, using the minimum vessel lights necessary
2A	Use current mitigation measures **OR** use side setting, when fishing north of 23° N.
2B	Use above current mitigation measures **OR** use side setting, in all areas
3A	Use current mitigation measures **OR** use an underwater setting chute, when fishing north of 23° N.
3B	Use above current mitigation measures **OR** use an underwater setting chute, in all areas
4A	Use current mitigation measures **OR** use a tori line (e.g. paired streamer lines), when fishing north of 23° N.
4B	Use above current mitigation measures **OR** use a tori line (e.g. paired streamer lines), in all areas
5A	Use current mitigation measures **OR** use side setting **OR** use an underwater setting chute, when fishing north of 23° N.
5B	Use above current mitigation measures **OR** use side setting **OR** use an underwater setting chute, in all areas
6A	Use current mitigation measures **OR** use side setting **OR** use an underwater setting chute **OR** use a tori line (e.g. paired streamer lines), when fishing north of 23° N.

6B	Use above current mitigation measures **OR** use side setting **OR** use an underwater setting chute **OR** use a tori line (e.g. paired streamer lines), in all areas
7A	Use current mitigation measures **OR** use side setting **OR** use a tori line (e.g. paired streamer lines), when fishing north of 23° N.
7B	Use above current mitigation measures **OR** use a tori line (e.g. paired streamer lines), in all areas
7C	a. In all areas, shallow setting boats use current mitigation measures, excluding the requirement to use blue-dyed bait, OR use side setting **OR** use an underwater setting chute **OR** use a tori line (e.g. paired streamer lines). b. North of 23° N. deep setting boats use current mitigation measures, excluding the requirement to use blue-dyed bait, **OR** use side setting **OR** use an underwater setting chute **OR** use a tori line (e.g. paired streamer lines), in conjunction with a line shooter and weighted branch lines.
7D	a. All deep setting vessels must either side-set, or use a tori line plus the currently required measures (line shooter with weighted branch lines, blue dyed thawed bait and strategic offal discards) when fishing north of 23° - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present; b. All shallow setting vessels must either side-set, or use a tori line plus the currently required measures (night-setting, blue dyed thawed bait and strategic offal discards) wherever they fish - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present.
8A	Use current mitigation measures **PLUS** side setting, when fishing north of 23° N.
8B	Use above current mitigation measures **PLUS** side setting, in all areas
9A	Use side setting when fishing north of 23° N.
9B	Use side setting in all areas
10A	Use side setting **UNLESS** technically infeasible in which case use current mitigation measures, when fishing north of 23° N.
10B	Use side setting **UNLESS** technically infeasible in which case use above current mitigation measures, in all areas

11A	Use side setting **UNLESS** technically infeasible, in which case use an underwater setting chute **OR** a tori line **OR** current mitigation measures without blue bait or strategic offal discards (shallow-setting vessels set at night, deep-setting vessels use line shooters with weighted branch lines), when fishing north of 23° N.
11B	Use side setting **UNLESS** technically infeasible, in which case use an underwater setting chute **OR** a tori line **OR** above current mitigation measures without blue bait or strategic offal discards (shallow-setting vessels set at night, deep-setting vessels use line shooters with weighted branch lines), in all areas
12	Voluntarily use side setting, **OR** night-setting, **OR** an underwater setting chute, **OR** a tori line, **OR** a line shooter with weighted branch lines, when fishing south of 23° N.

1. Basket gear may also be used if deep set longline fishing above 23° N., with a requirement that the mainline be set slack to maximize the sinking of baited hooks

8.4 Alternatives Considered but Eliminated from Detailed Analysis

As noted above, the primary objective of the proposed action is the cost-effective further reduction of the potentially harmful effects of fishing by Hawaii-based longline vessels on the short-tailed albatross, but the overarching goal is to reduce the potentially harmful effects of fishing by Hawaii-based longline vessels on all seabirds in a cost-effective manner. The strategy adopted to meet this action's objective is to reduce the rate of longline-seabird interactions. The alternative strategy, to reduce the consequences of interactions, is represented in current regulations by two measures, mandatory seabird handling techniques and annual attendance at a NMFS protected species workshop. These measures will remain in effect under all alternatives. They are not a part of the current action and will not be affected by it. No alternatives to eliminate or modify these measures were evaluated.

Some possible combinations of mitigation measures did not specifically appear in any of the alternatives due to impracticality or redundancy and these were, in effect, alternatives considered but not carried forward.

The alternatives that are analyzed here are intended to satisfy the objective of reducing the harmful effects of seabird interactions in the Hawaii-based longline fishery. Alternatives to impose measures on vessels registered to General Longline Permits were considered, but not carried forward. These vessels are prohibited from fishing in EEZ waters around Hawaii or landing any fish in Hawaii. They might tranship catches into Hawaii, but this has never happened in the history of the Hawaii fishery, due to the economics of running two vessels to land one vessel's catch (Sean Martin, personal communication).

Alternatives to impose measures on longline vessels based in California but not registered to Hawaii limited access permits were not considered as the Council does not have jurisdiction over these vessels which are prohibited from fishing in EEZ waters around Hawaii or landing any fish in Hawaii.

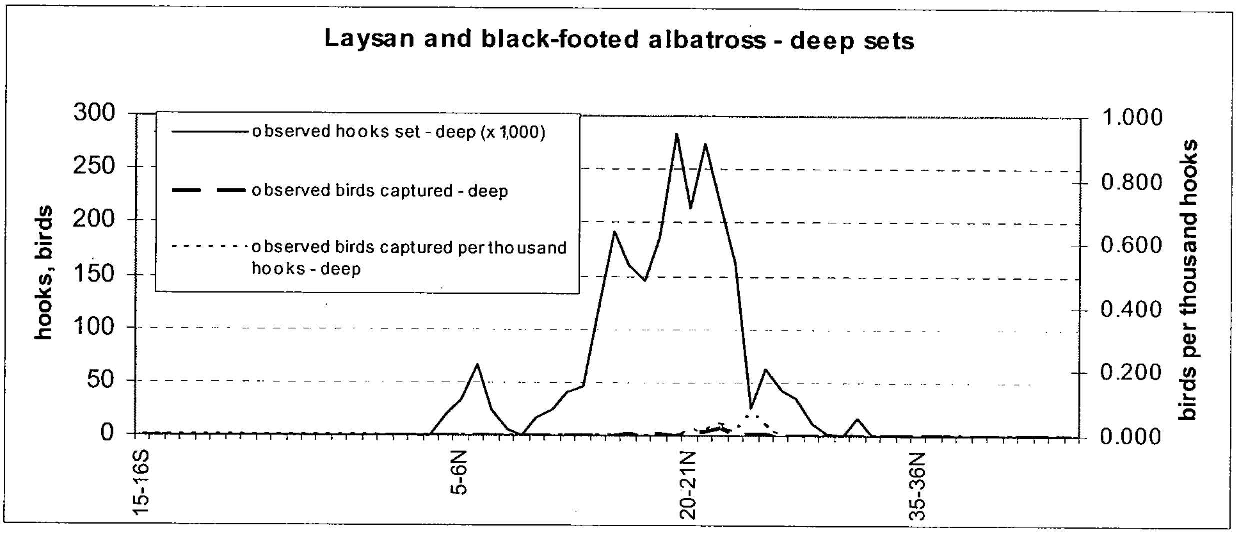
Other seabird interaction mitigation measures have been informally tested by fishermen (weighted hooks, towed trash bags, avoidance of setting in the vessel's wake, undyed thawed bait) and at least one, the bait-setting capsule, has been developed and tested as a prototype. Noise making, either with explosive devices or horns, has been shown to be ineffective. None of these measures, however, were considered by the Council in formulating its proposed action. None of these could be expected to have benefits of a different nature or greater magnitude than those evaluated here. Further, none of them have been tested in the Hawaii-based longline fishery, and their efficacies are unknown. Consequently, none of these measures were included in the alternatives evaluated here.

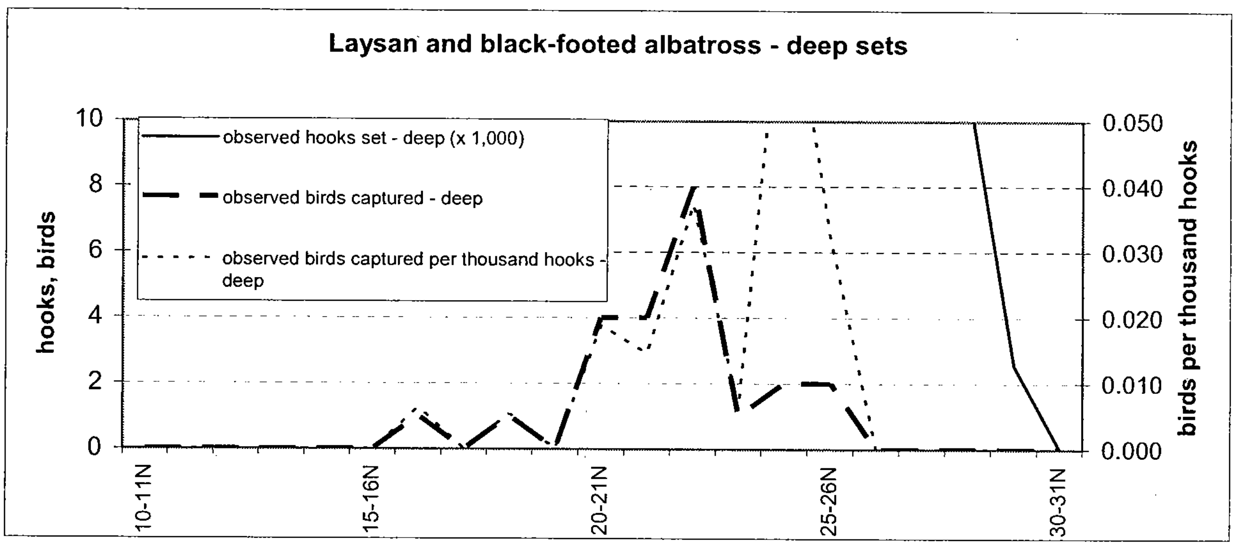
Other types of hooks and baits could eventually prove useful in mitigating seabird interactions. At this time, however, the specifications of hook and bait type in this fishery are rooted in experiments conducted in the Atlantic Ocean which dramatically reduced interactions with leatherback and loggerhead sea turtles. Any other combination of hook and bait would first have to be tested for efficacy in deterring interactions with sea turtles, and therefore, variations of hook or bait types were not included in the alternatives evaluated here.

Many of the alternatives considered here are paired, with one alternative employing seabird deterrents only at latitudes above 23° N. and the other employing deterrent measures wherever fishing is done. The current threshold for implementation of seabird deterrent measures in the Hawaii-based fleet is 23° N. The original rationale for that selection was to protect STAL and that is the lowest latitude at which a short-tailed albatross has ever been seen near Hawaii. The objective of this action however, is to cost-effectively reduce the harmful effects of all seabird captures by the fleet, so a reexamination of the rationale for this threshold is appropriate.

Black-footed and Laysan albatrosses forage across broad expanses of the Pacific ocean with black-footed albatrosses tending to move east to the coast of North America and Laysans tending to fly northward to the Gulf of Alaska. Foraging habitat includes the oceanic fronts and transition zone at latitudes north of Hawaii where elevated nutrient concentrations stimulate phytoplankton growth and indirectly all other trophic levels. Elevated squid concentrations attract seabirds, but they also attract swordfish, which in turn attract longline vessels and increase the likelihood of interactions between longlines and seabirds. Observer data were analyzed by 1degree increments to determine at which latitudes interactions were most prevalent (NMFS, PIRO unpub. data). Figures 3 and 4 graph combined Laysan and black-footed albatross captures observed in deep and shallow sets respectively before implementation of mandatory deterrent measures north of 23° N. The general conclusions are 1) there are no captures south of about 16° N despite a moderate amount of deep-set effort, 2) there are relatively few captures south of 23° N, 3) there is a rapid increase in captures at latitudes of 23° -26° N, 4) there is a relatively high rate of capture between about 27° and 30° N. (STFZ), 5) capture rates decrease in the range 31° - 41° °N. (Transition Zone [TZ]), and 6) very high capture rates are seen at still higher latitudes (SAFZ). "Observed captures" means birds recorded by NMFS vessel observers as hooked or entangled in the longline gear. These rates of observed fishing effort and interactions are not necessarily representative of actual rates of fishing effort or interactions but they represent the best available information.

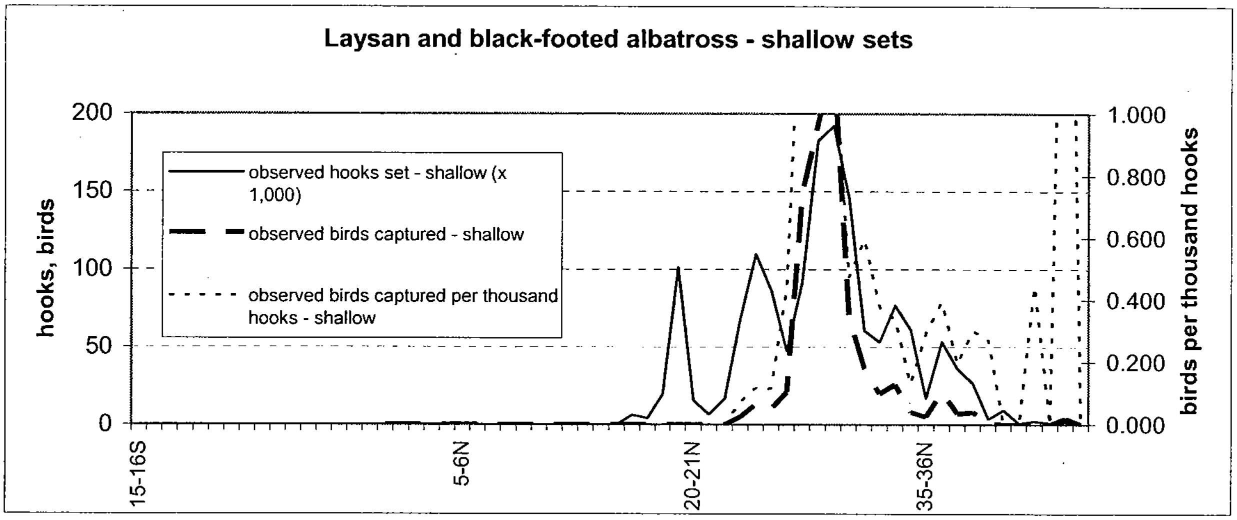
Figure 3 Observed Albatross Captures by Latitude in the Deep-set Sector of the Hawaii-based Longline Fishery (1994-1999) (Source: NMFS, Pacific Islands Regional Office, December 6, 2004)

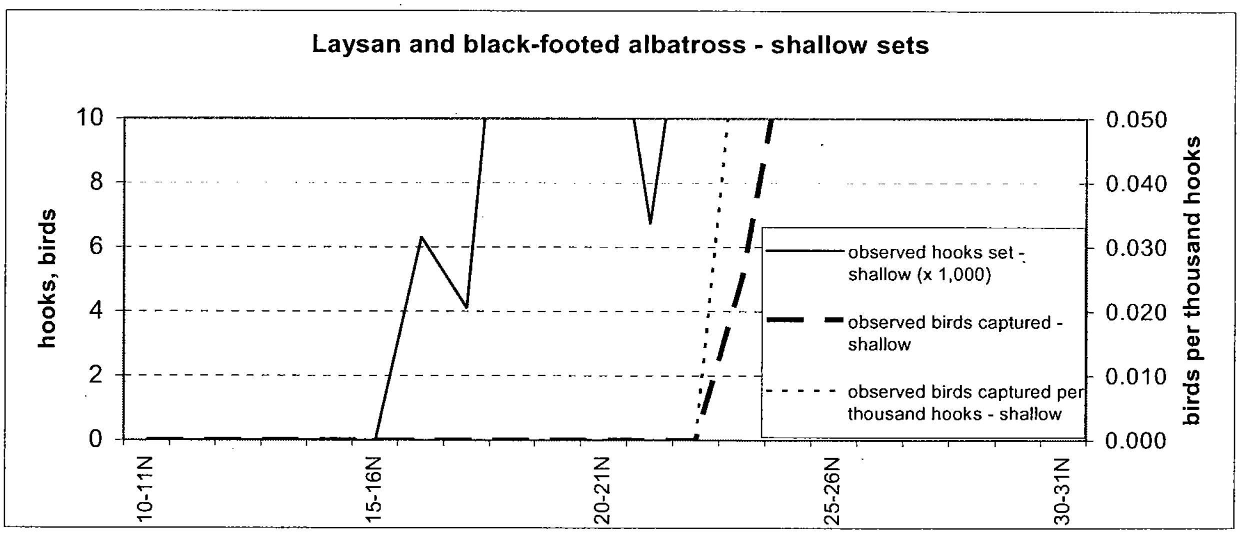




Set latitudes were put into 1 degree categories. For example, the 0-1 degree N. category included sets whose latitude was greater than or equal to 0 degrees and less than 1 degree N. ; the 0-1 degree S. category included sets whose latitude was greater than or equal to 0 degree and less than 1 degree S. (no sets on the equator were recorded). The latitude of a given set was taken as the vessel's latitude at the beginning of the deployment of the set. The lower graph is an expanded view of the portion of the upper graph where captures become more numerous. Note the different scales.

Figure 4 Observed Albatross Captures by Latitude in the Shallow-set Sector of the Hawaii-based Longline Fishery (1994-1999) (Source: NMFS, Pacific Islands Regional Office, December 6, 2004)





Set latitudes were again put into 1 degree categories. For example, the 0-1 degree N. category included sets whose latitude was greater than or equal to 0 degree and less than 1 degree N. ; the 0-1 degree S. category included sets whose latitude was greater than or equal to 0 degree and less than 1 degree S. (no sets on the equator were recorded). The latitude of a given set was taken as the vessel's latitude at the beginning of the deployment of the set. The lower graph is an expanded view of the portion of the upper graph where captures become more numerous. Note the different scales.

Another category of potential alternatives is time and/or area closures (obviously a time closure would apply to a certain area, or an area closure would apply for a specific time). The Hawaii-based longline fleet is currently subject to area closures around the NWHI and the MHI, the former especially significant in prohibiting longlining near seabird nesting areas. Time and area closures were considered in some detail but were not carried forward because the measures proved incompatible with the objective of the management measure to cost-effectively reduce the potential and real impacts of the fishery on seabirds. The paragraphs below summarize seasonable variability in seabird capture in the Hawaii-based longline fishery, and provide rationale for rejection of these types of operational controls on the fleet.

Seabird captures by the Hawaii-based longline fleet are characterized by strong seasonal variability. NMFS' annual report on seabird interactions in the longline fishery (NMFS 2004c) summarizes the 2003 takes by calendar quarter as shown in Table 6.

Table 6. Interactions with Black-footed and Laysan Albatross by Hawaii-based Longline Vessels by Calendar Quarter for 2003 (Source: NMFS 2004c)

Albatross Species	Interactions per Quarter				Total Takes
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	
Black-footed	28	76	7	0	111
95% C.I.	6-58	36-114	1-27	0-12	NA
Laysan	28	118	0	0	146
95% C.I.	6-58	71-161	0-16	0-12	NA

Cousins and Cooper (2000) summarize the reproductive biology of the black-footed albatross as follows. Black-footed albatross lay their eggs in mid-November to early December. The mean incubation period is 65.6 days, during which time the adults forage close to the breeding colony. The chick hatches between mid-January and early February, and a brooding period lasting one to two weeks ensues. During this period, at least one parent stays with the chick. The adults forage close to the breeding colony during this period as well, but subsequently begin to take longer trips of two to three weeks. First quarter takes are markedly lower than second quarter takes and this may reflect the fact that adults are feeding very close to the colony during the first quarter, perhaps predominantly within the area around the NWHI closed to longline fishing. Feeding of the chick continues into June, and fledging takes place in late July after the parents cease feeding the chick. Adults spend the remainder of the year dispersed over the northern Pacific. Non-breeders and failed breeders leave the colony earlier, in April. The Laysan albatross breeding schedule is similar to that of the black-footed albatross. Given this seasonality of breeding colony occupation, it's clear why the observed albatross takes are so heavily concentrated in the first half of the year.

Consideration of time or area limitations on effort must be tempered by an appreciation that seasonality in swordfish effort that corresponds with the seasonality of seabird abundance in the NWHI. The Hawaii-based shallow-set effort is strongly seasonal, with the greatest effort concentrated in the first half of the year. This is brought about by annual cycles of oceanographic conditions. In the summer and fall, water temperatures favorable for fishing for swordfish are found far to the north. At those latitudes, trips are long, fuel costs are high, weather can be unpredictable and dangerous, and product quality can suffer. In the winter and spring, cooler water is closer to Hawaii and trips are shorter, safer and more economical. This is why Hawaii-based swordfish effort is concentrated during the first half of the year, and why effort limitations during that period could severely impact the economics of the fleet. Given the objective of this action (the cost-effective reduction of the effects of the Hawaii-based longline fishery on seabirds), the status of potentially affected seabird populations (apparently stable to increasing, see Section 10.5), and the availability of a broad range of alternative measures, time/area closures were not considered in detail.

None of the alternatives explicitly include additional information gathering or analysis of effectiveness. Any form of evaluation of mitigation measures on commercial fishing vessels will be dependent on the ability of observers to gather useful information on the performance of seabird avoidance measures, and the types of adjustments to the requirements that might then be pursued. As noted below, the records made by the current NMFS observer program do not always lend themselves to the collection of statistically reliable data. Collection of detailed information on the performance of various mitigation measures may require the deployment of observers solely dedicated to observing seabirds and their interactions with longlines.

9.0 National Environmental Policy Act

A Final Environmental Impact Statement is being prepared by NMFS for this action. A Draft Environmental Impact Statement was published on August 27, 2004.

10.0 Physical and Biological Environment

This section provides background information on the natural environment in which the Pelagics FMP fisheries operate.

10.1 Oceanographic Environment

The Hawaiian Archipelago and the Marianas Archipelago, which includes Guam and the Commonwealth of the Northern Mariana Islands (CNMI), lie in the North Pacific subtropical gyre, while American Samoa lies in the South Pacific subtropical gyre. These subtropical gyres rotate clockwise in the Northern Hemisphere and counter clockwise in the Southern Hemisphere in response to tradewind and westerly wind forcing. Hence the Main Hawaiian Islands (MHI), Guam and CNMI, and American Samoa experience weak mean currents flowing from east to west, while the northern portion of the Hawaiian Archipelago experiences a weak mean current flowing from west to east. Imbedded in this mean flow are an abundance of mesoscale eddies created from wind and current interactions with bathymetry. These eddies, which can rotate either clockwise or counter clockwise, have important biological impacts. Eddies create vertical fluxes, with regions of divergence (upwelling) where the thermocline shoals and deep nutrients are pumped into surface waters enhancing phytoplankton production, and also regions of convergence (downwelling) where the thermocline deepens. North and south of the islands are frontal zones that also provide an important habitat for pelagic fish and thus are targeted by fishers. To the north of the Hawaiian and Marianas Archipelagoes, and also to the south of American Samoa, lie the subtropical frontal zones consisting of several convergent fronts located along latitudes 25°-40° N. and S. often referred to as the Transition Zones. To the south of the Hawaiian and Marianas Archipelagoes, and to the north of American Samoa, spanning latitudes 15° N.-15° S. lies the equatorial current system consisting of alternating east and west zonal flows with adjacent fronts.

Significant sources of interannual physical and biological variation are the El Niño and La Niña events. During an El Niño, the normal easterly trade winds weaken, resulting in a weakening of the westward equatorial surface current and a deepening of the thermocline in the central and eastern equatorial Pacific. Water in the central and eastern equatorial Pacific becomes warmer and more vertically stratified with a substantial drop in surface chlorophyll. A La Niña event exhibits the opposite conditions. During an El Niño the purse seine fishery for skipjack tuna shifts over 1,000 km from the western to the central equatorial Pacific in response to physical and biological impacts (Lehodey et al., 1997).

Physical and biological oceanographic changes have also been observed on decadal time scales. These low frequency changes, termed regime shifts, can impact the entire ocean basin. Recent regime shifts in the North Pacific have occurred in 1976 and 1989, with both physical and biological (including fishery) impacts (Polovina, 1996; Polovina et al., 1995).

Pelagic species are closely associated with their physical and chemical environment. Suitable physical environment for these species depends on gradients in temperature, oxygen or salinity, all of which are influenced by oceanic conditions on various scales. In the pelagic environment, physical conditions such as isotherm and isohaline boundaries often determine whether or not the surrounding water mass is suitable for pelagic fish, and many of the species are associated with specific isothermic regions. Additionally, areas of high trophic transfer as found in fronts and eddies are an important habitat for foraging, migration, and reproduction for many species (Bakun, 1996).

Oceanic pelagic fish such as skipjack and yellowfin tuna, and blue marlin prefer warm surface layers, where the water is well mixed by surface winds and is relatively uniform in temperature and salinity. Other fish such as albacore, bigeye tuna, striped marlin and swordfish, prefer cooler, more temperate waters, often meaning higher latitudes or greater depths. Preferred water temperature often varies with the size and maturity of pelagic fish, and adults usually have a wider temperature tolerance than sub-adults. Thus, during spawning, adults of many pelagic species usually move to warmer waters, the preferred habitat of their larval and juvenile stages. Large-scale oceanographic events (such as El Niño) change the characteristics of water temperature and productivity across the Pacific, and these events have a significant effect on the habitat range and movements of pelagic species. Tunas are commonly most concentrated near islands and seamounts that create divergences and convergences which concentrate forage species, also near upwelling zones along ocean current boundaries, and along gradients in temperature, oxygen and salinity. Swordfish and numerous other pelagic species tend to concentrate along food-rich temperature fronts between cold, upwelled water and warmer oceanic water masses.

These fronts represent sharp boundaries in a variety of physical parameters including temperature, salinity, chlorophyll, and sea surface height (geostrophic flow) (Niiler and Reynolds, 1984; Roden, 1980; Seki et al., in press). Biologically, these convergent fronts appear to represent zones of enhanced trophic transfer (Bakun, 1996; Olsen et al., 1994). The dense cooler phytoplankton-rich water sinks below the warmer water creating a convergence of phytoplankton (Roden, 1980; Polovina et al., in review). Buoyant organisms, such as jellyfish as well as vertically swimming zooplankton, can maintain their vertical position in the weak down-welling, and aggregate in the front to graze on the down-welled phytoplankton (Bakun, 1996; Olsen et al., 1994). The increased level of biological productivity in these zones attracts higher trophic-level predators such as swordfish, tunas, seabirds, and sea turtles, and ultimately a complete pelagic food web is assembled.

Near Hawaii, there are two prominent frontal zones. These frontal zones are associated with two isotherms (17° C and 20° C), and they are climatologically located at latitudes 32°-34° N. (the Subtropical Front or STF) and latitudes 28°-30° N. (the South Subtropical Front or SSTF) (Seki et al., in press). Both the STF and SSTF represent important habitats for swordfish, tunas, seabirds and sea turtles. Variations in their position play a key role in catch rates of swordfish and albacore tuna, and distribution patterns of Pacific pomfret, flying squid, loggerhead turtles (Seki et al., in press), and seabirds. Hawaii-based longline vessels targeting swordfish set their lines where the fish are believed to be moving south through the fronts following squid, the primary prey of swordfish (Seki et al., in press). Squid is also the primary prey item for albatross (Harrison et al., 1983), hence the albatross and longline vessels targeting swordfish are often present at the same time in the same area of biological productivity.

These frontal zones have also been found to be likely migratory pathways across the Pacific for loggerhead turtles (Polovina et al., 2000). Loggerhead turtles are opportunistic omnivores that feed on floating prey such as the pelagic cnidarian *Velella velella* ("by the wind sailor"), and the pelagic gastropod Janthina sp., both of which are likely to be concentrated by the weak downwelling associated with frontal zones (Polovina et al., 2000). Data from on-board observers in the Hawaii-based longline fishery indicate that incidental catch of loggerheads occurs along the 17° C front (STF) during the first quarter of the year and along the 20° C front (SSTF) in the second quarter of the year. The interaction rate, however, is substantially greater along the 17° C front (Polovina et al., 2000).

Species of oceanic pelagic fish live in tropical and temperate waters throughout the world's oceans. They are capable of long migrations that reflect complex relationships to oceanic environmental conditions. These relationships are different for larval, juvenile and adult stages of life. The larvae and juveniles of most species are more abundant in tropical waters, whereas the adults are more widely distributed. Geographic distribution varies with seasonal changes in ocean temperature. In both the Northern and Southern Hemispheres, there is seasonal movement of tunas and related species toward the pole in the warmer seasons and a return toward the equator in the colder seasons. In the western Pacific, pelagic adult fish range from as far north as Japan to as far south as New Zealand. Albacore, striped marlin and swordfish can be found in even cooler waters at latitudes as far north as latitude 50° N. and as far south as latitude 50° S. As a result, fishing for these species is conducted year-round in tropical waters and seasonally in temperate waters.

Migration patterns of pelagic fish stocks in the Pacific Ocean are not easily understood or categorized, despite extensive tag-and-release projects for many of the species. This is particularly evident for the more tropical tuna species (e.g., yellowfin, skipjack, bigeye) which appear to roam extensively within a broad expanse of the Pacific centered on the equator. Although tagging and genetic studies have shown that some interchange does occur, it appears that short life spans and rapid growth rates restrict large-scale interchange and genetic mixing of eastern, central and far-western Pacific stocks of yellowfin and skipjack tuna. Morphometric studies of yellowfin tuna also support the hypothesis that populations from the eastern and western Pacific derive from relatively distinct sub-stocks in the Pacific. The stock structure of bigeye in the Pacific is poorly understood, but a single, Pacific-wide population is assumed. The movement of the cooler-water tuna (e.g., bluefin, albacore) is more predictable and defined, with tagging studies documenting regular and well-defined seasonal movement patterns relating to specific feeding and spawning grounds. The oceanic migrations of billfish are poorly understood, but the results of limited tagging work conclude that most billfish species are capable of transoceanic movement, and some seasonal regularity has been noted.

In the ocean, light and temperature diminish rapidly with increasing depth, especially in the region of the thermocline. Many pelagic fish make vertical migrations through the water column. They tend to inhabit surface waters at night and deeper waters during the day, but several species make extensive vertical migrations between surface and deeper waters throughout the day. Certain species, such as swordfish and bigeye tuna, are more vulnerable to fishing when they are concentrated near the surface at night. Bigeye tuna may visit the surface during the night, but generally, longline catches of this fish are highest when hooks are set in deeper, cooler waters just above the thermocline (275-550 meters or 150-300 fathoms). Surface concentrations of juvenile albacore are largely concentrated where the warm mixed layer of the ocean is shallow (above 90 m or 50 fm), but adults are caught mostly in deeper water (90-275 m or 50-150 fm). Swordfish are usually caught near the ocean surface, but are known to venture into deeper waters. Swordfish demonstrate an affinity for thermal oceanic frontal systems which may act to aggregate their prey (Seki et al., in press) and enhance migration by providing an energetic gain by moving the fish along with favorable currents (Olsen et al., 1994).

10.2 Pelagic Management Unit Species

The Pelagics FMP manages a suite of "pelagic management unit species" (PMUS, see Table 7). These species have been assigned to species assemblages based upon the ecological relationships between species and their preferred habitat. The species complex designations for the PMUS are marketable species, non-marketable species and sharks. The marketable species complex has been subdivided into tropical and temperate assemblages. The temperate species complex includes those PMUS that are found in greater abundance in higher latitudes as adults including swordfish, bigeye tuna, bluefin tuna, albacore tuna, striped marlin and pomfret. The tropical species complex includes all other tunas and billfish as well as *mahimahi*, wahoo and *opah*.

Species of oceanic pelagic fish live in tropical and temperate waters throughout the world's oceans, and they are capable of long migrations that reflect complex relationships to oceanic environmental conditions. These relationships are different for larval, juvenile and adult stages of life. The larvae and juveniles of most species are more abundant in tropical waters, whereas the adults are more widely distributed. Geographic distribution varies with seasonal changes in ocean temperature. Migration patterns of pelagic fish stocks in the Pacific Ocean are not easily understood or categorized, despite extensive tag-and-release projects for many of the species. This is particularly evident for the more tropical tuna species (e.g., yellowfin, skipjack, bigeye, which appear to roam extensively within a broad expanse of the Pacific centered on the equator. Likewise, the oceanic migrations of billfish are poorly understood, but the results of limited tagging work conclude that most billfish species are capable of transoceanic movement, and some seasonal regularity has been noted.

Movements of pelagic species are not restricted to the horizontal dimension. In the ocean, light and temperature diminish rapidly with increasing depth, especially in the region of the thermocline. Many pelagic fish make vertical migrations through the water column, often moving toward the surface at night to feed on prey species that exhibit similar diurnal vertical migrations. Certain species, such as swordfish, are more vulnerable to fishing when they are concentrated near the surface at night. Bigeye tuna may visit the surface during the night, but generally, longline catches of this fish are highest when hooks are set in deeper, cooler waters.

Adult swordfish are opportunistic feeders, preying on squid and various fish species. Oceanographic features such as frontal boundaries that tend to concentrate forage species (especially cephalopods) apparently have a significant influence on adult swordfish distributions in the North Pacific.

Table 7. Pelagic Management Unit Species

English or Common Name	Scientific Name
Mahimahi (dolphinfishes)	*Coryphaena* spp.
Wahoo	*Acanthocybium solandri*
Indo-Pacific blue marlin: Black marlin	*Makaira mazara: M. indica*
Striped marlin	*Tetrapturus audax*
Shortbill spearfish	*T. angustirostris*
Swordfish	*Xiphias gladius*
Sailfish	*Istiophorus platypterus*
Pelagic thresher shark	*Alopias pelagicus*
Bigeye thresher shark	*Alopias superciliosus*

Table 7. Pelagic Management Unit Species

English or Common Name	Scientific Name
Common thresher shark	*Alopias vulpinus*
Silky shark	*Charcharinus falciformis*
Oceanic whitetip shark	*Carcharhinus longimanus*
Blue shark	*Prionace glauca*
Shortfin mako shark	*Isurus oxyrinchus*
Longfin mako shark	*Isurus paucus*
Salmon shark	*Lamna ditropis*
Albacore	*Thunnus alalunga*
Bigeye tuna	*T. obesus*
Yellowfin tuna	*T. albacares*
Northern bluefin tuna	*T. thynnus*
Skipjack tuna	*Katsuwonus pelamis*
Kawakawa	*Euthynnus affinis*
Dogtooth tuna	*Gymnosarda unicolor*
Moonfish	*Lampris* spp
Oilfish family	*Gempylidae*
Pomfret	*family Bramidae*
Other tuna relatives	*Auxis* spp, *Scomber* spp; *Allothunus* spp

None of the PMUS stocks in the Pacific are known to be overfished, although concern has been expressed for several species and data are unavailable for others. Concise definitions of the various criteria used in the Pelagics FMP to analyze current levels of harvest exploitation and the status of PMUS stocks can be found in a publication by Boggs et al. (2000). That document and the 2001 NMFS Report to the U.S. Congress both contain estimates of the status of PMUS stocks. Those two publications and the most recent report of the Standing Committee on Tuna and Billfish (SCTB) are the main sources for the following sections regarding the current status of PMUS stocks.

Swordfish

There is considerable debate concerning the stock structure of swordfish in the Pacific. Several studies have been unable to reject the hypothesis that there is a single, Pacific-wide stock, while some recent evidence indicates that there may, in fact, be some delineation of separate stocks in different parts of the Pacific Ocean (Ward and Elscot, 2000). A stock assessment for North Pacific Swordfish by Kleiber & Yokawa (2002), using the Multifan-CL length-based, age structured, model suggests that the population in recent years is well above 50% of the unexploited biomass, implying that swordfish are not over-exploited and relatively stable at current levels of fishing effort.

Bigeye tuna

Genetic analyses indicate that there is a single pan-Pacific stock of bigeye (Grewe and Hampton, 1998). The most recent stock assessment of bigeye was presented at the SCTB 's 17th meeting held in August 2004 Hampton et al (2004). The assessment uses the stock assessment model and computer software known as MULTIFAN-CL ((Fournier, et al 1998).The bigeye tuna model is both age (40 age-classes) and spatially structured (5 regions) and the catch, effort, size composition and tagging data used in the model are classified by 17 fisheries and quarterly time periods from 1950 through 2007. The last 4–5 years (depending on the fishery) constitute a projection period in which the last year's fishing effort for each fishery is assumed to continue into the future. The data used in the assessment were the same as those used in 2003, with the exception that pre-1965 Japanese longline size composition data became available recently and were used in the assessment, and an additional year of fishery data (2002 for longline, 2002 for Philippines and Indonesia, 2003 for purse seine) was included. Recruitment showed an increasing trend from the 1970s on, while biomass declined through the 1960s and 1970s after which it was relatively stable or declining slightly. The fisheries are estimated to have reduced overall biomass to around 40% of unfished levels by 2003, with impacts more severe in the equatorial region of the WCPO, particularly in the west. Yield analyses suggest that recent average fishing mortality-at-age is approximately equivalent to the fishing mortality at Maximum Sustainable Yield (MSY), although the probability distribution of $F_{MSY}/F_{Current}$ is skewed such that the probability of the ratio being greater than 1.0 (i.e. overfishing is occurring) is 0.67–0.77, depending on assumptions regarding the stock-recruitment steepness coefficient. On the other hand, the current level of biomass is estimated to be high, around 1.7–2.3 times the equilibrium biomass expected at MSY. Current biomass has remained high because of above average recruitment since about 1990. The analysis in which catchability in the main longline fisheries was allowed to vary over time produced more pessimistic results than the constant catchability models – absolute levels of recruitment and biomass are lower (although the trends are similar), fishing mortality and fishery impact are higher, and recent average levels of fishing mortality are estimated to substantially exceed MSY levels ($F_{Current}/F_{MSY} = 1.7$). Current biomass is estimated to exceed the MSY level ($B_{Current}/B_{MSY} = 1.25$) but is at a lower level than estimated by the constant longline catchability models. On the basis of all of the results presented in the assessment, it was concluded that maintenance of current levels of fishing mortality carries a high risk of overfishing. Should recruitment fall to average levels, current catch levels would result in stock reductions to near and possibly below MSY-based reference points. Reduction of juvenile fishing mortality in the equatorial regions would have significant benefits for both the bigeye tuna stock and the longline fishery.

Albacore tuna

Albacore stocks appear to be in good condition and are experiencing moderate levels of exploitation. The most recent stock assessment of the southern albacore stock was presented at the SCTB 's 16th meeting held in June 2003 by Labelle & Hampton (2003), using the Multifan-CL stock assessment model. They concluded that current biomass is estimated to be about half of the maximum estimated levels and about 60% of the estimated equilibrium unexploited biomass. The impact of the fisheries on total biomass is estimated to have increased over time, but is likely to be low, a reduction of about 3% from unexploited conditions. The model results continue to indicate that recent catches are less than the Maximum Sustainable Yield (MSY), aggregate fishing mortality is less than F_{MSY} and the adult biomass is greater than B_{MSY}.

North Pacific albacore stocks are assessed at 1-2 year intervals by the North Pacific Albacore Workshop, comprising the USA, Japan, Canada and Taiwan. According to the latest assessment (NPALW, 2000), the albacore stock is healthy and not being overfished (F/F_{msy} = 0.5-0.9; B/B_{msy} = 1.10 > MSST), even though present catches are in the estimated MSY and Optimum Yield (OY) range. Stock and catches are both increasing due to the continuation of a high productivity oceanic regime. More recently the Fourth Meeting of the Interim Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC) reviewed the status of North Pacific albacore (ISC 2004). ISC reviewed the methods and results generated from length-based, age-structured stock assessments, including virtual population analysis (VPA) based on ADAPT models and preliminary, fully-integrated statistical models based on MULTIFAN-CL software. Results from the ADAPT models indicated that annual estimates of biomass over the last decade were relatively 'high' (i.e., compared with estimated biomass in the mid 1970s through the late 1980s); however, very recent population estimates suggest a 'leveling off' of the stock at large. Estimated recruitment is quite variable and suggests two oceanographic regimes: a low 'productivity' period from 1975 to 1989; and a higher 'productivity' period since that time. Based on recent and forecasted catch and recruitment levels, fishing mortality is relatively high (roughly, F 20%), either in excess of that required to produce MSY assuming a low productivity scenario or roughly at the MSY level assuming a high productivity scenario and proxy biological reference points for this species.

Yellowfin tuna

Some genetic analyses suggest that there may be several semi-independent yellowfin stocks in the Pacific including possible eastern and western stocks which may diverge around 150°W (Grewe and Hampton, 1998; Itano, 2000). On the other hand, tagging studies have shown individual animals are capable of large east-west movements that would suggest considerable pan-Pacific mixing of the stock. In fact, earlier mtDNA analysis failed to distinguish the presence of geographically distinct populations (Scoles and Graves, 1993; Ward *et al.*, 1994).

The most recent stock assessment of western Pacific yellowfin was presented by Hampton & Kleiber, 2003, at the SCTB's 17th meeting held in August 2004, employing the Multifan-CL model. The yellowfin tuna model was age (28 age-classes) and spatially structured (5 regions) and the catch, effort, size composition and tagging data used in the model were classified by 17 fisheries and quarterly time periods from 1950 through 2007. The last 4–5 years (depending on the fishery) constitute a projection period in which the last year's fishing effort for each fishery is assumed to continue into the future. Five independent analyses were conducted to test the impact of using different methods of standardising fishing effort in the main longline fisheries, using estimated or assumed values of natural mortality-at-age, and assuming fixed or variable catchability for the main longline fisheries.. The data used in the assessment were the same as those used in 2003 with the exception of an additional year of fishery data (2002 for longline, 2002 for Philippines and Indonesia, 2003 for purse seine) was included. For both sets of analyses, the current results are more pessimistic than last year's results with lower overall recruitment, lower equilibrium yields, higher current exploitation rates, and higher impacts due to fishing. It is also important to note that the key reference points are sensitive to our initial assumptions regarding the nature of the stock-recruitment relationship. The assumed prior distribution for the steepness parameter for the stock and recruitment relationship is highly influential. Moreover, a relaxation of this assumption results in a more pessimistic assessment despite the lack of any evidence of a strong relationship between spawning stock biomass and recruitment. For future assessments, a comprehensive review of appropriate values of stock-recruiment steepness for yellowfin is required to determine appropriate values for inclusion in a range of sensitivity analyses. The main reference points from the stock assessment indicate that the long-term average biomass should remain above that capable of producing MSY, and that there is limited potential to expand long-term yields from the fishery at the current pattern of age-specific selectivity. The authors note, however, that this apparently healthy situation arises mainly from low levels of exploitation in sub-equatorial regions of the Western and Central Pacific Ocean. Reduction of juvenile fishing mortality in the western equatorial region principally the Indonesian fishery, would have significant benefits for both the yellowfin tuna stock and the longline fishery.

Bluefin tuna

Bluefin tuna are slower to become sexually mature than other species of tuna and this makes them more vulnerable to overfishing. Variability in catch per unit of effort (CPUE) in the eastern Pacific seems to be due to variability in the number of fish migrating from the western Pacific to the coast of North America. This variability may be driven by changes in the forage base available in the western Pacific. Conceivably, these variations in trans-Pacific movements could affect the catch rates of Hawaii-based vessels.

The Inter-American Tropical Tuna Commission reviews the status of bluefin tuna occasionally (IATTC 2001). Catches have decreased since the late 1950s, but now appear to be in recovery. Evidence for overfishing or for persisting decline in the stock, which is mainly in the western Pacific, is lacking. An MSY has not been determined, but a proxy value has been established by the Pacific Regional Fishery Management Council (PRFMC, 2003) of 20,000 metric tonnes (44 million pounds), with OY 75% of that MSY.

More recently the Fourth Meeting of the Interim Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC) presented the result of a MULTIFAN-CL stock assessment of Pacific bluefin (PBF) conducted on data from 1952 t0 2002 (ISC 2004).The PBF fishery has been sustained for over 50 years while taking annual catches similar to those taken in recent years PBF biomass and spawning stock biomass (S)have fluctuated widely over the fifty-year history examined in the stock assessment . These fluctuations have been driven mainly by recruitment changes (without trend) over this period. Biomass appears to have recovered from a record low level in the late 1980's to a more intermediate level in recent years, largely due to better than average recruitment during the 1990's (particularly the strong 1994 year-class). Despite good recruitment, however, the S has generally declined since 1995 and if the estimated recent fishing mortality rates (F) continue, S would likely continue to decline at least over the 2003-2005 period. Recent F is greater than Fmax, which has economic implications (too much fishing effort for the yield returned) and is also generally taken as an indicator of biological concern. In particular, the high F on young fish (ages 0-2) and older fish (ages 6+) may be cause for concern with respect to maintaining a sustainable fishery in future years. ISC recommended that there be no further increases in F for any of the fisheries taking PBF. Further, ISC also recommended that every effort should be made to reduce the uncertainty associated with the assessment results by undertaking improvements in the data collection, data analyses, and assessment models used in the PBF stock assessment process.

Skipjack tuna
It is believed that the skipjack tuna in the Pacific belong to a single population (Shomura *et al.*, 1994). All recent analyses indicate that harvest ratios are appropriate for maintaining current catch levels and that overall the stocks are very healthy (Boggs *et al.*, 2000). Although local depletions and variability may occur in response to local environmental conditions and fishing practices, the overall stock is healthy and can support existing levels of fishing (PFRP, 1999; SCTB, 2003).

The most recent stock assessment for western Pacific stocks was also presented at the SCTB's 16th meeting (Langley et al, 2003) using the Mutlifan-CL method. The results showed that biomass trends are driven largely by recruitment, with the highest biomass estimates for the model period being those in 1998-2001. The model results suggest that the skipjack population in the WCPO in recent years has been at an all-time high. The impact of fishing is predicted to have reduced biomass by 20-25%. An equilibrium yield analysis confirms that skipjack is currently exploited at modest level relative to its biological potential. The estimates of F/Fmsy and B/Bmsy suggest that the stock is neither being overfished nor in an overfished state. Recruitment variability, and influences by environmental conditions will continue to be the primary influence on stock size and fishery performance.

Kawakawa tuna, black marlin, shortbilled spearfish, sailfish
The stock status of small tunas such as the kawakawa (*Euthynnus affinis*) and various billfish are unknown. Catches of these species comprise a minor fraction of pelagic fisheries in the Western Pacific.

Blue marlin
Based on the assumption that there is a single, Pacific-wide stock, various recent analyses characterize the blue marlin population as stable and close to that required to support average maximum sustainable yield (AMSY) (Boggs *et al,* 2000; IATTC, 1999; PFRP, 1999; Hinton and Nakano, 1996). Kleiber et al (2003) conducted a Multifan-CL stock assessment of Pacific blue marlin. They found that there was considerable uncertainty in quantifying the fishing effort levels that would produce a maximum sustainable yield. It was concluded that, at worst, blue marlin in the Pacific are close to a fully exploited state, that is the population and the fishery are somewhere near the top of the yield curve. It appears that the stock has been in this condition for the past 30 years, while the level of longline fishing effort has increased in the Pacific.

Striped marlin
Little is known about the overall status of the putative northern stock that supports the fishery in the management area although longline CPUE has demonstrated a declining trend in recent years (WPRFMC, 1999d). Hinton & Bayliff (2002) presented an assessment of Eastern Pacific Ocean

(EPO) striped marlin. The trends for the catch rates of the northeastern and northwestern areas of the central-eastern Pacific are not significantly different. The same is the case for catch rates in the EPO north and south of 10N. These results suggest that the fish in the EPO belong to one stock. Reexamination of published genetic data by Hinton & Bayliff (2002) suggests that there is a stock located in the southwestern Pacific (Australia) , but provided no clear resolution of separate stocks for the Ecuador-Hawaii-Mexico triad of sampling locations.

The current biomass of striped marlin in the EPO is apparently equal to that which would produce the average maximum sustainable yield of about 4,500 mt. Retained catch and standardized fishing effort for striped marlin decreased in the EPO from 1990-1991 through 1998, and preliminary estimates indicate that nominal fishing effort in the area has continued to decrease during the 1999-2001 period. This may result in a continued decrease in standardized fishing effort for striped marlin, with an associated continuing increase in their biomass in the EPO.

Blue shark

Nakano and Watanabe (1992) attempted a stock assessment for blue sharks based on catch data from the high seas driftnet fishery (which ceased in 1992) with supplemental data from longliners. Although there was some concern about whether Nakano and Watanabe had sufficient information to make an adequate estimate of stock size (Wetherall and Seki, 1991), they estimated minimum stock size in the North Pacific at 52-67 million individuals and argued that "even the minimum stock can sustain the present catch level although the mortality rate at [the] early stage is not known for blue shark."

More recently, Matsunaga and Nakano (1999) analyzed catch data from Japanese longline research and training vessels. Two data sets were available, one from 1967-1970 and one from 1992-1995, and were geographically stratified. They found blue sharks to comprise between 73% and 85% of total catch in the 10°-20°N strata and 31-57% in the 0°-10°N strata during the two time periods. Matsunaga and Nakano found that blue shark CPUE increased slightly from the 1967-1970 to the 1992-1995 period in these two strata, but the difference was not statistically significant.

The most current stock assessment of blue shark in the Pacific was conducted by Kleiber et al (2001) using the Multifan-CL model. All scenarios generated by the model show a significant decline in the blue shark population during the 1980s followed by various degrees of recovery during the 1990s. The decline in the 1980s coincided with the existence of an extensive small-mesh driftnet fishery in the North Pacific and recovery of the stock occurs following the banning of the driftnet fishery. On the basis of the most pessimistic estimate of stock size, maximum sustainable yield (MSY) is estimated to be approximately twice the current take (average of annual takes from 1994 through 1998) by all fisheries in the North Pacific. In this scenario, the fishing mortality at MSY (F_{msy}) is approximately twice the current level of fishing mortality (average of fishing mortality from 1994 through 1998) by all fisheries in the North Pacific. Other, equally plausible estimates indicate that the stock could support an MSY up to four times current take levels and F_{msy} up to 15 times current fishing mortality.

Thresher sharks
In California, 94 percent of the total thresher shark commercial landings are taken in the driftnet ("drift gillnet") fishery for swordfish, where it is the second most valuable species landed. Catches peaked early in this fishery with approximately 1,000 mt taken in 1982 , but declined sharply in 1986 (Hanan *et al.*, 1993). Since 1990, annual catches have averaged 200 mt (1990-1998 period) and appear stable (Holts, 1998). Catch per unit effort (CPUE) has also declined from initial levels.

Declines in CPUE indicate a reduction in the thresher shark population (Holts, 1998). The decline in the driftnet CPUE as a measure of the magnitude of the decline of the stock is confounded by the effects of the various area and time closures, the offshore expansion of the fishery, and the changed emphasis from shark to swordfish among most of the fishers. Based on the estimated rate of population increase, the common thresher MSY is estimated to be as little as four to seven percent of the standing population that existed at the beginning of the fishery.

Mako sharks
This species is also taken primarily by the California driftnet fishery for swordfish. Although current catches are only about 80 mt/yr in the California fishery, the mako shark is still the second most valuable species taken in the fishery. Like the common thresher, shortfin mako catches have been affected by the changes that occurred in the driftnet fishery. Catches peaked soon after the fishery started (240 mt in 1982) and then declined. Makos are also taken in smaller amounts (<10 mt/yr) by California-based longliners operating beyond the EEZ (Vojkovich and Barsky, 1998). This fishery takes primarily juveniles and subadults, probably because the area serves as a nursery and feeding area for immature stages (Hanan *et al.*, 1993). The mako shark distribution is affected by temperature, with warmer years being associated with more northward movement. According to PRFMC (2003), clear effects of exploitation of the shrortfin mako shark have not been shown for West Coast populations, and local stocks are thought not to be overfished.

Ocean whitetip shark
The oceanic whitetip shark is one of the three most abundant sharks (Compagno, 1984). Bonfil (1994) estimated 8,200 tons of oceanic whitetips were caught from the WPCO in 1989. Stevens (1996) "roughly estimated" 50,000 to 239,000 tons of oceanic whitetips were caught by the international Pacific high-seas fisheries (purse seine, longline, and drift-net) in 1994. Although silky sharks represent more of the fisheries catch, oceanic whitetips are believed to be more abundant (Straurg, 1958). There have been no quantitative assessments of Pacific oceanic whitetip shark populations published to date.

Silky shark
The silky shark is one of the three most abundant pelagic sharks, along with the blue and oceanic whitetip sharks (Compagno, 1984). Bonfil (1994) estimated 19,900 tons of silky sharks were caught from the South Pacific Commission (SPC) zone in the central and south Pacific in 1989. Stevens (1996) estimated 84,000 tons of silky sharks were caught in the international Pacific high-seas fisheries (purse seine, longline, and drift-net). Oshiya (2000) has conducted a stock

assessment of Pacific silky sharks, with an estimated Pacific-wide standing stock of 170,000 to 240,000 tonnes, from which 15,000 and 20,000 tonnes is caught annually by longline vessels.

Mahimahi and Wahoo

Stock characteristics for *C. hippurus* are not known. A preliminary analysis of mahimahi in the central and western Pacific was presented at the 16th SCTB in June 2003 (Dalzell and Williams unpublished). Annual mahimahi catches in the Pacific Islands were generally small, of the order of a few hundred tonnes, but Taiwan, with its large longline fleet landed on average almost 7,000 tonnes per year. Plots of mahimahi and wahoo across the C-W Pacific showed that catch rates of mahimahi of these species were highest in sub-tropical latitudes. Catch rates were also strongly seasonal, with on average a three-fold difference between low and high season CPUEs. Longline catch rates of mahimahi and wahoo showed strong stratification by depth (as expressed by distance of the hook from the float line), with mahimahi CPUE highest on the shallowest hook, and wahoo CPUE highest on the third hook from the float line.

Catches of both species have been variable in both longline and troll fisheries in the U.S. Pacific Islands, but have increased markedly in American Samoa due to the rapid expansion of the longline fishery after 2000. Troll and longline catches have increased over the past 20 years in Hawaii. Catch rates have also been variable , but both troll and longline catch per unit effort (CPUE) data shows reasonably similar trend in Hawaii and American Samoa. Similar CPUE trends for mahimahi and wahoo were noted for troll fisheries in Guam and the Northern Mariana Islands. The average size of wahoo in troll and longline catches in Hawaii had remained relatively stable over the past two decades, as did the troll caught mean size of mahimahi. Hawaii longline caught mahimahi showed a major decline in mean size between the 1980s and 1990s. The average size of mahimahi and wahoo were larger in longline compared to troll catches. Troll caught wahoo declined in size in American Samoa. The average sizes of mahimahi in Guam and the CNMI were similar, but wahoo were slightly larger in the CNMI troll fishery.

A summary of the various PMUS and their status relative to the control rule reference points adopted by the Council is given in Table 8.

Table 8. Estimates of stock status in relation to reference points for PMUS.

Stock	Overfishing reference point	Is overfishing occurring?	Overfished reference point	Is the stock overfished?	Assessment results	Natural mortality[1]	MSST
Skipjack Tuna (WCPO)	F_{2002}/F_{MSY}=0.12	No	B_{2002}/B_{MSY}=3.1	No	Langley et al. 2003	>0.5 yr^{-1}	0.5 B_{MSY}
Yellowfin Tuna (WCPO)[2]	F_{2002}/F_{MSY}=0.63	No, probability that F_{2002}/F_{MSY} is >1 is ~15%	B_{2002}/B_{MSY}=2.46	No	Hampton et al. 2004a	0.8-1.6 yr^{-1}	0.5 B_{MSY}
Albacore Tuna (S. Pacific)	F_{2002}/F_{MSY}=0.05	No	B_{2002}/B_{MSY}=1.3	No	Labelle & Hampton 2003	0.3 yr^{-1}	0.7 B_{MSY}
Albacore Tuna (N. Pacific)	Unknown		Unknown			0.3 yr^{-1}	0.7 B_{MSY}
Bigeye Tuna (WCPO)[2]	F_{2002}/F_{MSY}=0.98	Yes, probability that F_{2002}/F_{MSY} is >1 is at least 67%	B_{2002}/B_{MSY}=1.75	No	Hampton et al. 2004b	0.4 yr^{-1}	0.6 B_{MSY}
Blue Marlin (Pacific)	F_{1997}/F_{MSY}=0.50	No	B_{1997}/B_{MSY}=1.4	No	Kleiber et al. 2002	0.2 yr^{-1}	0.8 B_{MSY}
Swordfish (N. Pacific)[3]	F_{2002}/F_{MSY}=0.33	No	B_{2002}/B_{MSY}=1.75	No	Kleiber & Yokawa 2004	0.3 yr^{-1}	0.7 B_{MSY}
Blue Shark (N. Pacific)	F_{1999}/F_{MSY}=0.01	No	B_{1999}/B_{MSY}=1.9	No	Kleiber et al. 2001	Unknown	
Other Billfishes	Unknown		Unknown			Unknown	
Other Pelagic Sharks	Unknown		Unknown			Unknown	
Other PMUS	Unknown		Unknown			Unknown	

[1] Estimates based on Boggs et. al 2000

[2] Assessment results based on statistical habitat-based standardized (SHBS) effort time-series and a SRR steepness assumption of 0.75

[3] Asssment results based on natural mortality fixed at 0.2 yr^{-1}

10.3 Sea Turtles

All sea turtles are designated under the ESA as either threatened or endangered. The breeding populations of the Mexico olive ridley turtles (*Lepidochelys olivacea*) are currently listed as endangered. Also listed as endangered are the leatherback turtles (*Dermochelys coriacea*) and hawksbill turtles (*Eretmochelys imbricata*). Green sea turtles (*Chelonia mydas*) and loggerhead turtles (*Caretta caretta*) are listed as threatened, but are afforded the same protection as endangered sea turtles. These five species of sea turtle are highly migratory, or have a highly migratory phase in their life history, and therefore, are susceptible to being incidentally caught by longline fisheries operating in the Pacific Ocean.

The populations of several species of sea turtles have declined in the Pacific as the result of nesting habitat loss and excessive and widespread harvesting for commercial and subsistence purposes (Eckert 1993). Leatherback and loggerhead turtles are the species of principal concern with regard to incidental take in Pacific pelagic longline fisheries. These fisheries are conducted mainly by Japan, Taiwan, Korea and the U.S. There are only two populations of loggerhead turtles in the Pacific, one originating in Australia where serious declines are occurring, and the other in southern Japan (Eckert 1993). Leatherback turtles inhabiting the Pacific mainly originate from nesting beaches in Mexico and Costa Rica where significant declines have been documented; from Indonesia where their status is uncertain but possibly stable; and from Malaysia where the nesting colony is nearly extinct despite 30 years of conservation measures (Eckert 1993).

The diet of the leatherback turtle generally consists of cnidarians (i.e., medusae and siphonophores) in the pelagic environment. Leatherback turtles have the most extensive range of any living reptile and have been reported circumglobally from latitudes 71° N. to 42° S. in the Pacific and in all other major oceans. In a single year a leatherback may swim more than 10,000 km. They lead a completely pelagic existence, foraging widely in temperate waters except during the nesting season, when gravid females return to beaches to lay eggs. Typically leatherback turtles are found in convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters. Hawaii fishers in offshore waters commonly see leatherback turtles, generally beyond the 100 fm curve but within sight of land. Two areas where sightings often take place are off the north coast of Oahu and the west coast of the Island of Hawaii. The pelagic zone surrounding the Hawaiian Islands is apparently regularly used as foraging habitat and migratory pathways for this species. Further to the north of the Hawaiian islands, a high seas aggregation of leatherback turtles is known to occur at 35° N. latitude, between 175° W. and 180° longitudes (NMFS, 1991).

The loggerhead turtle is listed as a threatened species throughout its range, primarily due to incidental mortality associated with commercial fishing operations and the alteration and destruction of its habitat. It is a cosmopolitan species found in temperate and subtropical waters and inhabiting continental shelves, bays, estuaries and lagoons. Major nesting grounds are generally located in warm temperate and subtropical regions, generally north of 25° N. or south of 25° S. latitude in the Pacific Ocean. For their first several years of life, loggerheads forage in open ocean pelagic habitats. Both juvenile and subadult loggerheads feed on pelagic crustaceans, mollusks, fish, and algae. As they age, loggerheads begin to move into shallower waters, where, as adults, they forage over a variety of benthic hard- and soft-bottom habitats (reviewed in Dodd, 1988). Satellite telemetry studies show that loggerhead turtles tend to follow 17° and 20° C sea surface isotherms north of the Hawaiian islands.

The olive ridley turtle is listed as threatened in the Pacific, except for the Mexican nesting population, which is listed as endangered, primarily because of over-harvesting of females and eggs. The olive ridley is one of the smallest living sea turtles (carapace length usually between 60 and 70 cm) and is regarded as the most abundant sea turtle in the world. Since the directed take of sea turtles was stopped in the early 1990s, the nesting populations in Mexico appear to be recovering, with females nesting in record numbers in recent years. In 1996, the primary nesting beach at La Escobilla in Oaxaca sustained over 800,000 nests. There is some discussion in Mexico that the species should be considered recovered. The olive ridley turtle is omnivorous and identified prey include a variety of benthic and pelagic items such as shrimp, jellyfish, crabs, snails, and fish, as well as algae and sea grass (Marquez, 1990).

Green turtles in Hawaii are genetically distinct and geographically isolated which is uncharacteristic of other regional sea turtle populations. Both the nesting population and foraging populations of green turtles in Hawaii appear to have increased over the last 30 years. Balazs and Chaloupka (2004) document a substantial long-term increase in abundance of the once seriously depleted green sea turtle stock in Hawaii. This population increase has occurred in a far shorter period of time than previously thought possible.

The hawksbill turtle is listed as endangered throughout its range. In the Pacific, this species is apparently declining due to the harvesting of the species for its meat, eggs and shell, as well as the destruction of nesting habitat by human occupation and disruption. There are no reports of interactions between this species and the Hawaii-based longline fishery, although the potential for interaction exists. Hawksbill turtles have a relatively unique diet of sponges.

The NMFS 2004 BiOp on the effects of the Hawaii pelagic longline fishery on sea turtle populations (NMFS 2004) concluded that the continuing operation of the fishery was not likely to jeopardize the continual existence and recovery of any sea turtle species. The use of side setting is a method of deploying baited hooks into the sea. The mitigation properties of large circle hooks and mackerel bait, that have been found to be effective at minimizing sea turtle interactions will not be affected by this deployment method, so this methodology should not have an adverse impact on listed sea turtle populations in the Pacific Ocean. However, NMFS is required to continue monitoring the incidental takes and mortality of sea turtles and seek ways to reduce them. Data for monitoring take levels and factors that affect takes are collected through a NMFS observer program operated by the Pacific Islands Regional Office and mandatory longline logbooks submitted to NMFS by longline vessel captains.

10.4 Marine Mammals

With the exception of the Hawaii-based longline fishery (Category I) all fisheries in the western Pacific region are classified as Category III under section 118 of the Marine Mammal Protection

Act of 1972 (62 FR 28657, May 27, 1997). As a Category I fishery, operators of vessels registered to Hawaii longline permits must submit federal logbooks and reports of injuries to marine mammals to NMFS, and carry observers if requested by NMFS.

Cetaceans that are listed under the Endangered Species Act (ESA) that have been observed in the region where Hawaii-based longline vessels operate include the humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), sei whale (*B. Borealis*), and the North Pacific right whale (*Eubalaena japonica*). Other cetaceans not listed under the Endangered Species Act, but protected under the Marine Mammal Protection Act are also occasionally encountered in the longline fishery. These species mainly consist of dolphins and the smaller beaked and toothed whales (NMFS Observer Program, unpub. data). Interactions between any species of cetaceans and the Hawaii longline fishery are unusual. Between 1994 and 1999, NMFS observers recorded two entanglements involving a humpback whale and sperm whale (Hill *et al.*, 1997; Nitta and Henderson, 1993; Dollar, 1991). False killer whales occasionally strip the bait from longline hooks (NMFS Observer Program, unpub. data). To avoid this type of interaction Hawaii-based longline vessels that encounter false killer whales delay setting their lines until a sufficient distance between the vessel and the whale school has been achieved (NMFS Observer Program, unpub. data.

Hawaiian monk seals comprise one of the two remaining species of the genus *Monachus*, one of the most primitive genera of seals. The species was listed as endangered under the ESA in 1976, and it is one of the most endangered marine mammal species in the United States. The Hawaiian monk seal is endemic to the Hawaiian Archipelago and Johnston Atoll, and is the only endangered marine mammal that exists wholly within the jurisdiction of the United States.

Hawaiian monk seals are brown or silver in color, depending upon age and molt status, and can weight up to 270 kg. Adult females are slightly larger than adult males. It is thought that monk seals can live to 30 years. Monk seals stay on land for about two weeks during their annual molts. Monk seals are nonmigratory, but recent studies show that their home ranges may be extensive (Abernathy and Siniff 1998). Counts of individuals on shore compared with enumerated sub-populations at some of the NWHI indicate that monk seals spend about one-third of their time on land and about two thirds in the water (Forney et al. 2000).

The six major reproductive sites are French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll and Kure Atoll. Small populations at Necker Island and Nihoa Island are maintained by immigration, and a few but growing number of seals are found throughout the MHI, where preliminary surveys have counted more than 50 individuals. NMFS researchers have also observed monk seals at Gardner Pinnacles and Maro Reef. Additional sightings and at least one birth have occurred at Johnston Atoll, excluding eleven adult males that were translocated to Johnston Atoll (nine from Laysan Island and two from French Frigate Shoals) over the past 30 years.

In 2001, the minimum population estimate for monk seals was 1,378 individuals (based on enumeration of individuals of all age classes at each of the subpopulations in the NWHI, derived estimates based on beach counts for Nihoa and Necker, and aerial survey estimates for the MHI) (Carretta et al. 2003). The best estimate of the total population size was 1,409.

Population trends for monk seals are determined by the highly variable dynamics of the six main reproductive sub-populations. The sub-population of monk seals on French Frigate Shoals has shown the most change in population size, increasing dramatically in the 1960s-1970s and declining in the late 1980s-1990s. In the 1960s-1970s, the other five sub-populations experienced declines. However, during the last decade the number of monk seals increased at Kure Atoll, Midway Atoll and Pearl and Hermes Reef while the sub-populations at Laysan Island and Lisianski Island remained relatively stable. At the species level, however, demographic trends over the past decade have been driven primarily by the dynamics of the French Frigate Shoals subpopulation, where the largest monk seal population is experiencing an increasingly unstable age distribution resulting in an inverted age structure. This age structure indicates that recruitment of females and pup production may soon decrease. In the near future, total population trends for the species will likely depend on the balance between continued losses at French Frigate Shoals and gains at other breeding locations including the MHI. The recent sub-population decline at French Frigate Shoals is thought to have been caused by male aggression, shark attack, entanglement in marine debris, loss of habitat and decreased prey availability. The Hawaiian monk seal is assumed to be well below its optimum sustainable population, and, since 1993, the overall population has declined approximately 0.7% per year (Carretta et al. 2003). The Hawaiian monk seal is characterized as a strategic stock under the MMPA.

Monk seals feed on a wide variety of teleosts, cephalopods and crustaceans, indicating that they are highly opportunistic feeders (Rice 1964, MacDonald 1982, Goodman-Lowe 1999).

Evidence of interactions between monk seals and the Hawaii longline fishery began to accumulate in 1990, and included three hooked seals and 13 unusual wounds thought to have resulted from fishing interactions. In 1991, NMFS prohibited longline fishing within a Protected Species Zone which extends 50 nautical miles around the NWHI and includes the corridors between islands. Subsequent to the establishment of the Protected Species Zone there have been no reports of interactions between monk seals and the Hawaii longline fishery.

10.5 Seabirds

NMFS' observer records show that Hawaii-based pelagic longline fishing operations inadvertently hook and kill black-footed albatrosses (*Phoebastria nigripes*) and Laysan (*P. immutabilis*) albatrosses. On rare occasions, wedge-tailed (*Puffinus pacificus*) and sooty (*Puffinus griseus*) shearwaters are also incidentally hooked. Only seven shearwaters of various species were observed hooked by Hawaii-based longline vessels between 1994 and 2004. NMFS observers have also reported boobies hovering over baited hooks and that some birds may actually attempt a dive, however, no boobies have been reported hooked. The short-tailed albatross (*P. albatrus*) and Newell's shearwater (*Puffinus auricularis newelli*) are two seabird species listed under the Endangered Species Act present in the area where the Hawaii longline fishery operates. No short-tailed albatross or Newell's shearwater have been observed or reported taken by the longline fishery. Until recently, the only confirmed sighting of a short-tailed albatross near a Hawaii longline vessel was recorded on January 23, 2000, by a NMFS observer at 33° 9 N, 147° 49 W. The short-tailed albatross sighted was a juvenile bird. More recently, a short-tail albatross was observed near a shallow-setting vessel on November 18, 2004 and December 23, 2004. No sighting of a Newell's shearwater has been recorded for the fishery, and one is unlikely given the difficulty of distinguishing a Newell's shearwater from other shearwater species when in flight. Moreover, unlike albatrosses, which can and do make attempts at baited hooks deployed by longliners, interactions with shearwaters are extremely rare events. A total of five shearwaters have been caught and killed by the fishery, one fleshfooted shearwater, two sooty shearwaters and two unidentified shearwaters between 1994-2003 (NMFS PIRO observer data). No Newell's shearwaters have been recorded caught or killed by the Hawaii-based longline fishery. The US Fish & Wildlife Service has not expressed concern about this species' interactions with the Hawaii-based longline fishery in its Biological Opinions.

Between August 19, 2002 and October 28, 2002, NMFS observers collected information onboard pelagic vessels operating out of American Samoa and reported no seabird interactions. No albatross species are present in American Samoa. There are some shearwater species present, such as the wedge-tailed shearwater, that have the potential to lethally interact with longline gear. No reports or observed information on seabird/fishery interactions is available from pelagic fisheries operating in other areas under the Pelagics FMP. Therefore, the focus of this assessment is on the seabird species that are observed to interact, or have the potential to interact, with the Hawaii-based longline fishery.

10.5.1 Description of Potentially Affected Seabird Species

Albatrosses (Order Procellariiformes, Family Diomedeidae)
Three species of albatross breed and forage in the North Pacific: the short-tailed albatross, the black-footed albatross and the Laysan albatross (Table 9). NMFS observer data show that fishery-seabird interactions occur between the Hawaii-based longline fishery and two species of albatross: the black-footed albatross and the Laysan albatross. Neither the black-footed albatross nor the Laysan albatross are listed as endangered under ESA. Both seabirds are protected under the Migratory Bird Treaty Act (MBTA). Under the World Conservation Union (IUCN), the black-footed albatross is listed as "endangered" and the Laysan albatross as "vulnerable." The short-tailed albatross is listed as endangered under ESA and is considered "vulnerable" under IUCN. There have been no reports of interactions between the short-tailed albatross and the Hawaii-based longline fishery.

Albatross populations are particularly vulnerable to large-scale unnatural mortalities. Although albatrosses are long-lived (up to 60 years) they mature late (7-12 years) (Marchant and Higgins, 1990; Robertson, 1995; Bergin, 1997), produce only a single chick every one to three years (Marchant and Higgins, 1990) and both parents are typically required to successfully fledge their chick (Fisher, 1971; Fisher, 1975). Thus the loss of one parent may lead to the loss of the pair's chick as well as to the less successful mating of the remaining member of the pair for years to come (Richdale, 1950; Fisher, 1972; Cousins and Cooper, 2000). Albatrosses may return to the breeding colonies at two or three years of age but the average age at first breeding is seven or eight years (Rice and Keyon, 1962; Hasegawa and DeGange, 1982). Albatrosses fit the model of a "K-selected" species (MacArthur and Wilson, 1967; Pianka, 1970): slow development, late reproduction, large body size and a low potential rate of population. Populations of K-selected species do not bounce back rapidly from severe declines in population size and are therefore at greater risk of local, and inevitably global extinction from such declines.

Albatrosses are nest site specific and lay a single egg during a breeding season. But albatrosses may not breed every year. Albatrosses are dependent upon their flight feathers for foraging and must take time from breeding to molt and grow new flight feathers. As a consequence, it is estimated that at any one time approximately 25% of an albatross population may not return to breed (Cochrane and Starfield, 1999).

Table 9. Summation of current best available data for the numbers of breeding pairs of black-footed, Laysan and short-tailed albatrosses for each known breeding locality (Source: E. Flint, USFWS, Hawaii, and H. Hasegawa, Toho University, unpubl. data)

Breeding Locality	Black-footed Albatross		Laysan Albatross		Short-tailed Albatross	
Kure Atoll	2,020[a]	2000	3,899[a]	2000	--	
Midway Atoll	21,829	2004	408,133	2004	--	
Pearl and Hermes Reef	6,116[a]	2003	6,912[a]	2003	--	
Lisianski Island	3,737[a]	2002	26,500	1982	--	
Laysan Island	21,006	2004	140,861	2004	--	
French Frigate Shoals	4,259	2004	3,226	2004	--	
Necker Island	112[a]	1995	500[a]	1995	--	
Nihoa Island	31[a]	1994	0	1995	--	
Kauai Island	0	1995	159	2004	--	
Lehua Island	10	2002	12	2002	--	
Niihau Island	unknown		175	1998	--	
Kaula Island	0[b]	1998	63	1993	--	
Oahu Island	0	2002	13	2003	--	
Subtotal	59,120		590,453		--	
Senkaku Islands (Kita-Kojima)	56	2002	--		50	2003
Bonin Island (Chichijima)	405	2003	14		--	
Izu Island (Torishima)	1,560[a]	2003	0 (2003)		276	2003
Subtotal	2,021		14		326	
Guadalupe Island	--		193	2000	--	
Other Mexican Islands	--		23	2003	--	
World Total	61,141		590,683		326	

[a] Indicates an extrapolation to total eggs from chicks counted later in the season (assumes 75% reproductive success. [b] Survey at Kaula was done 16-17 November 1998, which is slightly early to rule out that eggs were laid after this date. Nine birds were present on the island.

Short-tailed Albatross (*Phoebastria albatrus*)

On November 29, 2000, the USFWS issued a BiOp on the effects of the Hawaii-based longline fleet on the short-tailed albatross (USFWS 2000). In November 2002, the USFWS issued a revision of that BiOp with additional information which reflected a change in the fishery, (i.e. the closure of the shallow set swordfish segment) . The 2002 revision contains the Terms and Conditions under which the deep-setting tuna targeting segment of the Hawaii-based longline fleet continues to operate. USFWS issued a further BiOp on October 8th, 2004, which, despite a no jeopardy finding once again included new Terms and Conditions for the shallow set segment of the longline fishery. This most recent BiOp has yet to be implemented by NMFS.

The following is a brief overview of the biology and distribution of the short tail albatross.The short-tailed albatross is the largest seabird in the North Pacific with a wingspan of more than 3 meters (9 ft) in length. The short-tailed albatross bill is larger than the bills of Laysan and black-footed albatrosses, and is characterized by a bright pink color with a light blue tip and defining black line extending around the base. The plumage of a young fledgling (i.e., a chick that has successfully flown from the colony for the first time) is brown and at this stage, except for the bird's pink bill and feet, the seabird can be easily mistaken for a black-footed albatross. As the juvenile short-tailed albatross matures, the face and underbody become white and the seabird begins to resemble a Laysan albatross. In flight, however, the short-tailed albatross is distinguished from the Laysan albatross by a white back and by white patches on the wings. As the short-tailed albatross continues to mature, the white plumage on the crown and nape changes to a golden-yellow.

The short-tailed albatross is known to breed only in the western North Pacific Ocean, south of the main islands of Japan. Although at one time there may have been more than ten breeding locations (Hasegawa 1979), today there are only two known active breeding colonies, Minami Tori Shima Island ("Torishima") (30°29′N, 140°19′E) and Minami-Kojima Island (25°56′N, 123°42′E). On December 14, 2000, one short-tailed albatross was discovered incubating an egg on Yomejima Island of the Ogasawara Islands (southernmost island among the Mukojima Islands).

A few short-tailed albatrosses have also been observed attempting to breed, although unsuccessfully, at Midway Atoll National Wildlife Refuge ("Midway")(28°12′N, 177°20′W) in the NWHI. Midway lies roughly 1,750 miles east and slightly to the north of Torishima. It is unknown if short-tailed albatrosses historically bred in the NWHI. Visits to the NWHI by short-tailed albatrosses were first recorded on Midway in 1938, when a female was seen incubating an infertile egg (Haden, 1941; Munro, 1944). Sighting and banding records (Table 10) show that between 1938 and 2003, at the most, 22 short-tailed albatrosses visited the NWHI, with only one or two sighted on the same island at any one time. The first time two short-tailed albatrosses were known to be present on Midway at the same time, although located at different locations, occurred in February 1981. One female, has returned to Midway in most years since 1988, and has laid a total of four infertile eggs (Table 10).

Table 10. Short-tailed albatross observations in the NWHI (Source: R. Pyle, Bishop Museum, Hawaii, and USFWS, Hawaii, unpublished refuge reports)

Year	Month	Day	Location	Birds	Description
1938	Dec	--	Midway Atoll, Sand Is.	1	Immature
1939	Dec	--	Midway Atoll, Sand Is.	1	Injured then died
1940	Nov	28	Midway Atoll, Sand Is.	1	Immature
1962	Winter	--	Midway Atoll, Sand Is.	1	Adult
1965	Winter	--	Midway Atoll	1	Immature
1966	Mar	18	Midway Atoll, Eastern Is.	1	Banded[1]
1972	Nov	--	Midway Atoll, Sand Is.	1	Band 558-30754
1973	May	--	Midway Atoll, Sand Is	1	Band 558-30754
1973 - 1974	Fall - Winter	--	Midway Atoll, Sand Is	1	Band 558-30754
1974 - 1975	Fall - Winter	--	Midway Atoll, Sand Is	1	Band 558-30754
1976	Mar	--	Laysan Island	1	Immature-unbanded
1976	Winter	--	Tern Island	1	Immature-unbanded
1976	Winter	--	Midway Atoll, Sand Is.	1	Band 558-30754
1977	Dec	--	Midway Atoll, Sand Is.	1	Band 558-30754
1978	Oct	25	Midway Atoll	1	Band 558-30754
1979	Jan	16-20	Midway Atoll	1	--
1979	Nov	7	Midway Atoll, Sand Is.	1	Band 558-30754
1980	Jan	38335	Midway Atoll	1	Band 558-30754
1980	Jan	13	Tern Island	1	--
1980	Dec	12	Midway Atoll, Sand Is.	1	Band 558-30754
1981	Oct - Dec	--	Midway Atoll, Sand Is.	1	Band 558-30754
1982	Jan	25	Tern Island	1	--
1982	Nov	Mid-	Midway Atoll	1	Band 558-30754
1983	Feb	10	Midway Atoll	1	Band 558-30754
1984	Dec	15	Midway Atoll, Sand Is.	1	000 white[2]
1985	Nov	20	Midway Atoll, Sand Is.	1	000 white
1987	Feb - Mar	--	Midway Atoll, Sand Is.	1	000 white
1988	Dec	2	Midway Atoll, Sand Is.	1	000 white
1989	Dec Dec	8-12 14	Midway Atoll, Sand Is.	2	015 yellow[3]/000 white (at different locations)
1990 -1991	Fall – Winter	--	Midway Atoll, Sand Is.	2	000 white/015 yellow
1991 -1992	Dec - Mar	--	Midway Atoll, Sand Is.	2	000 white/015 yellow
1992 -1993	Dec - Jan	--	Midway Atoll, Sand Is.	2	000 white/015 yellow
1993-1994	Oct Jan Feb-Mar	2611	Midway Atoll, Sand Is. (First time birds seen together)	2	000 white/015 yellow sitting on infertile egg
1994	Feb - Mar Mar	924	French Frigate Shoals Kure Atoll, Green Is.	1	Band 043 yellow[4]

Table 10. Short-tailed albatross observations in the NWHI (Source: R. Pyle, Bishop Museum, Hawaii, and USFWS, Hawaii, unpublished refuge reports)

Year	Month	Day	Location	Birds	Description
1994-1995	Nov Nov - April	3	Midway Atoll, Sand Is.	2	000 white/015 yellow
1995 -1996	Nov Jan Dec - Feb	8813	Midway Atoll, Sand Is. Midway Atoll, Eastern Is.	2	015 yellow sitting on infertile egg 051 red[5]
1996	Feb	13	Midway Atoll, Sand Is.	1	172 black[6]
1997-1998	Nov	4	Midway Atoll, Sand Is.	1	015 yellow sitting on infertile egg
1998-1999	Jan-Mar Oct Feb-May	-2015	Midway Atoll, Sand Is. Midway Atoll, Eastern Is.	2	015 Yellow 057 Blue[7]
1999-2000	Oct Nov Dec-Feb	28 17 --	Midway Atoll, Sand Is. (057 Blue moved to female - 10 min dance) Midway Atoll, Eastern Is.	3	015 Yellow 057 Blue 051 Red
2000-2001	Oct-Apr Jan Oct-Apr Mar	-- 8-9 -- 28	Midway Atoll, Sand Is. Midway Atoll, Eastern Is.	4	057 Yellow/ 133 Black[8] 051 Red/ 057 Orange[9]
2001-2002	Oct-Apr Oct-Apr	-- --	Midway Atoll, Sand Is. Midway Atoll, Eastern Is.	2	015 Yellow sitting on infertile egg; colored band removed; metal band on left leg 051 Red
2002-2003	Oct-Mar Jan Nov-Mar	-- 3-13 --	Midway Atoll, Sand Is. Midway Atoll, Eastern Is.	3	Bird with metal band on left leg10 Unknown juvenile Unknown male wearing a metal band
2003-2004	Oct-Apr	--	Midway Atoll, Eastern Is.	1	Unknown adult male, metal wearing band 130-01319?[11]

[1] Chandler Robbins placed two USFSW bands (nos. 767-95701 and 767-95702) on the bird. [2] Bird was banded as a chick on Torishima March 20, 1979. [3] Bird was first banded as a chick on Torishima, March 24, 1982. [4] Bird was first banded as a chick on Torishma, April 19, 1989. [5] Bird was first banded as a chick on Torishma, April 14, 1987. [6] Bird was first banded as a chick on Torishima, April 4, 1993; Bird had all dark plumage. [7] Bird was first banded as a chick on Torishima, April 11, 1988. [8] Bird was first banded as a chick on Torishima, April 8, 1993. [9] Bird was first banded as a chick on Torishima, April 18, 1990. [10] Most likely 015 Yellow. [11] Most likely banded as a chick on Torishima, March 24, 1982.

Historically, the short-tailed albatross ranged along the coasts of the entire North Pacific Ocean from China, including the Japan Sea and the Okhotsk Sea (Sherburne, 1993), to the west coast of

North America. Prior to the harvesting of the short-tailed albatross at their breeding colonies, this albatross was considered common year-round off the western coast of North America (Robertson, 1980). The short-tailed albatross ranges from approximately 66°N to 10°N latitude (King, 1981) and are known to occur near St. Lawrence Island, north to the Bering Strait, south to the Barren Islands in Lower Cook Inlet and in the Gulf of Alaska (DeGange, 1981). Other Bering Sea records include sightings around the Komandorskie Islands, Diomede Islands, and Norton Sound (AOU, 1961). As discussed above, three sightings of short-tailed albatrosses have been reported in the waters surrounding the NWHI.

Prior to the 1880s, the short-tailed albatross population was estimated to be in the millions and it was considered the most common albatross species ranging over the continental shelf of the United States (DeGange, 1981). Between 1885 and 1903, an estimated five million short-tailed albatrosses were harvested from the Japanese breeding colonies for the feather, fertilizer, and egg trade, and by 1947 only three birds remained. By 1949 the species was thought to be extinct (Austin, 1949). In 1950, ten short-tailed albatrosses were observed nesting on Torishima (Tickell, 1973).

In an effort to protect the short-tailed albatross from feather hunters, Torishima was declared a "Kinryoku" (no hunting area) in 1933, but the regulation was not enforced (Yamashina in Austin, 1949). In 1956 the Japanese government declared the short-tail albatross a protected species and declared Torishima a National Monument (Tickell, 1975). In 1972 Japan further designated the short-tailed albatross a special bird for protection (King, 1981). Currently, under the World Conservation Union (IUCN) criteria for identification of threatened species, the conservation status for the short-tail albatross is vulnerable (Croxall and Gales, 1998). The species is also listed in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES; July 1, 1975) which protects the endangered species by prohibiting its commercial import or export or the trade of its parts across international borders. Currently, the short-tailed albatross is listed as an endangered species throughout its range under the Endangered Species Act 1973 (ESA) (65 FR 46643, July 31, 2000).

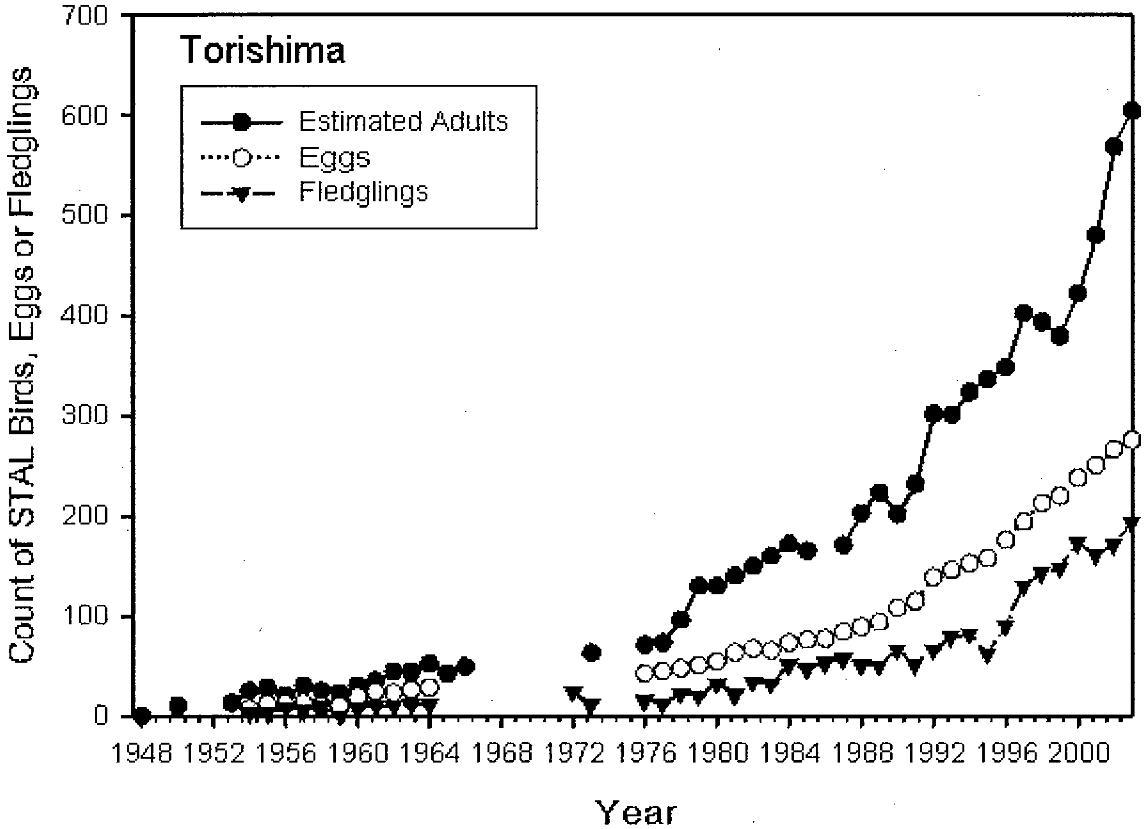
Today, the breeding population of the short-tailed albatross is estimated at approximately 326 breeding pairs: 276 pairs on Torishima (Table 11) and 50 pairs on Minami-Kojima (Figure 5). The short-tailed albatross have an annual survival rate of 96% and a population growth rate of 7.8% (65 FR 46643, July 31, 2000; Hasegawa, 1997). Because of the robust growth of the population at Torishima, and the fact that short-tailed albatrosses do not return to the colony until three or four years of age, a large number of these birds are dispersed at sea. At least 25% of the reproducing adults also remain at sea during each breeding season (Cochrane and Starfield, 1999). As a consequence, the exact number of individuals in the population is difficult to assess and at this time is unknown. The population size has been estimated at about 1,900 (P. Sievert, pers. comm.). This estimate is based on a deterministic model that was fit to observed numbers and incorporated age-specific survivorship data collected for short-tailed albatrosses on Torishima.

Table 11. Short-tailed albatross census counts at Torishima, Japan, between 1977 and 2004 (Source: Tickell, 1975; Sanger, 1972; Hasegawa, 1977). Sub-adults were not always differentiated from adults in some years.

Breeding Season	Breeding Pairs	Adults	Sub-adults	Eggs	Chicks	Chicks Fledged
1977 – 1978	--	73	12	40	12*	12
1978 – 1979	--	96	12	--	--	22
1979 – 1980	--	130	32	50	20	20*
1980 – 1981	--	130	--	54	--	32
1981 – 1982	--	140	--	63	--	21
1982 – 1983	--	150	--	67	--	34
1983 – 1984	--	160	--	65	--	32
1984 – 1985	--	172	--	73	--	51
1985 – 1986	--	165	--	76	--	47
1986 – 1987	--	146*	--	77	64*	53
1987 – 1988		171	--	84	58*	57
1988 – 1989	--	203*	--	89	--	51
1989 – 1990	--	223	--	94	--	50
1990 – 1991	115*	202	--	108	66	66
1991 – 1992	--	232	--	115	--	51
1992 – 1993	--	302	--	139	--	66
1993 – 1994	--	301	--	146	--	79
1994 – 1995	--	324	--	153	--	82
1995 – 1996	--	337	--	158	--	62
1996 – 1997	--	349	--	176	--	90
1997 – 1998	--	388	--	194	--	130
1998 – 1999	--	426	--	213	--	143
1999 – 2000	--	440	--	220	–	148
2000 - 2001		476		238		173
2001 - 2002		502		251		161
2002 - 2003		534		267		171
2003 - 2004		552		276		193

*Values marked by an asterisk indicate there are uncertainties associated with the data (i.e., very few observations).

Figure 5. Counts of short-tailed albatross (STAL) adults, eggs and fledglings on Torishima between 1947 and 2003 (Sources: Tickell, 1975; Sanger, 1972; Hasegawa, 1977; H. Hasegawa and P. Sievert, pers. comm.).



Black-footed Albatross (Phoebastria nigripes)
The NWHI contain the primary breeding colonies of the black-footed albatross population (Table 8). A comparatively smaller population estimated at about 11,000 black-footed albatrosses breed on Torishima (P. Sievert, pers.comm.). Although the at-sea distributions of Hawaiian and Japanese black-footed albatrosses overlap both in the western Pacific and around the NWHI, these two populations have been reproductively separated (genetically distinct units) for no more than three quarters of a million years (Walsh and Edwards, in review). Due to an absence of any significant gene flow between Hawaiian and Japanese populations of black-footed albatrosses, Walsh and Edwards (in review) suggest that Hawaiian and Japanese black-footed albatrosses fulfill the criteria for separate phylogenetic species and should be designated full species (*P. nigripes* and *P. nihonus*, respectively).

Discriptively, the black-footed albatross has a dark bill, legs and feet at all stages of their development. The black-footed albatross is slightly larger and heavier than the Laysan albatross, (Harrison et al., 1983; Whittow, pers. comm.). The Japanese black-footed albatross is reported to be slightly smaller than its Hawaiian counterpart (H. Hasegawa, pers. comm.). The plumage colorations for both the immature and adult black-footed albatrosses are extremely similar; brown with a white band at the base of their bill and a white sweep defining their eyes. One of the distinguishing features between adult and juvenile (i.e., young-of-the-year) black-footed albatrosses are that the juveniles lack the white plumage at the base of their tail. The plumage of the immature birds can be, but is not always, slightly darker in coloration than the adult birds. Generally, as the juvenile black-footed albatrosses mature, they tend to become more gray or dusty in appearance (Miller, 1940).

The feather and egg trade in the early 1900s destroyed nesting colonies on Izu, Wake, Bonin and Marcus Islands, as well as colonies on Johnston and Taongi Atolls (Rice and Kenyon, 1962; McDermond and Morgan, 1993). However, a small population of approximately 1,106 - 1,206 black-footed albatrosses have recolonized the Japanese Islands of Torishima (Rice and Kenyon, 1962; Hasegawa, 1984; Ogi et al., 1994) and there have been recent observations of black-footed albatrosses visiting Wake Island (Rauzon, 1988, unpubl. observ.) and two mated pairs have been sighted over Minami Iwo Jima in 1982 (E. Flint, pers.comm.). Since 1998, there have been no reports of visitations by black-footed albatross to Johnston Atoll or to Marcus Island (E. Flint, pers. comm.).

Black-footed and Laysan albatrosses range throughout the North Pacific between 20°N and 58°N. Knowledge of their distribution comes primarily from reports of encounters with banded birds, from scientific transects, and from observations. A few birds have been tracked over long distances by satellites (Anderson and Fernandez, 1998). Researchers used satellite telemetry to study the movements of a male black-footed albatross during its pelagic travels off the coast of California (Hyrenbach and Dotson, 2001). This albatross covered a distance of 5,067 km during 35 days, and moved over a broad range of ocean water temperatures (22–15°C). The rate of movement of the tracked albatross varied significantly during different periods of the day, and was influenced by ambient light levels during the night (Hyrenback and Dotson, 2001).

The black-footed albatross occurs regularly in large numbers off the west coast of Canada and the United States and off the East Coast of Japan.

The most recent estimate of the world population of breeding black-footed albatrosses is 327,753 individuals, with 58,898 breeding pairs in 12 colonies (Table 9). Nine of the colonies are located in the NWHI comprising the majority of the breeding population.

Seventy-five percent of the NWHI breeding pairs nest in three colonies that are routinely surveyed by the USFWS: Laysan Island, Midway Atoll and French Frigate Shoals (Figure 6). The two largest black-footed albatross colonies accounting for approximately 70% of world population are on Midway Atoll and Laysan Island. French Frigate Shoals accounts for about 6% of the world population.

Three black-footed albatross colonies are also located in the Western Pacific (estimated 3,123 breeding pairs) accounting for 5% of the world population. On, Torishima, six black-footed albatross chicks were successfully reared in 1957, and since then the number of chicks reared has increased from 914 in 1998, to 1,170 in 2003 (H. Hasegawa, unpubl. data). The black-footed albatross populations on Bonin and Senkaku Islands have also modestly increased (Table 9).

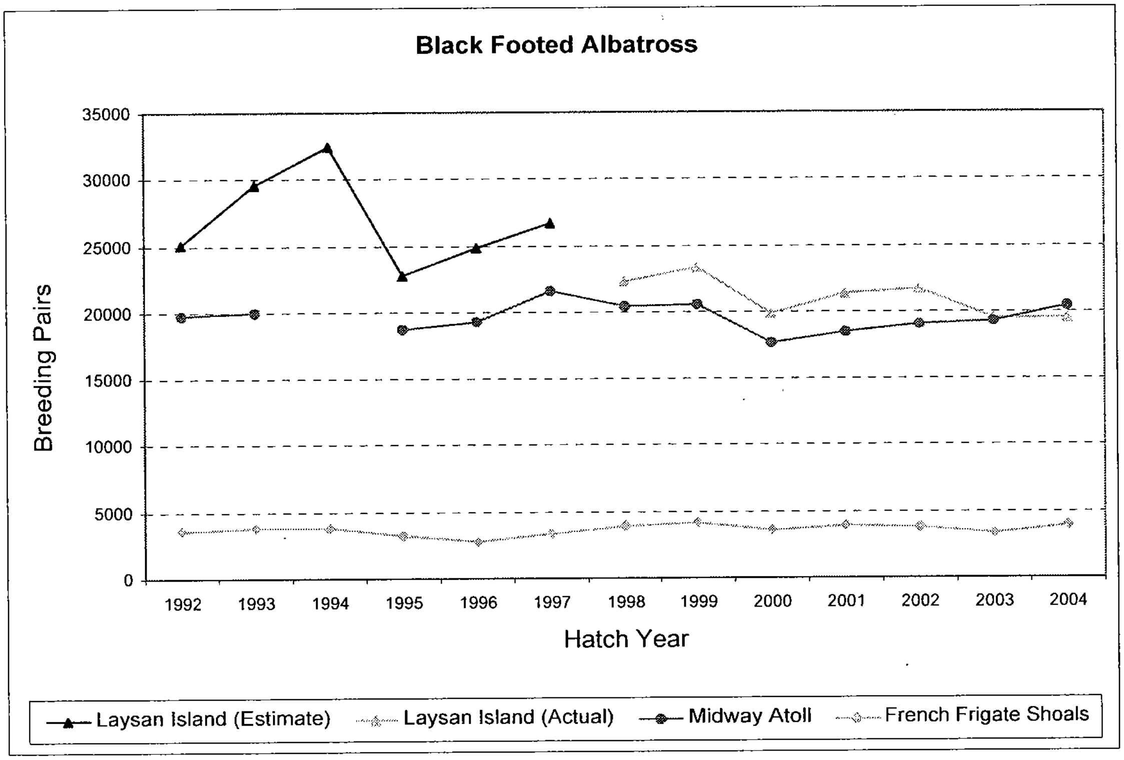


Figure 6. Counts of black-footed albatross breeding pairs at French Frigate Shoals, Midway Atoll and Laysan Island, NWHI for years 1992 to 2004. Counts of breeding pairs for Laysan Island were extrapolated from plot counts of eggs for years 1992 to 1997. All other data points were obtained from direct counts of breeding birds (Source: E. Flint, USFWS, Hawaii).

The USFWS was recently petitioned to list the black-footed albatross under the ESA (Earthjustice 2004). However, the USFWS rejected the petition in a letter to Earthjustice, dated December 3, 2004, stating that emergency listing was not warranted at this time. The petition painted a dismal picture of the prospects for black-footed albatrosses, arguing that the Pacific population is in decline and that this decline is exacerbated by human threats, particularly pelagic longline fishing. However, Harrison (1990) reports that in the early 1980s, black-footed albatross populations in the NWHI ranged from 36,240 to 49,410 nesting pairs, or taking the average, about 43,000 pairs. The most recent nesting population estimate for the NWHI is about 55,775 nesting pairs (NMFS 2004). The difference represents an increase of 12,775 nesting pairs or an increase of 30% over this time period. Midway's black-footed albatross population has increased to over 20,000 nesting pairs, from a population in the early 1980s of 6,500-7,500 nesters - an increase of 300% in less than two decades. Using an even more conservative estimate from the early 1960s of 7,000 pairs (Robbins 1961) indicates a tripling of the black-footed albatross population size over the past 40 years. The Midway nesting population of black-footed albatrosses in 2005 amounted to 21,829 nesting pairs, or a 7% increase on the 2004 total

(USFWS 2005) Similarly, both the black-footed albatross nesting populations at French Frigate Shoals and Laysan Island in 2003 appeared to be at the high end of the population sizes observed in the early 1980s (Harrison 1990). In addition, the overall increase of black-footed albatross nesting pairs in the NWHI increased by 7.2% between 2001 and 2003 (USFWS 2004b). The most recent information indicates that NWHI nesting numbers have remained stable since 1991(USFWS 2005). Taken together, these observations strongly suggest either an increasing population, or at worst, a stable population.

Elsewhere in the Pacific there are additional indications that black-footed albatross populations are either increasing or stable. According to Dr. Hiroshi Hasegawa of Toho University, the small (< 3,000 nesting pairs) populations of black-footed albatrosses on several Japanese offshore islands have all increased and are expanding their nesting ranges (Hiroshi Hasegawa personal communication to Craig Harrison 2004). The petition asserted that the Japanese population segment of the black-footed albatross population is in grave danger because "...small populations are particularly vulnerable to rapid loss of genetic variation due to genetic drift, and the low genetic variability of the Japanese population may cause it consequently to suffer from inbreeding depression. The Japanese species in particular may be most vulnerable to extinction given its depressed level of genetic diversity for its observed population size." However, this statement is not supported by any scientific evidence because all available scientific evidence points to increased viability of this small population segment with the consequent maintenance of its contribution to population diversity. Indeed, the existence of these small population segments support the conclusion that the global population of black-footed albatrosses is stable since one would expect the range of the species to decline if the total population had declined. It is also interesting to note that, like the NWHI black-footed albatross nesting populations, the Japanese population segments are surrounded by large concentrations of longline fishing, and these populations have continued to thrive notwithstanding the existence of these and other pelagic fisheries.

Similarly, at sea counts of black-footed albatrosses off the California coast show an upward trend from 1994 to 2002, with some of the highest numbers observed in 2000 and 2001. The increasing trend in apparent albatross abundance off the California coast appears to be related to oceanographic phenomena such as El Niños, and the Pacific Decadal Oscillation (PDO) to a cold PDO (Larry Spear personal communication). These trends taken together with those from the NWHI, cannot be interpreted to mean that the global or Pacific populations of black-footed albatrosses are experiencing a serious decline, or in need of additional legal protection under the ESA and the petition was denied by the USFWS.

The petition asserted the potential for pelagic longline fisheries to exacerbate the decline in black-footed albatross populations, citing a paper by Lewison & Crowder (2003) which uses a simple matrix projection model of the black-footed albatross population to reach this conclusion. Allied to this assertion are interaction estimate scenarios which extrapolate U.S. observer data to longline fleets operating in the North Pacific, primarily Japanese and Taiwanese vessels. Under all scenarios, Lewison & Crowder (2003) state that their estimates of black-footed albatross mortalities are likely to cause an overall reduction in the size of the black-footed albatross population over the next 60 years. However, the observed population trends for black-footed albatrosses do not match the assertions in the petition nor do they support the conclusions provided in the paper. Moreover, the longline fleet size has, as a whole, grown in the Pacific Ocean over the past 50 years. But, as available scientific information indicates, black-footed albatross populations have not declined despite this substantial increase in the amount of longline effort.

Lewison and Crowder (2003) inappropriately attempt to extrapolate observer records from Hawaii-based vessels to other international longline fleets. Such a methodology fails to recognize the significant differences in these fisheries. To apply Hawaii black-footed albatross data to the international fleet, one must realize that the Hawaii fleet has a different mix of components than the international fleet, components being modes of operation (depth, time of day, bait, etc.) and areas of operation. In other words, to avoid applying inappropriate comparisons the Hawaii data must be stratified into relevant components and then the component data applied to the corresponding components of the international fleet. There is no indication in Lewison and Crowder (2003) whether the authors performed this key analysis.

Finally, results contained in the Lewison and Crowder paper are simply out of date, and based upon highly speculative interpretations of available data. The authors themselves acknowledge the uncertainty associated with their extrapolations and estimates. Despite a publication date of 2003, this study uses data and information which are at least 5 to 6 years old, and cites none of the more recently published work on seabird interactions in the Hawaii fishery. Specifically, Lewison and Crowder (2003) does not refer to the order of magnitude decline in seabird takes by the Hawaii pelagic longline fleet since the curtailment of swordfish fishing in March 2001, nor the implementation of seabird mitigation measures in this fleet since 2002. Similar seabird mitigation measures are currently being tested and employed on Japanese longliners operating in the North Pacific. In short, conclusions contained in Lewison and Crowder (2003) are based upon a series of erroneous assumptions and information concerning longline fishing fleets operating in the North Pacific Ocean, and available data on long-term black-footed albatross population trends simply do not support those conclusions.

Laysan Albatross (*Phoebastria immutabilis*)

Laysan albatrosses are characterized by white plumage on their head, neck and chest, and sooty brown plumage on their upper wings, back and tail. The Laysan albatrosses' underwings have variable patches of dark and white plumage and are distinguished by dark leading edges and wing tips. Laysan albatrosses have fleshy-pink colored legs and webbed feet, and in flight the feet project beyond the tail. The Laysan albatross eye is defined with gray and black plumage that extends to a thin line behind the eye. There are no distinguishing characteristics between sexes or between adult and immature phases.

Over the past century, the Laysan albatross population experienced several disturbances. It is estimated that before the feather hunters reached Marcus Island, the island had a population of one million Laysan albatrosses (Rice and Kenyon, 1962). Feather hunters also raided Laysan albatross colonies in the NWHI taking at least 300,000 birds from Laysan Island in 1909 (Dill and Bryan, 1912). To protect the colonies from further devastation, President Theodore Roosevelt established the Hawaiian Islands Bird Reservation on February 3,1909 (Executive

Order 1019). The Reservation initially included all of the NWHI except for Midway Islands, which were under the jurisdiction of the U.S. Navy Department (Clapp and Kridler, 1977). Jurisdiction over the Reservation was transferred to the Department of the Interior on 25 July 1940. However, tens of thousands of birds were killed during WWII, and then later thousands more were killed by the U.S. Navy in an attempt to reduce bird strike hazards to aircraft (Robbins, 1966). In 1996, Executive Order 13022 transferred the administration of Midway Atoll to the Department of Interior to be managed by the U.S. Fish and Wildlife Service as a National Wildlife Refuge.

The most recent estimate of the Laysan albatross population is 3.4 million individuals, with 623,622 breeding pairs in 15 colonies (Table 9). Twelve of the colonies are located in the NWHI comprising of the majority of the breeding population (623,495 breeding pairs). The largest Laysan albatross colony (71% of the world population) is on Midway Atoll (Figure 7). A complete direct nest count on Midway Atoll in 2003 found that the number of nesting pairs of Laysan Albatrosses had increased by 53.9% since 2001 (USFWS 2004b). The most recent census in 2004 showed that the number of nesting pairs was still elevated but had declined by 7.5% as compared to the previous year (USFWS 2005). Laysan Island has the second largest colony (22% of the world population). The most recent information indicates that NWHI nesting numbers for these populations remain stable (USFWS 2005). Taken together, therefore, these observations suggest either an increasing population or at worst a stable population. A Laysan albatross colony located on Bonin Island is comprised of 14 breeding pairs while three other colonies (with a total of 113 breeding pairs) are located in the Eastern Pacific on Guadelupe (Dunlap, 1988), the San Benedicto Islands, and Isla Clarion, Mexico (Howell and Webb, 1992). Since 1998, there have been no reports of visitations by Laysan albatrosses to Johnston Atoll or to Marcus Island (E. Flint, pers. comm.).

More Laysan sightings are being reported on the California coast, perhaps due to the colony in Mexico. It is unknown at this time if the colony is growing due to juvenile recruitment or to immigration from other colonies. The great majority of pelagic encounters of Laysan albatross have come from west of the 180° meridian (Robbins and Rice, 1974).

A serious problem for the Laysan albatross population is lead poisoning of chicks from weathering lead-based paint on old buildings on Midway Atoll. Chicks raised in nests close (< 5 meters) to buildings ingest deteriorating paint directly from the buildings or paint chips that have fallen in and around their nests. Blood lead concentrations in chicks near buildings average 440 µg/dL, compared to an average blood lead of 6 µg/dL in chicks nesting more than 100m from buildings. For comparison, the Centers for Disease Control's blood level of concern for children is 10 µg/dL. The chicks near buildings frequently exhibit a condition of peripheral neuropathy called "droopwing." These chicks cannot raise their wings, leading to broken bones and open sores. They die either as a direct result of lead poisoning or from starvation when their parents stop feeding them. It is estimated that chicks suffering significant detrimental effects from lead exposure on Midway's Sand Island could number in the thousands per year (Finkelstein, 2004).

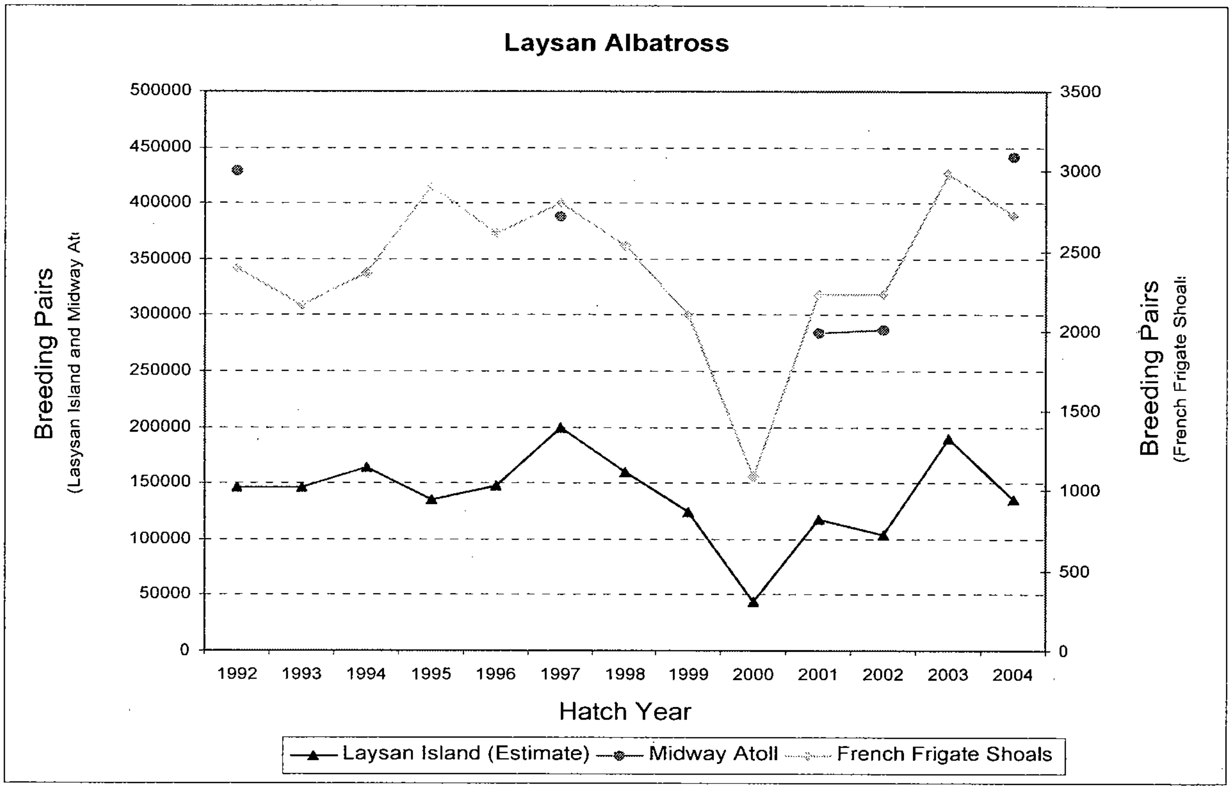


Figure 7. Counts of Laysan albatross breeding pairs at French Frigate Shoals, Midway Atoll and Laysan Island, NWHI for years 1992 to 2004. Counts of breeding pairs for Laysan Island were extrapolated from plot counts of eggs for years 1992 to 2003. All other data points were obtained from direct counts of breeding birds (Source: E. Flint, USFWS, Hawaii).

Shearwaters (Order Procellariiformes, Family Procellariidae)

Three species of shearwaters breed in the Hawaiian Islands and forage in the area in which the Hawaii longline fishery operates. These are the wedge-tailed shearwater (*Puffinus pacificus*), Christmas shearwater (*P. nativitatis*) and the Newell's shearwater (*P. auricularis newelli*). A fourth shearwater, the short-tailed shearwater (*P. tenuirostris*), breeds in Australia but migrates to foraging areas at Kotzebue Sound which is north of the Arctic Circle in Alaska. Short-tailed shearwaters may be present in Hawaiian waters between September and May during their annual migration.

The Newell's shearwater is listed as threatened under the U.S. Endangered Species Act and is considered vulnerable by the IUCN. The Newell's shearwater has been given this conservation status because of its small population size, approximately 14,600 breeding pairs, their isolated breeding colonies, and the numerous hazards affecting them at their breeding colonies including urban development and introduced predators like rats, cats, dogs and mongoose (Ainley et al., 1997). The conservation status of the Christmas shearwater to date is unknown. Harrison (1990) estimated that there were approximately 3,100 Christmas shearwaters nesting in the Hawaiian Islands in the late 1980s. Given that the Hawaiian Islands are at the species most northern boundary, it is possible that the Christmas shearwater population is more abundant near breeding colonies located in the mid- and South Pacific. The wedge-tailed shearwater is one of the most abundant seabirds in the Hawaiian Islands with an estimated 1,330,000 birds (Harrison, 1990). Worldwide there is an estimated 5.2 million wedge-tailed shearwaters (Whittow, 1997).

Shearwaters are known to forage in the area where Hawaii-based longline vessels operate, but lethal interactions between shearwaters and the Hawaii-based longline fishery are rare events. A total of five shearwaters have been caught and killed by the fishery, one fleshfooted shearwater, two sooty shearwaters and two unidentified sherawaters (NMFS PIRO observer data). No Newell's shearwaters have been recorded caught or killed by the Hawaii-based longline fishery. Both the Newell's and wedge-tailed shearwaters are known to prefer foraging areas of either low water temperature, such as the cool upwelling waters of the North Pacific Transition Zone (NPTZ), or high salinity (Gould, 1983; Spear et al., 1999). Also, high densities of these birds are seen in the southeastern portion of the Hawaii longline fleet's area of operations (Spear et al., 1999). It is not unusual for a petrel to accidentally fly onto a vessel during rough weather and high seas. Usually, these birds remain on board for a brief period, or overnight, before they depart back to sea.

Shearwaters are most active in the day and skim the ocean surface while foraging. During the breeding season, shearwaters tend to forage within 50 - 62 miles (80 -100 km) of their nesting burrows (Harrison, 1990). Shearwaters also tend to be gregarious at sea and only the Newell's and short-tailed shearwaters are known to occasionally follow ships (Harrison, 1996). Shearwaters feed by surface-seizing and pursuit-plunging (Warham, 1990). Often shearwaters will dip their heads under the water to site their prey before submerging (Warham, 1990). Shearwaters are efficient swimmers as their pelvises are narrow and their legs are placed far back on their body, however, adaptions to swimming make shearwaters extremely awkward on land (Harrison, 1990).

Shearwaters are extremely difficult to identify at sea, as the species are characterized by mostly dark plumage, long and thin wings, a slender bill with a pair of flat and wide nasal tubes at the base, and dark legs and feet. Like the albatross, the nasal tubes at the base of the bill enhances the bird's sense of smell, assisting them to locate food while foraging. The wedge-tailed shearwater may be more distinct from the other species of shearwaters as it is slightly larger with flesh-colored legs and feet and has a long wedge-shaped tail (Harrison, 1990). The wedge-tailed shearwater is also polymorphic, meaning that there are dark, light and intermediate plumage forms (Whittow, 1997).

Newell's Shearwater (Puffinus auricularis newelli)
The Newell's shearwater was listed as a threatened species under the ESA on September 25, 1975 (40 FR 44149). The Newell's shearwater breeds only in colonies on the main Hawaiian Islands, such as on Molokai, Hawaii, and mainly on Kauai (Pratt et al., 1987; Harrison, 1990; Reynolds et al., 1997a,b). The Newell's shearwater (*Puffinus auricularis newelli*) was once

widespread in the main Hawaiian Islands, but is reduced to a few remnant breeding colonies because of urbanization and predation by introduced mammals.

The species was thought to be extinct in the Hawaiian Islands by 1908, but was found to be breeding on Kauai in 1967 (King and Gould, 1967; Sincock and Swedberg, 1969). Historically, the bird was collected for food by the Polynesians who colonized the Hawaiian Islands. Since then much of the breeding habitat for the species has been converted to agricultural, military, commercial or residential land (Cuddily and Stone, 1990). The loss of nesting habitat for the species is considered one of the primary causes for the present decline of its populations (Ainley et al., 1997). Predation of adults and chicks by introduced predators, such as mongooses (*Herpestes auropunctatus*), rats (*Rattus* spp.), feral cats and barn owls (*Tyto alba*) (Byrd and Telfer, 1980; Harrison, 1990), is another factor in the species decline.

The Newell's shearwater is highly pelagic, occurring year-round in the tropical and subtropical waters mostly to the east and south of the Hawaiian Islands (Ainley et al., 1997). The bird especially frequents the Equatorial Countercurrent, from near the portion of the equator lying south of the Hawaiian Islands east to about 120°W and north to and around the main Hawaiian Islands (22°N). Isolated sightings of Newell's shearwater are recorded from central and south Pacific, west to the Commonwealth of the Northern Mariana Islands and Guam, Wake Island, and Johnston Atoll (King and Gould, 1967; Pratt et al., 1987), and south to the Marquesas Islands and Samoa (Pratt et al., 1987; Grant et al., 1994; Spear et al., 1995).

Newell's shearwaters breed in burrows or deep rock crevices between 160 and 1,200 m elevation (Reynolds and Ritchotte, 1997). Breeding pairs form in the years before mating. Mating usually begins at six years of age (Brooke, 1990). One smooth, white egg is laid by the female in a breeding season. Both parents attend to a chick which is irregularly until it fledges in October (Telfer et al., 1987). For unknown reasons, fledglings are attracted to lights which can lead to mortality in urban settings (Reed et al., 1985). The annual adult survivorship of a Newell's shearwater is estimated to be about 90% (Ainley et al., 1997).

Wedge-tailed Shearwater (Puffinus pacificus)

The wedge-tailed shearwater is one of the largest of the tropical shearwters with an overall length of 43 cm, and body mass of 390 g (Whittow, 1997). The bird has grayish brown plumage on its back and white on its belly and underparts except for dark edge to the wings and dark undertail coverts. The sexes are indistinguishable and there are a light and a dark morph to this species.

The wedge-tailed shearwater has migratory behaviors. From September to November, large flocks of the species gather offshore before migrating near the Hawaiian Islands (King, 1974). Often during this period there may be rafts of birds with up to 700 individuals. The wedge-tailed shearwater breeds between February and November in the Northern Hemisphere and August and October to May and June in the Southern Hemisphere.

The wedge-tailed shearwater breeds from Kure Island in the NWHI to Maui Island in the main Hawaiian Islands (Ainley et al., 1997). The wedge-tailed shearwater also breeds on other islands spread throughout the Northeast and South Pacific, including Johnston Atoll and Christmas, Bonin, Volcano, Marshall, and Caroline Islands, and the Indian Ocean where it is known to breed as far west as Madagascar (Whittow, 1997).

A female wedge-tailed shearwater lays a single white egg in a burrow at sea level. The bird may use ledges and rock piles on rocky islands such as Necker in the NWHI (Harrison, 1990), or use shell debris or crevices under coral ledges (Gallagher, 1960). Both adults share in the excavation of the burrow, incubation of the egg, and feeding of the young (Shallenberger, 1973; Shallenberger, 1984). First breeding is at four years of age (Floyd and Swanson, 1983), and a wedge-tailed shearwater may live as long as 29 years (E. Flint in Whittow, 1997).

Christmas Shearwater (Puffinus nativitatis)

Christmas shearwaters are slender-bodied with a length of 35-38 cm and body mass of 354 g. (Harrison,1983). Their plumage is dark brown with their underparts being lighter than their upperparts. The sexes are indistinguishable.

The Christmas shearwater breeds primarily in the tropical Pacific ranging as far north as the Hawaiian Islands to as far south as Easter Island (Harrison, 1996). The species usually breeds on remote, small, flat and sandy islands under dense vegetation such as naupaka (*Scaevola sericea*). Christmas shearwaters also breed on a steep grass covered slope on Motu Nui (Johnson et al., 1970).

Breeding adults return to the NWHI from early to late February (Naughton, 1982). A breeding pair will occupy a nest site in early to late March (Seto, 2001). The nest is a shallow scrape or depression in the ground, and usually located under vegetation. The female lays a single white egg each breeding season, and both parents share incubation of the egg and feeding of the chick (Seto, 2001). Chicks fledge between September and October on Midway Atoll The oldest record of a banded Christmas shearwater was 17 years on Laysan Island (K. Swift in Seto, 2001).

Boobies (Order Pelecaniformes, Family Sulidae)

Three species of boobies also breed in the NWHI and forage in the North Pacific: the masked booby (*Sula dactylatra*), the brown booby (*Sula leucogaster*) and the red-footed booby *(Sula sula*). Currently, the World Conservation Union classifies boobies as "not globally threatened." Like the albatrosses, the boobies are also long-lived and have a delayed maturity. Unlike the albatrosses, which are primarily surface feeders, the boobies are plunge divers and also tend to take flying fish (*Cypselurus* spp.) just above or at the surface of the water.

To date, there have been no reports of lethal interactions between boobies and the Hawaii-based longline fishery, but boobies are reported to sit on vessel decks and watch the baited hooks as they are being set or hauled back. NMFS fishery observers report boobies hovering over baited hooks and some birds may actually attempt a dive, however, no boobies have been reported hooked. Although the foraging behavior of boobies may differ from that of the albatrosses, such that they do not interact with longline fishing vessels or gear in the same manner, boobies are present during fishing operations and the potential for fatal interactions does exist.

Boobies breed throughout the Hawaiian Archipelago, and three localities have been routinely monitored by the USFWS in Honolulu (Table 12). Harrison (1990) reported breeding pair numbers from surveys of booby colonies completed between 1981 and 1988. From the surveys completed in the 1980s, it was estimated that there were about 14,000 masked boobies, 1,500 brown boobies and 11,000 red-footed boobies (Harrison, 1990).

Table 12: NWHI booby counts at Johnston Atoll, Midway Atoll and Tern Island, French Frigate Shoals, between 1979 and 1996 (Source: USFWS Refuges Office, Honolulu, Hawaii, unpubl. data.)

Year	Johnston Atoll			Midway Atoll	Tern Island	
	Red-footed Booby	Masked Booby	Brown Booby	Red-footed Booby	Red-footed Booby	Masked Booby
1979	--	--	--	--	385	--
1980	--	--	--	--	441	--
1981	40	--	92	--	394	--
1982	--	--	80	--	341	--
1983	35	--	56	--	500	--
1984	40	--	150	--	605	--
1985	57	--	135	178	727	--
1986	86	--	123	--	691	--
1987	84	1	169	--	735	--
1988	102	3	200	282	932	--
1989	116	3	189	410	1133	--
1990	119	9	217	427	888	--
1991	189	5	204	--	1267	--
1992	230	11	287	555	1348	18
1993	312	13	401	--	1579	23
1994	309	14	369	--	1040	29
1995	320	18	361	--	1561	32
1996	--	--	--	563	2194	35

The age at first breeding for boobies is usually four years (Woodward, 1972). Boobies tend to lay between one and two eggs each breeding season. Red-footed boobies only lay one egg each season while brown boobies lay one or two eggs (Nelson, 1978). Masked boobies lay two eggs and when both eggs hatch, the oldest hatchling ejects its sibling from the nest (Anderson, 1990). The ejected chick is not protected by the parents and dies (Anderson, 1990). Adult boobies are known to live at least 22 years, if not longer (Clapp et al., 1882; Anderson, 1993).

10.5.2 Seabird Interactions with Longline Fishing Vessels

Worldwide Longline Seabird Interactions

Brothers first quantified the magnitude of the incidental catch of albatrosses for the Japanese longline fishery in the Southern Ocean and found that by conservative calculation 44,000 albatrosses were killed annually (Brothers, 1991). Albatrosses are incidentally caught in longline operations when they attempt to take bait from baited hooks and are hooked or entangled in the process. Albatrosses forage around longline fishing vessels because they often provide the birds ample food in the form of bait, discarded bait and offal (unwanted body parts of fish catch) (Harrison et al., 1983). In many instances albatrosses successfully remove a bait or part thereof from a hook without being hooked. The incidental catch of albatrosses has since been estimated in a number of other fisheries (Murray et al., 1993; Moloney et al., 1994; Ashford et al., 1995; Klaer and Polacheck, 1995; Alexander et al., 1997; Klaer and Polacheck, 1997; Brothers et al., 1999a), including the Hawaii-based pelagic longline fishery in which an estimated 1,963 black-footed albatrosses and 1,479 Laysan albatrosses became incidental catch in 1998 (Kleiber, 1999).

Researchers began documenting declines in wandering albatross (*P. exulans*) populations on islands in the Southern Ocean in 1979 (Croxall, 1979; Tomkins, 1985; Weimerskirch et al., 1987; Weimerskirch and Jouventin, 1987; Croxall et al., 1990). The declines were attributed to the incidental catch of these birds by the tuna longline industry in the region (Gales, 1993; CCAMLR, 1994; Birdlife International, 1995; Kalmer et al., 1996; Gales et al., 1998; Klaer and Polacheck, 1995). By the early 1990s, at least six of the world's albatross species were known to have experienced recent declines in population size (Gales, 1993) and it was determined that the single greatest anthropogenic threat to these seabirds was the longline fishing industry (Birdlife International, 1995; Brothers et al., 1998; Gales, 1998; Cousins and Cooper, 2000). The Australian Government formally recognized this threat in 1995, when it listed the incidental catch of seabirds during oceanic longline fishing operations as a key threatening process on Schedule 3 of the *Endangered Species Protection Act 1992.* The United Nations Food and Agriculture Organization Committee on Fisheries formulated an initiative calling for longlining nations experiencing incidental seabird catch to voluntarily employ proven seabird mitigation methods in their fisheries. The U.S. National Plan of Action (NPOA) to reduce the incidental catch of seabirds in U.S. fisheries was published in February 2001 (DOC, 2001). The goal of the NPOA is to reduce the incidental catch of seabirds in U.S. longline fisheries where it is determined by a regional fishery management council to be a problem.

The worldwide albatross incidental catch-rate by longline vessels was estimated to average 0.4 albatrosses per 1,000 hooks set (Alexander et al., 1997; Bergin, 1997) although there is variation around this number. For instance, Brothers (1991) reported a catch rate of 1-1.6 albatrosses per 1,000 hooks near New Zealand while Klaer and Polacheck (1997) estimated an incidental catch rate of 0.15 albatrosses per 1,000 hooks for Japanese longline vessels fishing in the Australian Fishing Zone. In comparison, between 1994 and 1998, the USFWS estimated 0.10 Laysan albatrosses and 0.12 black-footed albatrosses caught per 1,000 hooks in the Hawaii longline fishery (USFWS, 2000).

Data sources primarily focus on the findings and observations made onboard Hawaii-based pelagic longline vessels and the seabird populations nesting in the NWHI. The Hawaii-based longline fleet encounters seabirds because the fleet operates in known foraging grounds for the seabirds that nest in the NWHI. At present, this fishery is the only fishery operating under the

Pelagics FMP known to interact with seabirds. At-sea seabird observations for vessels operating in Guam and CNMI are absent and a limited number of NMFS observations of the American Samoa longline operations (76 sets) did not detect any interactions there.

Hawaii-based Longline Seabird Interactions

Hawaii-based pelagic longline fishing operations hook, entangle and kill black-footed albatrosses (*Phoebastria nigripes*) and Laysan albatrosses (*P. immutabilis*) that nest in the Northwestern Hawaiian Islands (NWHI). The birds follow the longline vessels and dive on the baited longline hooks during setting or hauling of the longline, become hooked or entangled and subsequently drown. Besides the direct mortality to adult birds, fishing-related deaths may also have a negative influence on chick survival if one or both parent birds are killed. On rare occasions wedge-tailed and sooty shearwaters are also incidentally caught by these vessels. Although the endangered short-tailed albatross (*P. albatrus*) is seen in the areas where the fishery operates and is known to visit the NWHI, there are no observations or reports of interactions between the fishery and short-tailed albatrosses. In the Hawaii-based longline fishery, the problem of incidental seabird catch occurs mainly among those fishing vessels targeting broadbill swordfish (*Xiphias gladius*) or a mixture of swordfish and bigeye tuna (*Thunnus obesus*), and fishing near known seabird foraging areas.

Although seabird interactions were known to occur in the Hawaii longline fishery prior to the inception of the NMFS observer program, the deployment of observers by the NMFS on longliners from1994 onwards provided data to quantify seabird interaction rates. It is unknown how many seabirds were incidentally caught by the fishery prior to the inception of the NMFS observer program, but it is likely that the pre-observer seabird interaction rates were similar to the rates collected by the NMFS observers. Management initiatives generated by the Western Pacific Regional Fishery Management Council (WPRFMC) in the early 1990s to regulate the Hawaii-based longline fishery mitigated some of the incidental seabird catch. These included a limited entry program, a maximum vessel length of 101 ft, and the implementation of a 50 nautical mile protected species closed area around the NWHI. The observer data provided the spatial distribution of seabird interactions for the fleet, and when analyzed it showed that catches of black-footed albatrosses were found to be significantly related only to proximity to nesting colonies and longitude, while catches of Laysan albatrosses were significantly related to proximity to nesting colonies and year. In addition, data collected by NMFS observers showed that vessels fishing to the north of the Hawaiian islands with a line-shooter targeting principally tunas had seabird catch rates one order of magnitude less than vessels employing no line-shooter and targeting swordfish.

The two major sources of information on albatross interactions with Hawaii-based longline vessels are the mandatory logbook and observer data collection programs administered by NMFS. The longline logbook program requires operators of longline vessels to complete and submit to NMFS a data form containing detailed catch and effort data on each set (50 CFR 660.14). Although the information is extensive, it does not compare to the completeness of the data collected by NMFS observers. Furthermore, preliminary comparisons between logbook and observer data indicate under-reporting of protected species interactions by vessel operators in the logbooks (NMFS, 1996).

The observer program administered by NMFS was implemented in February, 1994 to collect data on protected species interactions (marine turtles have highest priority) which include: all sea turtles, especially green, leatherback, and loggerhead turtles; Hawaiian monk seals; selected whale and dolphin species; and seabirds, including the albatross species and the brown booby (*Sula leucogaster*). The NMFS observer program achieved 5.3% coverage of all trips in the first year it was implemented, and then was unable to rise above 5% over the next five years (Table 13). The selection of trips to observe was based on a sampling design by DiNardo (1993) to monitor sea turtle interactions. Because most interactions with sea turtles tended to occur on vessels setting shallow and targeting swordfish, most trips observed tended to be those that fished above 23°N and targeted swordfish or a mixture of swordfish and tuna. As a consequence of regulatory changes, and with the prohibition of shallow-setting, a new sampling program was designed by M. McCracken by which observers are randomly placed on vessels. The data from this program cover observed trips from February 25, 1994 (tail end of first quarter 1994), to the present, and provide the primary source of statistical information on seabird interaction rates for the Hawaii longline fishery.

Table 13 NMFS observer program coverage of Hawaii-based longline fishing vessels between 1994 and 2003 (Source: PIRO website)

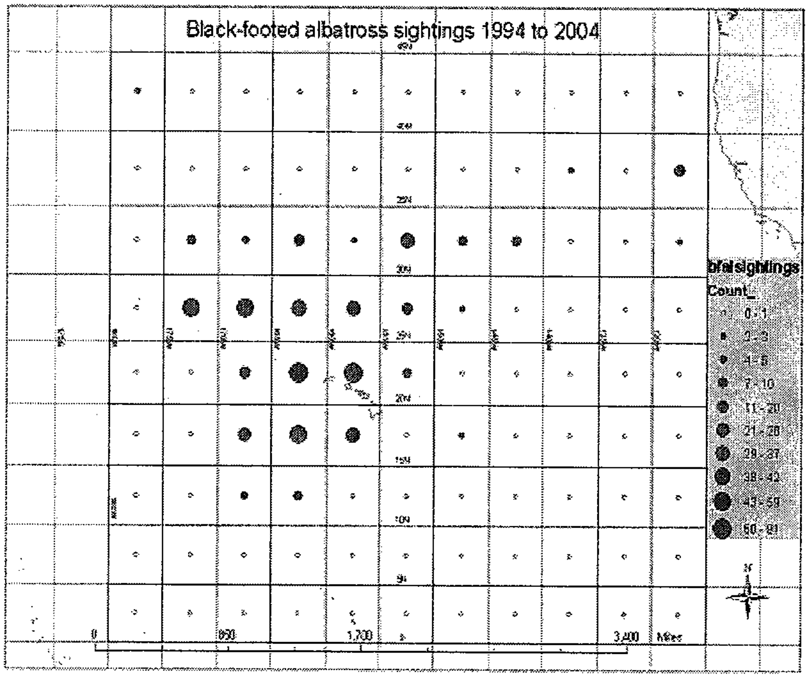
Year	Number of Trips	Observed Number of Trips	Average % Coverage
1994	1,031	55	5.3
1995	937	42	4.5
1996	1,062	52	4.9
1997	1,123	40	3.6
1998	1,180	48	4.1
1999	1,136	38	3.3
2000	1,134	118	10.4
2001	1,035	233	22.5
2002	1,193	294	24.6
2003	1,120	266	22.2

*Year 2000 was calculated as the time period between August 25, 2000 and March 31 2001. Year 2001 was calculated as the time period between July 1, 2001 and June 30, 2002.

NMFS observers record protected species data from three main types of events that include approaches, contacts and sightings. At sea seabird abundance around Hawaii longline fishing vessels is also collected (Figure 8). Sighting events are descriptions of seabird activity or behavior that do not involve approach or contact. An approach event is when a seabird is observed coming closer to the vessel or the gear and in some cases attempting to make contact. A contact event is when the seabird is observed to touch the gear. Any seabirds that become entangled or hooked in the gear are considered as incidental catch. A mortality is usually recorded by a NMFS observer when a seabird is brought onboard during the haul. Dead seabirds retrieved on the haul-back are assumed to have been hooked during the set. Infrequently, albatrosses are incidentally caught during the haul, and if caught the birds usually survive.

The recording of approach and contact events are important in that these data could be used to improve analysis of seabird interactions. For instance, seabird mitigation data collected on Hawaii longline fishing vessels during 1998 (McNamara et al.,1999) suggested that approach and contact events by albatrosses are correlated with hooking events (Figure 8). Further, contact events also appear to be linearly correlated with the number of seabirds present (Figures 9 & 10). Because seabird mortalities are statistically rare events (Brothers, 1991; Perkins and Edwards, 1996), gathering enough mortality data to show a statistically significant difference between mitigation methods may be difficult given that the seabird interaction rates for the Hawaii longline fishery are very low (Section 10.4.4.5).

The relationship described above suggests that albatross behavior is density independent, such that as bird abundance increases the number of approaches (or attempts to contact the gear) and contact events increase linearly. Since albatross abundance varies at sea, the data could be biased by inequalities in their abundance during the application of various deterrent methods. Albatross abundance data could be taken so that results could be presented in units of behaviors/mortality per bird (Grabowsky et al., in prep.). This correction is successful only if the number of behaviors show a linear correlation with changes in abundance. The data from the McNamara et al. (1999) study and that of Gilman et al. (2002) suggest that the assumption that albatross attempt and contact events are correlated with a catch event, is valid. Thus the collection of data regarding approach and contact events could be used to improve analysis of seabird interactions.



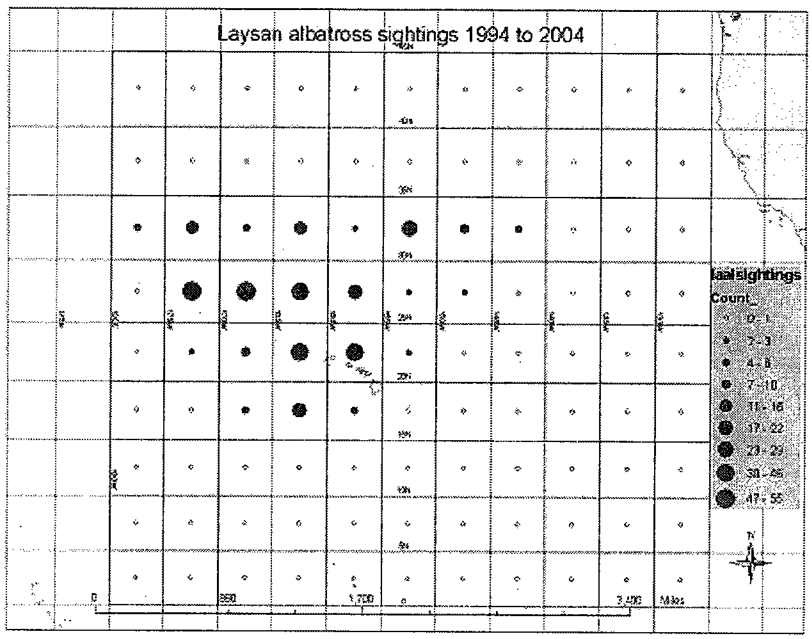


Figure 8. Abundance of black-footed albatrosses (top map) and Laysan albatrosses (bottom map) around Hawaii-based longline vessels during fishing operations (Source: NMFS Observer Program, unpubl. info.).

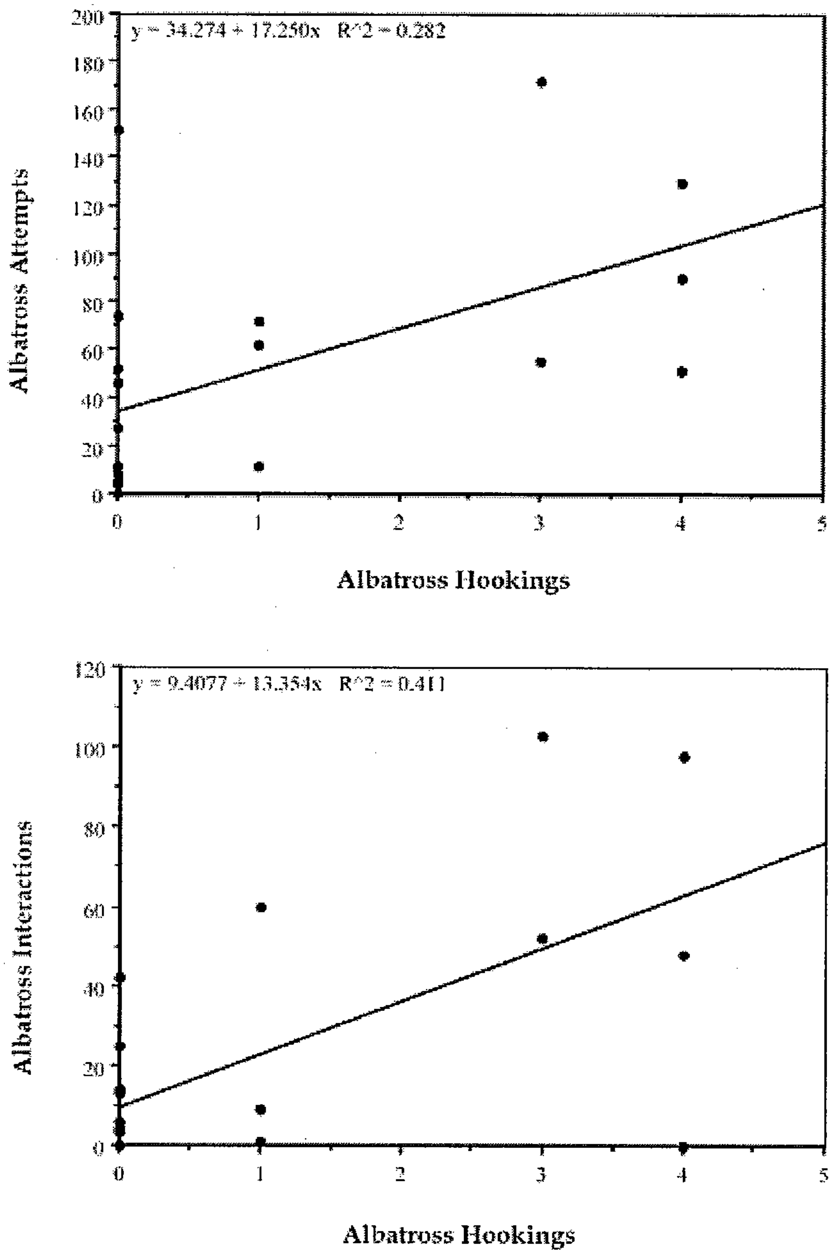


Figure 9. Relationships of albatross attempts, interactions and mortalities. The relationship between the total number of albatross attempts and hooking events for all 21control observation periods during the set in which albatrosses were present. (Source: Data obtained from McNamara et al., 1999.) The product-moment correlation coefficient (r) between the number of attempts and the mortality is $r = 0.531$ (n = 21, $k = 1$, df = 19) which demonstrates that there is a significant ($P < 0.05$) relationship between attempts and hookings. Bottom - The relationship between the number of contact events or interactions and hooking events recorded over the same 21 control observation periods. The correlation coefficient for these data is $r = 0.641$ (n = 21, $k = 1$, df = 19) again demonstrating that there is a significant ($P < 0.05$) relationship between interactions and seabird hookings

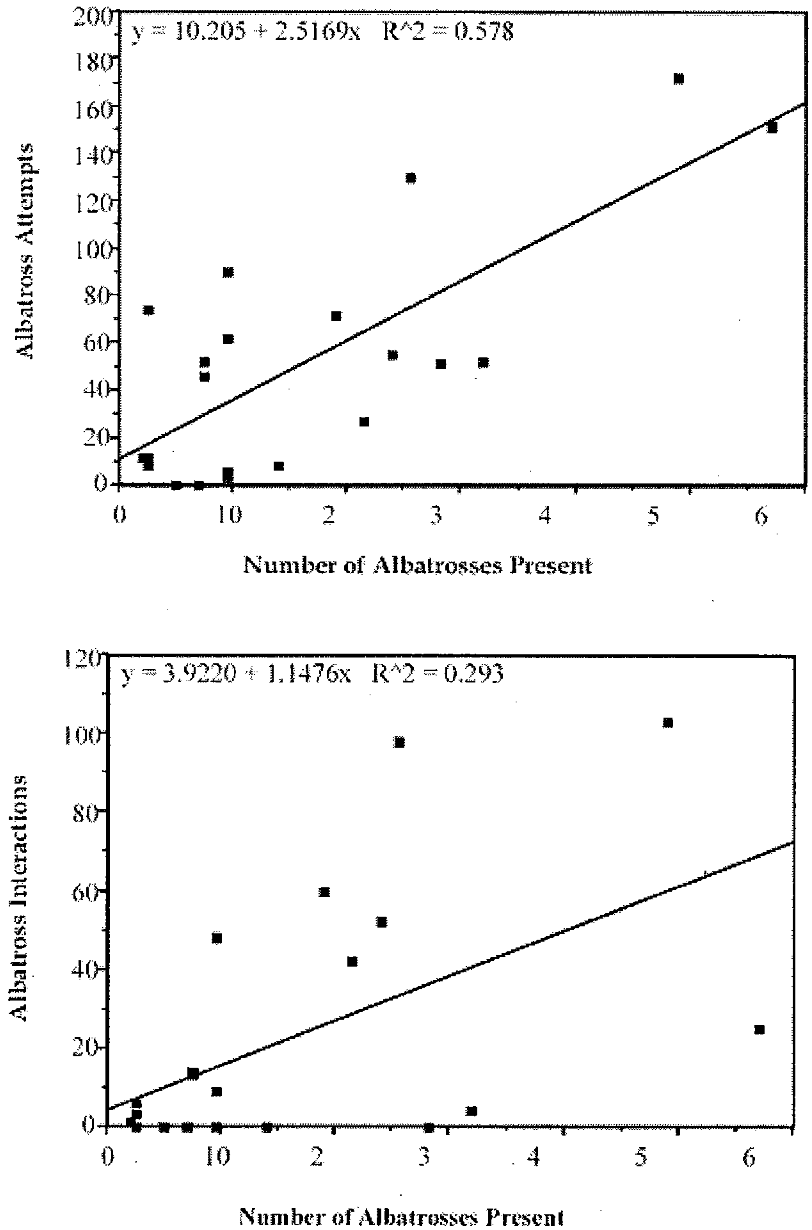


Figure 10. Relationships between albatross attempts, interactions and numbers present. The relationship between the number of albatross attempts and the total number of albatrosses present for each of the 21 control observation periods on the set. The plot illustrates a correlation of $r = 0.760$ (n = 21, $k = 1$, df = 19) demonstrating that there is a significant ($P < 0.05$) linear relationship between the number of birds present and the number of attempts made towards baits on the set. Bottom - The relationship between the number of contact events or interactions and the number of albatrosses present during control observations on the set. The correlation coefficient for this plot is $r = 0.541$ (n = 21, $k = 1$, df = 19) which is significant ($P < 0.05$). (Source: Data obtained from McNamara et al., 1999.)

Estimating the Incidental Catch of Seabirds by the Hawaii-based Longline Fishery
NMFS' Southwest Fisheries Science Center, Honolulu Laboratory (NMFS, SWFSC Honolulu Laboratory [now PIFSC]) used data from observer reports and the Western Pacific Daily Longline Fishing Log to estimate the annual incidental catch of seabirds in the Hawaii longline fishery, and to describe the spatial distribution of the catch.

Fleet-wide incidental catch estimates prior to 1998, were computed using a regression tree technique and bootstrap procedure (Skillman and Kleiber, 1998). The regression tree technique revealed structure in observer data sets and was applied to an array of independent variables (e.g., month, latitude, longitude, target species, gear type, sea surface temperature and distance to seabird nesting colonies). The model was "pruned" by cross validation, meaning that only the statistically significant predictors of seabird catches were kept in the analysis. Interestingly, this analysis showed that catches of black-footed albatrosses were found to be significantly related only to proximity to nesting colonies and longitude, while catches of Laysan albatrosses were significantly related only to proximity to nesting colonies and year (Klieber, 1999). In 1999, McCracken (2000) developed a new prediction model to estimate the number of black-footed and Laysan albatrosses caught by the Hawaii longline fishery during 1999, and then re-estimated takes for earlier years, 1994-1998 (Table 14).

For each albatross species, McCracken developed a prediction model that related the number of catches documented by an observer to ancillary variables recorded in the vessel's logbook or derived from such variables. The model was then used to predict the number of albatrosses caught on each unobserved trip on the basis of the predictor variables recorded in the logbooks for those trips. The total annual interactions for the fleet was estimated by adding the sum of predicted catches for the unobserved trips to the sum of recorded catches for the observed trips. After exploring several alternative statistical models for interaction estimation, a negative binomial generalized linear model was adopted. Variables well represented in the logbooks and transformations of them were considered as candidate predictors. A bootstrapping procedure that takes into account the uncertainty of the prediction model parameter estimates, and also the random variation of actual unobserved interactions about the expected predicted values was used to construct approximate "prediction intervals" for take. The bootstrap analysis also produced estimates of the estimation bias; the latter was used to adjust the point estimates. Point estimates adjusted for estimation bias and approximate prediction intervals for interaction are given in Table 1. Estimates of catches for the years 1994-1998 differ from values computed and reported by P. Kleiber in 1999. The revised estimates are based on a larger accumulation of observer statistics and different prediction models.

It was estimated that between 1994 and 1999, an average of 1,175 Laysan albatrosses and 1,388 black-footed albatrosses were incidentally captured and presumed killed in the Hawaii longline fishery each year (Table 14). These average annual incidental catches represented about 0.46% and 0.05% of the estimated 1998 worldwide black-footed and Laysan albatross populations, respectively. Albatross behavior, coupled with their numbers, may explain why so many more black-footed albatrosses interact with Hawaii longline fishery than Laysan albatrosses. The world breeding population of the Laysan albatross (558,415 birds) was estimated to be roughly ten times that of the black-footed albatross (61,866 birds), yet more black-footed albatrosses were recorded to interact with the Hawaii-based longline fishery, suggesting that the latter species was more seriously affected (Cousins and Copper, 2000). Satellite telemetry studies have shown that in general the Laysan albatrosses tend to fly to Alaska to forage whereas the black-footed albatrosses fly to the west coast continental U.S. (Anderson and Fernandez, 1998).

The number of Hawaii longline fishery interactions with all seabirds has been significantly reduced since 2000, due to the closure of the swordfish segment of the Hawaii-based longline fishery, and the implementation of new seabird mitigation measures based on research conducted cooperatively by the fishery participants, environmental organizations, and NMFS.

The increase between 2002 and 2003 may partially reflect the increase in nesting populations of black-footed and Laysan albatrosses in the NWHI discussed above.

Table 14. Estimated annual total incidental catch of albatrosses in the Hawaii longline fishery based on catches recorded by NMFS observers on monitored fishing trips. (Source: McCracken, 2000a, NMFS 2002, 2003, 2004)

Year	Black-footed	Laysan albatrosses
1994	1,830	2,067
1995	1,134	844
1996	1,472	1,154
1997	1,305	985
1998	1,283	981
1999	1,301	1,019
2000	1,339	1,094
2001	258	252
2002	65	51
2003	111	146

Even though no short-tailed albatrosses had been observed or reported to interact with Hawaii-based longline vessels or their gear, a Biological Assessment (NMFS, 1999) was developed to assess the impact of the Council's 1999 recommendations for seabird mitigation measures on short-tailed albatrosses. The assessment concluded that between one and three short-tailed albatrosses may be in the area where the fishery operated, based on the at-sea sighting from aboard the NOAA *Townsend Cromwell* and visitations to the NWHI. Given the historical levels of fishing effort and no interactions of short-tailed albatrosses with the Hawaii longline fishery, the probability of a single interaction was assessed to be extremely low; and this probability was judged likely to be reduced when seabird mitigation techniques were employed. Subsequently, the USFWS estimated in a 2000 BiOp on the same action that, based on a random distribution of the short-tailed albatrosses in the North Pacific, and the area fished by the Hawaii longline fishery, 334 short-tailed albatrosses are in the area where the fishery operates and that up to 2.2 birds would be incidentally caught each year. On November 18, 2002, the USFWS completed another BiOp on the closure of the shallow-set sector of the fishery and amended the incidental take statement for the Hawaii-based longline fishery from 2.2 short-tailed albatrosses per year to one bird per year. In October 2004, USFWS published another BiOP which focused on the reopening of the swordfish segment of the Hawaii-based longline fishery. The 2004 BiOp contained an incidental take statement of one short-tailed albatross per year for the Hawaii-based longline fishery.

Data collected by NMFS' Observer Program was used to calculate seabird interaction rates with the Hawaii longline fishery as shown in Table 15. The data are shown for the time periods 1994-1999 and 2002-2003 as these are periods when the fishery has operated under consistent sets of regulations. Up to 1999, the fishery had no regulations in place requiring the use of seabird mitigation measures. Between January 2001 and April 2001, the fishery was subject to varying regulations on shallow set fishing, culminating with a complete ban on shallow set fishing by Hawaii-based longline vessels between April 2001 and April 2004. Between 2001 and 2003 the deep set sector was required to use the seabird mitigation measures currently in place. Examining the two time periods (1994-1999 vs. 2002-2003) separately provides information on the impact of the regulatory controls.

The north-south split of the data for both shallow and deep sets stems from the 2001 implementation of the current requirement to use seabird avoidance methods when fishing north of 23° N. Separating the areas (above vs. below 23° N) allows examination of differences in interaction rates that are due to seabird abundance or differences in fishing operations rather than differences in regulatory controls. Obviously there is no 2002-2003 information on shallow setting interaction rates as shallow setting was prohibited during that time period.

The data in Table 15 show that during 1994-1999 Hawaii-based longline vessels targeting swordfish (shallow set) the had a far higher incidental catch rate of seabirds than vessels targeting tuna (deep set) (Table 15). One reason for this is that vessels targeting swordfish are more likely to operate within the foraging range of the seabirds. Black-footed and Laysan albatrosses nesting in the NWHI forage predominantly to the north and northeast of the Hawaiian Archipelago, flying as far as Alaska or the western coast of the contiguous U.S. (Anderson and Fernandez, 1998). The region of greatest interaction between seabirds and the longline fishery as it operated in 1998 is a latitudinal band between 25°N and 40°N stretching from the international dateline to about 150°W (Figure 8). This band, referred to as the North Pacific Transition Zone, contains a broad, weak, eastward flowing surface current composed of a series of fronts situated between the Subtropical Gyre to the south and Subarctic Gyre to the north (Roden, 1980; Polovina, 2000; Seki et al., 2002). The convergent fronts are zones of enhanced trophic transfer with high concentrations of phytoplankton, zooplankton, jellyfish and squid (Bakun, 1996; Olson et al., 1994). The increased level of biological productivity in these zones attracts, in turn, higher trophic level predators such as swordfish, sea turtles and seabirds. Hawaii-based longline vessels that target swordfish set their lines where the fish are believed to be moving south through the fronts following squid, the primary prey of swordfish (Seki et al., 2002.). Squid is also the primary prey item for the albatrosses (Harrison et al., 1983). Hence, the albatrosses and the longline vessels targeting swordfish are often present at the same time in the same northern front of high biological productivity.

Table 15. Estimated incidental catch of albatrosses in the Hawaii-based longline fishery by set type and area based on NMFS observer records from 1994-1999 and 2002 -2003. (Source: MCracken 2004).

Strata	Black-footed	Laysan	Black-footed and Laysan combined
1994-1999 (birds per set)			
South Deep	0.00741	0.00841	0.01582
South Shallow	0.00809	0.00841	0.01650
North Deep	0.03898	0.03117	0.07016
North Shallow	0.29853	0.2473	0.54583
2002-2003 (birds per set)			
South Deep	0.00545	0.00254	0.00799
North Deep	0.00673	0.01704	0.02378

A second reason that longline vessels targeting swordfish incidentally caught a larger number of seabirds than vessels targeting tuna relates to differences in gear configuration and the depth and time of gear deployment. Longline gear targeting swordfish generally consists of fewer hooks between floats (3-5), branch line (gangion) weights attached further from the hooks and buoyant chemical light sticks. During swordfish fishing the longline is set at a shallow depth (5-60 m), and the line and baited hooks sink comparatively slowly. Consequently, albatrosses following behind a vessel targeting swordfish have a greater opportunity to dive on hooks and become caught. In addition, vessels targeting swordfish during 1994-1999 often set their lines in the late afternoon or at dusk when the foraging activity of seabirds may be especially high.

Vessels targeting tuna differ from those targeting swordfish in that they generally operate in warm waters further south and set their lines at a relatively deep depth (15-180 m or greater). To facilitate the deployment of fishing gear at these depths vessels increase the longline sink rate by employing a hydraulic line-setting machine (line-shooter or line-setter) and branch lines with 40-80 gram weights attached close (20-90 cm) to the hooks. The use of a line-setting machine and weighted branch lines to increase the longline sink rate also reduces the incidental catch of seabirds by decreasing the time that baited hooks are near the surface and accessible to feeding seabirds.

Table 16 presents seabird interaction estimates for the fishery during two time periods in 2000 and 2001 in 2000, the Hawaii-based longline fishery operated under two different management regimes: 1) between January 1 - August 24, 2000, the Hawaii-based longline fleet was prohibited from fishing within a box (termed "Area A") which was bounded by 28°N, 44°N, 150°W and 168°W (Figure 11); between August 25 - 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 28°N and 44°N and between 173°E and 168°W ("Area B" Figure 10). Further, targeting of swordfish (shallow-setting) was prohibited in waters between the equator and 28°N, from 173°E to 137°W ("Area C" Figure 10).

Total fleet wide incidental catches of seabirds during the two time periods in 2000 were estimated using a prediction model that related observer recorded catch to ancillary (predictor) variables recorded in logbooks (McCracken, 2001). The incidental seabird catch for unobserved trips was predicted by applying the model to the predictor variables recorded in the logbooks for those trips.

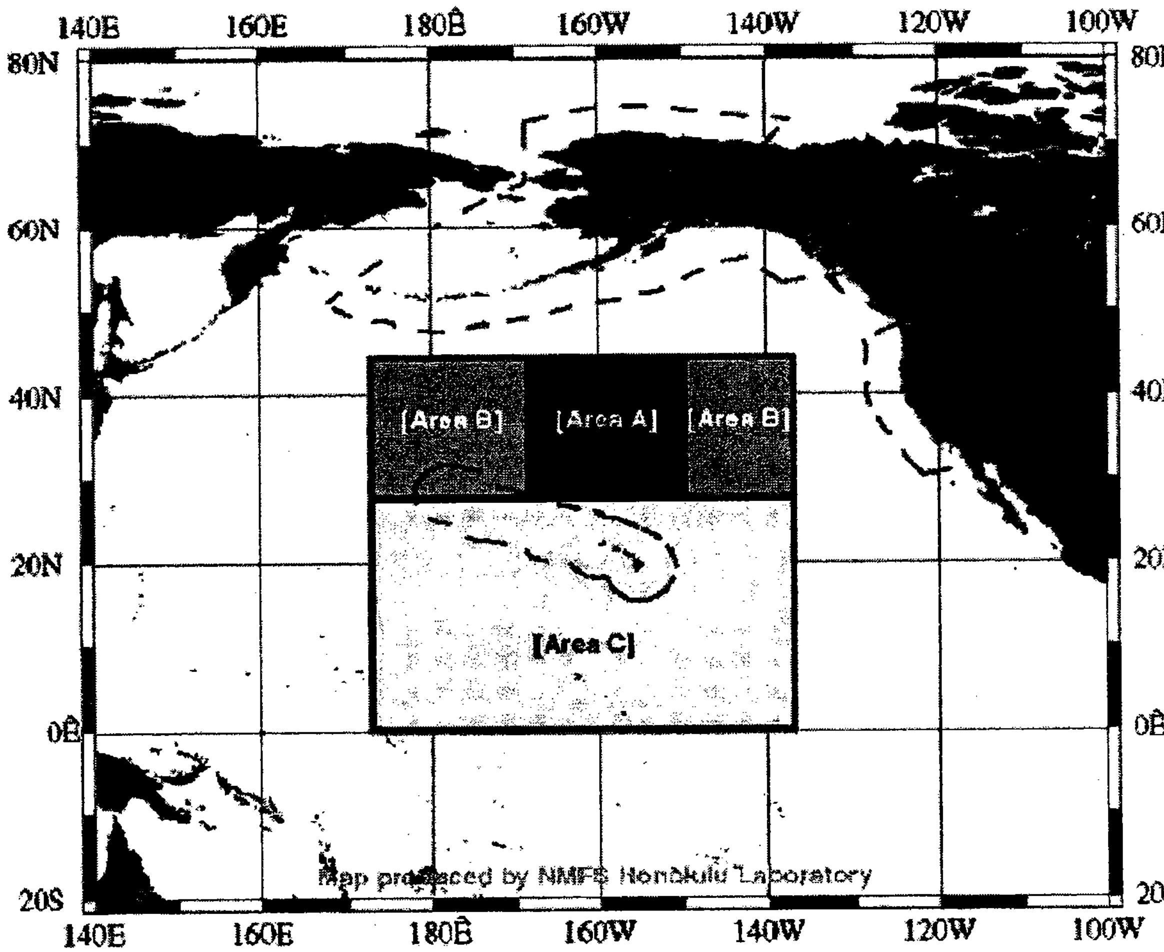


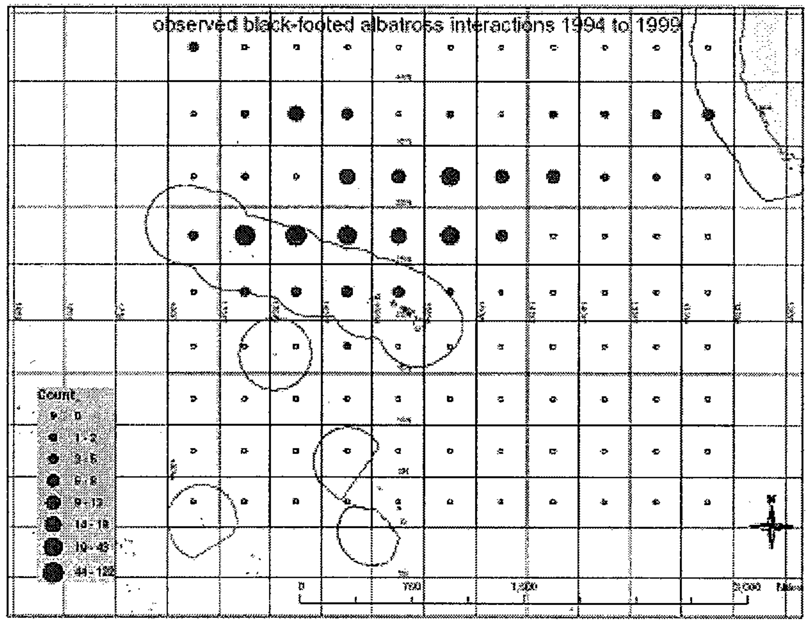
Figure 11. Temporary area restrictions imposed on the Hawaii-based longline fishery between 2000 and 2001.

Table 16. Estimated fleet-wide seabird catches in the Hawaii-based longline fishery between 2000 and 2001 (Source: McCracken, 2001).

Year	Black-footed Albatross		Laysan Albatross	
	Estimated Catch	95% CI	Estimated Catch	95% CI
2000[a]	272	212-373	155	108-215
2001[b]	58	Not available	62	Not available

[a] Year 2000 was calculated as the time period between August 25, 2000 and March 31, 2001.
[b] Year 2001 was calculated as the time period between July 1, 2001 and June 30, 2002.

In 2000, both deep-setting vessels and shallow-setting vessels were fishing, whereas in 2001 the shallow-set fishery was closed between the dates listed, and therefore only deep-setting vessels were fishing. Figure 12 illustrates the interaction rates with seabirds on Hawaii-based longline vessels onboard. Figure 12 is based on 1994-1999 data because this is the time period when there were no seabird mitigation requirements in place and thus this allows a comparison of unmitigated interaction rates by geographical area. Clearly interaction rates were highest in the north, and far lower in the south for both seabird species. This corresponds with the information presented in Figure 3 and 4. In general 1) there are no captures south of about 16 degrees N despite a moderate amount of deep-set effort, 2) there are relatively few captures south of 23 degrees N, 3) there is a rapid increase in captures at latitudes of 23 degrees -26 degrees N, 4) there is a relatively high rate of capture between about 27 degrees and 30 degrees N., 5) capture rates decrease in the range 31 degrees -41 degrees N. (Transition Zone), and 6) very high capture rates are seen at still higher latitudes . "Observed captures" means birds recorded by NMFS vessel observers as hooked or entangled in the longline gear. These rates of observed fishing effort and interactions are not necessarily representative of actual rates of fishing effort or interactions but they represent the best available information.



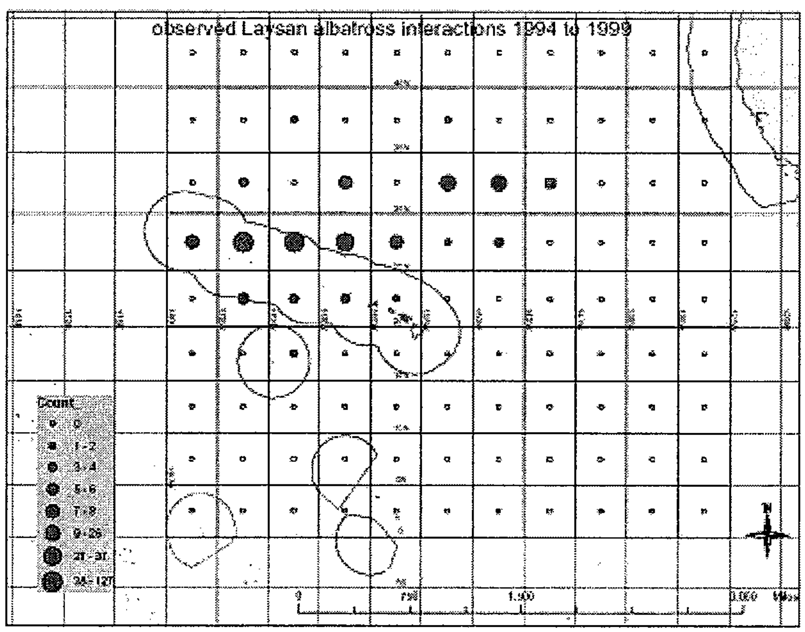


Figure 12. Observed interactions of black-footed albatrosses (top) and Laysan albatrosses (bottom) between 1994-1999 in the Hawaii-based longline fishery (Source: NOAA Fisheries Observer Program, unpubl. info.).

Table 17 translates this and more recent data into estimates of the average number of trips that fishery participants could expect to take per seabird interaction in each fishery sector and area if no seabird deterrence strategies were used (again, with the exception of line shooters with weighted branch lines which have been used on virtually all deep sets throughout the modern history of this fishery). Interaction rates for shallow sets come from the 1994-1999 time period as shallow-setting was prohibited between 2000 and 2004. Interaction rates for deep sets in the north are also from the 1994-1999 time period as regulatory changes including the imposition of mitigation measures were required in this area beginning in 2000. Operating information (average sets per trip and trips per year) for these groups is from the 1994-1998 time period as regulatory changes at the end of 1999 restricted shallow setting. Information for deep sets in the south is from the 2002-2003 time period as no mitigation measures have been imposed for the south and it is preferable to use the most recent data available. Operating information for deep sets comes from the second quarter of 2004 as this most recent information best describes current operating conditions. In all cases, operating information is not available on a geographic basis.

Table 17. Expected Years per Interaction when no Mitigation Measures are used (Sources: McCracken 2004; Ito & Machado 1999; PIFSC website report on the Hawaii longline fishery for the second quarter of 2004)

Type and Area	Interactions per Set	Sets per Interaction	Average Sets per Trip	Trips per Interaction	Average Trips per Year	Years per Interaction
North Deep	.07016	14	11.1	1.28	12.40	0.10
South Deep	.00799	125	11.1	11.28	12.40	0.91
North Shallow	.54583	2	14.6	0.13	3.14	0.04
South Shallow	.01650	61	14.6	4.15	3.14	1.32

As shown above, when no mitigation measures are used, deep setting vessels in the south are expected to have slightly more than one interaction per year, while those in the north are expected to have up to 10 per year. Similarly shallow setting vessels in the south are expected to have less than one interaction per year, while those in the north are expected to have up to 25 interactions per year. Because of the difference in the average number of trips per year between the (seasonal) shallow and deep fishery sectors (3.14 vs. 12.4), it will be longer before an interaction occurs on vessels in the south shallow fishery as compared to those in the south deep fishery.

10.6 Pelagics FMP fisheries

The Pelagics FMP manages unique and diverse fisheries. Although fisheries in American Samoa, the Northern Mariana Islands, Guam and the Pacific Remote Island Areas are also managed under the Pleagics FMP, this document focuses on Hawaii's fisheries as they are the only ones affected by the alternatives considered here. Hawaii-based longline vessels are capable of traveling long distances to high-seas fishing grounds, while the smaller handline, troll, charter and pole-and-line fisheries—which may be commercial, recreational or subsistence —generally occur within 25 miles of land, with trips lasting only one day.

Hawaii's pelagic fisheries are small in comparison with other Pacific pelagic fisheries such as distant-water purse seine fisheries and other foreign pelagic longline fisheries (NMFS 1991), but they comprise the largest fishery sector in the State of Hawaii (Pooley 1993). Tuna, billfish and other tropical pelagic species supply most of the fresh pelagic fish consumed by Hawaii residents and support popular recreational fisheries (Boggs and Kikawa 1993).

Of all Pelagics FMP fisheries, the Hawaii-based limited access longline fishery is the largest. This fishery accounted for the majority of Hawaii's commercial pelagic landings (17.3 million lb) in 2003 (Table 18). The fleet includes a few wood and fiberglass vessels, and many newer steel longliners that were previously engaged in fisheries off the U.S. mainland. None of the vessels are over 101 ft in length and the total number is limited to 164 vessels by a limited entry program. The longline fleet has historically operated in two distinct modes based on gear deployment: deep-set longline by vessels that target primarily tuna and shallow-set longlines by those that target swordfish or have mixed target trips including albacore and yellowfin tuna. Swordfish and mixed target sets are buoyed to the surface, have few hooks between floats, and are relatively shallow. These sets use a large number of lightsticks since swordfish are primarily targeted at night. Tuna sets use a different type of float placed much further apart, have more hooks per foot between the floats and the hooks are set much deeper in the water column. Hawaii-based tuna longline vessels typically deploy about 34 horizontal miles of mainline in the water and use a line shooter. The line shooter increases the speed at which the mainline is set, which causes the mainline to sag in the middle (more line between floats), allowing the middle hooks to fish deeper. The average speed of the shooter is nine knots with an average vessel speed of about 6.8 knots. No light sticks are used and float line lengths average 22 m (72 feet) with branch line lengths averaging 13 m (43 feet). The average number of hooks deployed is 1,690 hooks per set with an average of 27 hooks set between floats. There are approximately 66 floats used during each set. The average target depth is 167 m, and gear is allowed to soak during the day, with total fishing time typically lasting about 19 hours, including the setting and hauling of gear.

Table 18. Hawaii-based longline fishery landings 1999-2003 (WPRFMC, 2004b)

Item	1999	2000	2001	2002	2003
Area Fished	EEZ and high seas	EEZ and high seas	EEZ and high seas	EEZ and high seas	EEZ and high seas
Total Landings (million lbs)	28.3	23.8	15.6	17.5	17.4
Catch Composition*					
Tuna	41%	41%	52%	52%	65%
Swordfish	9%	9%	1%	1%	2%
Miscellaneous	32%	32%	36%	37%	31%
Sharks	18%	18%	11%	10%	2%
Season	All year	All year	All year	All year	All year
Active Vessels	119	125	101	100	110
Total Permits	164	164	164	164	164
Total Trips	1,138	1,103	1,034	1,165	1,215
Total Ex-vessel Value (adjusted) ($millions)	$50.5	$52.5	$34.1	$38.4	$38.6

* Number of fish

A summary of other Hawaii-based pelagic fisheries is given in Table 19. The Hawaii-based skipjack tuna, or aku (skipjack tuna) fishery, is also known as the pole-and-line fishery or the bait boat fishery because of its use of live bait. The aku fishery is a labor-intensive and highly selective operation. Live bait is broadcast to entice the primary targets of skipjack and juvenile yellowfin tuna to bite on lures made from barbless hooks with feather skirts. During the fast and furious catching activity, tuna are hooked on lines and in one motion swung onto the boat deck by crew members.

Handline fishing is an ancient technique used to catch yellowfin and bigeye tunas with simple gear and small boats. Handline gear is set below the surface to catch relatively small quantities of large, deep-swimming tuna that are suitable for sashimi markets. This fishery continues in isolated areas of the Pacific and is the basis of an important commercial fishery in Hawaii. Three methods of pelagic handline fishing are practiced in Hawaii, the ika-shibi (nighttime) method, the palu-ahi (daytime) method and seamount fishing (which combines both handline and troll methods).

Troll fishing is conducted by towing lures or baited hooks from a moving vessel, using big-game-type rods and reels as well as hydraulic haulers, outriggers and other gear. Up to six lines rigged with artificial lures or live bait may be trolled when outrigger poles are used to keep gear from tangling. When using live bait, trollers move at slower speeds to permit the bait to swim "naturally." The majority of Hawaii-based troll fishing is non-commercial; however, some full-time commercial trollers do exist.

Hawaii's charter fisheries primarily troll for billfish. Big game sportfishing rods and reels are used, with four to six lines trolled at any time with outriggers. Both artificial and natural baits are used. In addition to lures, trollers occasionally use freshly caught skipjack tuna and small yellowfin tuna as live bait to attract marlin, the favored landings for charter vessels, as well as yellowfin tuna.

The recreational fleet primarily employs troll gear to target pelagic species. Although their motivation for fishing is recreational, some of these vessel operators sell a portion of their landings to cover fishing expenses and have been termed "expense" fishermen (Hamilton 1999). While some of the fishing methods and other characteristics of this fleet are similar to those described for the commercial troll fleet, a survey of recreational and expense fishermen showed substantial differences in equipment, avidity and catch rates compared to commercial operations. Vessel operators engaged in subsistence fishing are included in this recreational category.

Table 19 Fishery information for Hawaii's non-longline pelagic fisheries for 2000 (Sources: Adapted from WPRFMC, 2002) Data do not include all landings for recreational fishers.

Gear/Vessel Type	Troll/Handline	Pole-and-line Fishery
Area Fished	Inshore and EEZ	Inshore and EEZ
Total Landings	3.4 million pounds	696,000 pounds
Catch Composition	48% yellowfin 18% mahimahi 10% wahoo 8% albacore 7% blue marlin	99.6% skipjack tuna <1% <1% <1% <1%
Season	All year	All year
Active Vessels	1,455	6
Total Trips	18,700	198
Total Ex-vessel Value	$8 million	$1.1 million

A survey conducted by O'Malley and Pooley (2003) provides estimates of average income for various vessel classes in the Hawaii-based longline fleet in 2000 (Table 20). Only vessels that were interviewed in the survey were included in the final income statements, which include fixed costs, variable costs, labor costs, and gross and net revenue. These tables were calculated by including zero costs in the calculated averages for each vessel target and classification. Swordfish and tuna vessels earned a net return of $27,484 and $55,058, respectively. Among the tuna vessels, the small vessels were the most profitable. These vessels had higher gross revenues and, consequently, higher labor costs but lower fixed and variable costs. On average swordfish vessels were larger than tuna vessels and had higher levels of capitalization and greater operating expenses (NMFS 2001a).[18] Large swordfish vessels were generally more profitable than smaller swordfish vessels due to higher gross revenues.

Table 20. Reported Average Annual Revenue and Costs for the Hawaii-based Longline Fleet, 2000.[1] (Source: O'Malley and Pooley 2003)

Category	Swordfish average	Tuna average	Small tuna average	Medium tuna average	Large tuna average	Medium swordfish average	Large swordfish average
Gross revenue ($)	490,301	495,456	502,740	496,578	485,286	459,465	526,277
Fixed costs total ($)	93,207	90,597	66,409	93,056	84,433	81,520	105,633
Variable costs total ($)	230,232	184,986	147,503	182,868	239,749	239,928	221,449
Labor costs ($)	139,379	164,815	187,685	167,378	142,896	114,422	160,619
Total costs ($)	462,818	440,398	401,597	443,302	467,078	435,870	487,701
Net revenue ($)	27,483	55,058	101,143	53,276	18,208	23,595	385,776

[1]Vessels are classified by size (small <56 ft, medium 56.1 ft to 73.9 ft, large >74 ft) and target (tuna or swordfish)

Sociocultural Setting

The following description of the sociocultural setting focuses on the Hawaii-based longline fishery as that is the only fishery likely to be affected by the proposed actions. This description of the affected environment records the present social context, including socioeconomic problems, opportunities and conflicts created in the fisheries and communities by recent federal fishery management regulations.

A comprehensive description of the sociocultural setting of the Hawaii longline fishery is provided in Chapter 3 of the Pelagic Fisheries FMP FEIS (NMFS 2001a). This section summarizes the discussion in the Pelagic Fisheries FMP FEIS and incorporates new information that has become available since the Pelagic Fisheries FMP FEIS was released.

The Hawaii longline fishery is an example of a fishery that experienced rapid development as a result of the participation of new groups of fishers of various ethnic backgrounds. The contemporary longline fishery is ethnically complex, and the ethnic composition of its participants differs markedly from that of the state population as a whole.

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[18] Swordfish vessels were typically larger than tuna vessels because they generally operated in the rougher sea and weather conditions of more northerly waters (NMFS, 2001). In addition, the fishing grounds for swordfish are more distant. Between 1991 and1998, the average distance traveled to first set by swordfish vessels was 570 miles, whereas the average distance traveled by tuna vessels was 275 miles.

Prior to the 2001 prohibition on deployment of swordfish-target longline gear, differences in the ethnicity of participants in the longline fishery were linked to differences within the fleet in terms of a number of related factors, including target species, fishing grounds, and vessel operating characteristics. Nearly all of the swordfish/mixed vessels were owned and crewed by Vietnamese Americans. In contrast, this ethnic group operated only about four or five longline vessels targeting tuna. Demographic data on vessel owners and operators collected in a 2000 survey of the Hawaii-based longline fleet conducted by O'Malley and Pooley (2002) showed this ethnic differentiation within the longline fleet (Table 21).

Table 21. Ethnicity of Hawaii Longline Vessel Owners in 2000.[1] (Source: O'Malley and Pooley 2003)

Vessel Classification	Caucasian (%)	Korean-American (%)	Vietnamese American (%)	Number
Fleet	27	30	43	120
Swordfish	6	0	94	70
Tuna	41	53	6	50
Small tuna	31	64	6	16
Medium tuna	31	64	6	36
Large tuna	72	22	6	18
Medium swordfish	11	0	89	18
Large swordfish	3	0	97	32

[1]Vessels are classified by size (small <56 ft, medium 56.1 ft to 73.9 ft, large >74 ft) and target (tuna or swordfish)

This ethnic differentiation within the longline fleet based on target species largely disappeared after the 2001 prohibition on deployment of swordfish-target longline gear. Twenty to 30 of the longline vessels owned by Vietnamese Americans dropped their Hawaii longline limited access permit and relocated to southern California where they continued to target swordfish. Three swordfish vessels relocated to American Samoa and changed ownership (O'Malley and Pooley 2002). The remainder of the Vietnamese American vessel owners elected to stay in Hawaii and switch to targeting tuna.

The Pelagic Fisheries FMP FEIS stated that Vietnamese American vessel owners nearly exclusively hired other individuals of Vietnamese ancestry (NMFS 2001a). Boat owners of Korean descent reportedly hired predominately crews from the Federated States of Micronesia while the crews of longline vessels owned by Caucasians were reported to generally be a mixture of Micronesians and Hawaii residents of various ethnicities. However, the aforementioned survey conducted by O'Malley and Pooley (2002) indicated that a recent trend among Hawaii-based longline vessels is the hiring of foreign crew, primarily from the Philippines. In 2000, only six interviewed vessels employed foreign crews. By 2001, over 54 percent of the vessels employed foreign crew. Currently, about 75 percent of crew members are Filipinos who commit to a one-year contract, working and living on the vessel while their families remain in the Philippines (Allen and Gough 2004). The survey questionnaire administered by O'Malley and

Pooley asked vessel owners who changed from hiring local to foreign crews what motivated them to switch. Three answers were given, corresponding to the ethnicity of the vessels' owners. Korean Americans stated the foreign crew members were easy to work with; Caucasian Americans found foreign crew to be cheaper than local crew; and Vietnamese Americans switched because they could not find Vietnamese American crew who wanted to fish for tuna.

Vietnamese American vessel owners in particular have become increasingly dependent on Filipino crews (personal communication., Stewart Allen, NMFS PIFSC). With this increased reliance on foreign crews, some Vietnamese American vessel owners have become concerned that new U.S. immigration policies may make it difficult to hire and retain a sufficient number of crew members (personal communication., Stewart Allen, NMFS PIFSC).

The majority of the Filipino crew are from fishing families or communities in the Philippines (Allen and Gough 2003). About half have education or training in a marine related field, and the majority have considerable experience as fishermen outside of the Philippines. For example, individuals have worked in Guam, South Africa, Taiwan, Latin America, and California in a variety of fishing fleets. They are hired through a recruitment agency and brought to Hawaii utilizing a C-1 transit visa. Their transit status does not allow them to leave the pier, which increases their desirability as workers as they tend to the vessels while in port. Most 2003 arrivals came to Hawaii via California, as the latter state offers easier access to the U.S. With respect to job satisfaction, the majority of Filipino crew would rather work on a cargo vessel than on a Hawaii-based longline boat. However, Hawaii-based longline vessels are generally preferred over boats in other fleets (e.g., the Japanese fleet based in Guam). Those with larger families or more education are less satisfied with the pay.

The increasing dependence on Filipino crews has been accompanied by a change in the way in which crew members are paid in the Hawaii-based longline fleet. In 2000, the majority of the interviewed vessel owners were paying the captain and crew using the share method (O'Malley and Pooley 2002). First, specific expenditures such as fuel, oil, ice, bait, provisions, gear, and auction fees were deducted from the gross revenue. The remaining revenue was then split in half, 50 percent for crew and 50 percent for the vessel owner. However, Filipino crew members are paid a monthly salary and in some cases a tonnage or captain's bonus depending on the catch. Salaries start at $385 per month and are arranged between the vessel owner, manning agency and individual (Allen and Gough 2004). The average monthly salary of these foreign workers is $475. Local and Micronesian crew continue to be paid a percentage of the earnings rather than a set salary.

O'Malley and Pooley (2002) noted that the type of crew remuneration used can significantly affect the cost of operating a longline vessel. The researchers compared the annual costs to pay crew using the share method and those that paid a fixed salary. The 2000 fleet average annual cost using the crew shares method was $152,097, and the annual cost to pay the crew a monthly salary was $44,333 (this figure does not include the agency and immigration fees associated with the hiring of foreign crew).

The Pelagic Fisheries FMP FEIS predicted that the closure of the swordfish-targeting segment of the Hawaii longline fishery would disproportionately and negatively affect Vietnamese American fishermen (NMFS 2001a). The FEIS described the predicted effects on vessel owners as "immediate and substantial," as well as imposing "severe economic hardship" on crew members of Vietnamese descent. The FEIS cited a study of workers laid off from the sugar industry on the island of Hawaii to describe the range of possible effects, including sustained unemployment and loss of income and the resulting social and psychological impacts. These included heightened feelings of anxiety, depression, illness, and increased problems in relationships among laid-off employees and family members.

A subsequent exploratory study of the impacts to Vietnamese American vessel owners and captains conducted by Allen and Kleiber (2003) revealed that many of the effects predicted by the FEIS were present, as well as some additional impacts that had not been anticipated. Many Vietnamese Americans had already been regulated out of other U.S. fisheries; several mentioned that they have dealt with hardships and challenges in the industry before but the closure of the swordfish portion of the Hawaii longline fishery was the toughest situation they'd faced. Swordfish fishing is a lucrative business, and the loss of income that Vietnamese American fishermen experienced after the closure of the Hawaii fishery had many direct and indirect negative socioeconomic effects on individuals, families and households, and the Vietnamese community. The passage below excerpted from Allen and Kleiber (2003) summarizes some of the effects:

Many [Vietnamese Americans] mentioned having to cut back on educational expenses at all levels, such as not being able to afford private schools or having to borrow for college expenses, accumulating additional debt. Nearly all spoke about wanting their children to have quality educations so they would not have to fish for a living.

Interviewees reported a range of effects on the closeness and cohesion of their families. Family solidarity suffers when a family member is not present for extended time periods. Fishing families are accustomed to their husband or father being gone on long fishing trips, which is especially the case with swordfishing in Hawaii, which typically required longer trips than tuna fishing. Although family members may not like this, they adapted because of the financial benefits. Fishermen and family members also mentioned that the time between trips allowed for high-quality family time, including vacations. People who moved boats to California had many additional expenses aside from moving the boat there. Wives who travel to Los Angeles to meet boats between swordfish trips and assist with many aspects of the business incur direct costs are such as airfare, car rental, and hotels. In addition, being gone 7-10 days a month makes it more difficult to obtain a job to supplement income. Disruption of normal behavior, coupled with financial stress, can cause friction among family members, reflected by increased arguments and conflicts.

Interviewees expressed a range of emotions including bewilderment at the closure and its reported justification; loss of confidence that the family would be adequately cared for; shame at not being able to help family members here or elsewhere; sadness at the decrease in the quality of life, which many suggested was quite high before the ban; anger at the federal government for closing the fishery; frustration at being unable to thwart the ban legally or politically, at having to rely on others, and that the international fleet is not regulated; blame on entities both inside and outside the industry for their inability to prevent or lessen the ban despite rallies and financial support.

When the ban was first introduced, fishermen pulled together to fight it but that enthusiasm and solidarity waned as time dragged on and the ban became permanent. Several interviewees mentioned existence of a Vietnamese Fishing Association that previously existed and dissolved following the ban. Such associations are an important source and indicator of cohesion and support among the fishing community.

Owners of Hawaii-based longline vessels that fished during 2001 received economic assistance from the federal direct economic assistance program because of the sudden impact of the regulations. Owners of tuna vessels received $16,000, while owners of swordfish vessels received $32,000 because the new regulations had a greater impact on their operations. O'Malley and Pooley (2003) note that the amount given to the swordfish vessels covered about 89 percent of the estimated cost to convert to tuna fishing (not including the labor to assemble the gear and the time spent learning to fish for tuna). However, the need for many of the owners of swordfish vessels to repay large bank loans acquired to purchase their vessels forced some to relocate to California or switch to tuna fishing before the economic assistance was disbursed (personal communication. Stewart Allen, NMFS PIFSC). The economic assistance program did not benefit the crew members of swordfish or tuna longline vessels.

During fishing experiments conducted by NMFS to test fishing methods and gears that may reduce turtle interactions in the Hawaii longline fishery, five vessels (all owned by Vietnamese Americans) were contracted to participate in the experiments. The vessel owners received a total of $311,147 for conducting a total of 194 sets (personal communication Stewart Allen, NMFS PIFSC). While this was a short-term source of income, it was a substantial amount to a vessel owner making payments on a vessel as well as supporting a family. The contribution of the pelagic longline fishery to overall economic activity in Hawaii is small. Moreover, the economic impacts of the closure of the swordfish portion of the Hawaii longline fishery on fishermen and their families gradually lessened as fishermen outfitted their vessels to participate in fisheries on other stocks (most notably tuna), relocated to California and continued to fish for swordfish in areas that remained open (e.g., the high seas in the Pacific Ocean east of 150°W), or found other jobs that may or may not be fishing-related.

The April 2004 removal of the prohibition on shallow setting is expected to have positive overall economic impacts on participants in the Hawaii longline fishery. Holders of Hawaii longline limited access permits that choose to engage in shallow setting are likely to benefit from catches of swordfish, a high value pelagic species. Holders of Hawaii longline limited access permits that choose not to engage in shallow setting are likely to benefit each year by being able to sell their share of shallow set certificates to other permit holders.

One hundred and twenty (73%) of the 164 Hawaii longline limited access permit holders requested shallow set certificates for 2004. As shown in Table 22, about 80 percent of the permit holders who currently own vessels categorized as swordfish boats in 1999 requested certificates. Four of these vessel owners relocated in California after the swordfish component of the longline fishery was closed in 2001. Also among those who requested certificates were permit holders who currently own vessels categorized as tuna boats in 1999 and permit holders who do not currently own a longline vessel.

Table 22 Allocation of Shallow-set Certificates Among Hawaii Longline Limited Access Permit Holders (Source: NMFS PIRO)

Category	Permit holders as of May 1, 2004		
	Requested 2004 certificates	**Did not request 2004 certificates**	**Total**
Permit holders who owned vessels categorized as tuna vessels in 1999[1]	30	15	45
Permit holders who owned vessels categorized as swordfish vessels in 1999[1]	20	5	25
Permit holders who owned vessels that can not be linked to 1999 vessel categorizations[2]	41	19	60
Permit holders who did not own vessels in 2004	29	5	34
Total	120	44	164

[1] Vessel categorizations are based on an analysis conducted by NMFS to identify vessels qualifying for the 2001 Direct Economic Assistance Program.

[2] Vessel names rather than permit numbers or permit holders were used to establish linkages between the permits in 2004 and 1999. Consequently, a given vessel categorized in 1999 may have been under different ownership in 2004. If a vessel name change occurred between 1999 and 2004, no link between the permits in 2004 and 1999 could be identified. In addition, for seven of the 118 vessels categorized in 1999 the vessel name could not be identified.

A number of factors may make it difficult for Vietnamese Americans to regain a dominant position in the swordfish portion of the Hawaii longline fishery. Under the effort quota allocation scheme developed for the reopened fishery vessel owners must bear the costs of acquiring an adequate number of shallow-set certificates each year, and those owners that switched to tuna fishing in 2001 would incur the costs to rig over from tuna fishing to swordfish fishing—these latter costs are reported to be about $15,000 (WPRFMC 2004b). In addition, Vietnamese American vessel owners that have hired Filipino crews may find these crew members unwilling to endure the longer fishing trips that swordfish fishing entails (personal communication Stewart Allen, NMFS PIFSC)

Hawaii Fishing Communities

The Magnuson-Stevens Act defines a "fishing community" as "...a community that is substantially dependent upon or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew, and fish processors that are based in such communities" (Sec. 3 (16)). NMFS further specifies in the National Standard guidelines that a fishing community is "...a social or economic group whose members reside in a specific location and share a common dependency on commercial, recreational, or subsistence fishing or on directly related fisheries dependent services and industries (for example, boatyards, ice suppliers, tackle shops)".

In 1998, the Council identified the islands of American Samoa, the Northern Mariana Islands and Guam as fishing communities for the purposes of assessing the effects of fishery conservation and management measures on fishing communities, providing for the sustained participation of such communities, minimizing adverse economic impacts on such communities, and for other purposes under the MSA (64 FR 19067). In 2002, the Council identified each of the islands of Kauai, Ni'ihau, Oahu, Maui, Molokai, Lanai and Hawaii as a fishing community (68 FR 46112).

The city of Honolulu on the island of Oahu is the base of the longline and other industrial-scale fleets and the center of the state's fish marketing/distribution network (NMFS 2001a). However, the total number of pelagic fisheries-related jobs in the Honolulu metropolitan area compared to the overall number of jobs in the area is very small. Oahu contains approximately three-quarters of the state's total population, and over one-half of Oahu's residents live in the "primary urban center," which includes greater Honolulu. Thus, although Oahu has a high level of engagement in fishing and especially longline fishing relative to the other islands in Hawaii, the island's level of dependence on it is lower due to the size and scope of Oahu's population and economy.

As described in Section 3.7, during the past few years the Hawaii longline fishery has been affected by a series of legal decisions that resulted in changes in the federal management regime for the fishery. In 2001, total catch and ex-vessel value in the fishery decreased by about 34 percent, primarily as a result of the implementation of litigation-driven management measures that eliminated the swordfish portion of the Hawaii longline fishery. Swordfish, the largest component of the longline catch in 2000, became a negligible component in 2001.

Although the closure of the swordfish portion of the Hawaii longline fishery had a negative economic impact on some local businesses, the closure did not affect the sustained participation of any fishing community in Hawaii's pelagic fisheries. Many of the fishermen that formerly targeted swordfish outfitted their vessels to target other pelagic species, most notably tuna. In recent years, bigeye tuna has been the largest component of the pelagic catch, followed by yellowfin tuna, and albacore. As a result of an increase in the catch of bigeye tuna the ex-vessel value of landings in Hawaii's pelagic fisheries increased to about $45.3 million in 2002.

In April 2004, NMFS reopened the swordfish-targeting segment of the Hawaii longline fishery under new federal rules. While it is uncertain at this early stage of the reopening what the regional impacts will be, the effects are likely to be positive. Moreover, should the measures to mitigate sea turtle interaction prove successful, it is likely that the amount of swordfish fishing effort allowed will be increased, resulting in additional regional economic benefits.

The nature and magnitude of Hawaii communities' dependence on and engagement in pelagic fisheries have also been affected by the overall condition of the state's economy. As described in the Pelagics FEIS (NMFS 2001a), tourism is by far the leading industry in Hawaii in terms of generating jobs and contributing to gross state product. In the first years of the new century Hawaii's tourism industry suffered major external shocks, including the September 11 terrorist attacks and SARS (severe acute respiratory syndrome) epidemic (Brewbaker 2003). The market for tuna weakened due to the decline in tourists arriving from Japan and elsewhere and due to a weak export demand. More recently, the decline in the value of the U.S. dollar compared with other currencies such as the Euro and the Japanese yen has made it more expensive for Americans to travel overseas and cheaper for foreign visitors to visit Hawaii. The weak U.S. dollar, combined with moderate growth in the national economy, is expected to help boost the state's tourism industry. Both domestic and international visitor counts have shown a general increasing trend (Brewbaker 2003). These improvements in Hawaii's tourist industry will likely have a positive economic effect on local businesses engaged in the harvesting, processing and marketing of pelagic fishery resources.

10.7 Environmental Impacts of the Alternatives

It is important to recognize that the pelagic ecosystem responds to ambient climatic and oceanographic conditions on a variety of spatial and temporal scales and that, even in the complete absence of any fishing, stock sizes fluctuate, sometimes quite dramatically. It is also clear from the species accounts that initiation of very marked declines in some groups—such as sea turtles, seabirds and possibly sharks—coincided with operations of the high seas drift-gillnet fishery in the 1980s and early 1990s. Added to the serious impacts to protected species resulting from that fishery was a regime shift that markedly lowered the carrying capacity and productivity of the ecosystem at that time. Because of the long life spans and limited reproductive potential of sea turtles, seabirds and sharks, these populations are likely to be only beginning to recover from these circumstances.

Information requirements for analyzing seabird- longline interactions are complicated for three reasons: first, the natural systems in which seabirds and longline fisheries are active are complex, with wide variation in natural variability at seasonal, annual and decadal scales; second, human interventions into the natural environment affecting seabirds is widely spread over time and space, with activities decades old still affecting seabird populations; and third, the available information from monitoring seabird populations is limited. Yet the Magnuson-Stevens Fishery Conservation and Management Act requires that the best available scientific information be used for decision-making. In this case, the basic information provided in this document, as well as interpretations of that information, comes from either peer-reviewed sources or from scientists at the US Fish and Wildlife Service's Pacific Region Office and NMFS' Pacific Islands Fisheries Science Center and Pacific Islands Regional Office. To the extent possible, this information complies with the Data Quality Act and NOAA standards (NOAA Information Quality Guidelines, September 30, 2002) that recognize information quality is composed of three elements - utility, integrity and objectivity. Central to the preparation of this regulatory amendment is objectivity which consists of two distinct elements: presentation and substance. The presentation element includes whether disseminated information is presented in an accurate, clear, complete, and unbiased manner and in a proper context. The substance element involves a focus on ensuring accurate, reliable, and unbiased information. In a scientific, financial, or statistical context, the original and supporting data shall be generated, and the analytic results shall be developed, using sound statistical and research methods.

At the same time, however, the Federal government has recognized, "information quality comes at a cost. In this context, agencies are required to weigh the costs and the benefits of higher information quality in the development of information, and the level of quality to which the information disseminated will be held." (OMB Guidelines, pp. 8452-8453).

There are a number of issues inherent in the analysis of the affected environment, where issues of information quality and uncertainty might pertain. These include the use of different methodologies (and results) in terms of interaction estimates, the effectiveness of various mitigation measures and the interpretation of available seabird population data. In each case this document discusses the advantages and disadvantages of available information and clearly states the methodologies and assumptions used in its analyses.

One of the important potential costs in acquiring "perfect" information (which is never available), is the cost of delay in decision-making. While the precautionary principle suggests that decisions should be made in favor of the environmental amenity at risk (in this case seabirds), this does not suggest that perfect information is required for any preferred alternative to proceed. In brief, it does suggest that caution be taken but that it not lead to paralysis until perfect information is available. This regulatory amendment has used the best available information and made a broad presentation of it. The process of public review of this document provides an opportunity for comment and challenge to this information, as well as for the provision of additional information.

10.7.1 Target Stocks

The Hawaii longline fishery is a multi-target fishery in which fishermen expect to catch a range of PMUS. None of the alternatives are expected to significantly affect the fishing operations or catches of the Hawaii-based longline fleet, and therefore none are anticipated to result in detectable impacts on target stocks.

10.7.2 Non-target Stocks

There are a few non-target fish species such as lancet fish and stingrays which have no economic value and are therefore generally discarded as bycatch. Because none of the alternatives are expected to significantly affect the fishing operations or catches of the Hawaii-based longline fleet, they should not result in any impacts on these non-target stocks. Non-endangered seabirds can also be considered as non-target stocks (impacts on threatened and endangered species such as short-tailed albatrosses, sea turtles and Hawaiian monk seals are discussed below). Based on research to date, none of the alternatives are anticipated to have negative impacts on seabirds, and some are anticipated to have positive impacts by further reducing fishery interactions.

10.7.3 Habitat

None of the alternatives are expected to have adverse impacts on essential fish habitat (EFH) or habitat areas of particular concern (HAPC) for species managed under the Pelagics, Bottomfish and Seamount Groundfish, Precious Corals, Crustaceans, or Coral Reef Ecosystems Western Pacific Fishery Management Plans (Table 23) because they are not expected to significantly affect the fishing operations or catches of the Hawaii-based longline fleet, and thus they are not likely to lead to substantial physical, chemical, or biological alterations to the habitat, or result in loss of, or injury to, these species or their prey.

Table 23. Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) for species managed under the Pelagics, Crustaceans, Bottomfish and Seamount Groundfish, Precious Corals, Crustaceans, and Coral Reef Ecosystems, Western Pacific Fishery Management Plans. All areas are bounded by the shoreline, and the outward boundary of the EEZ, unless otherwise indicated.

SPECIES GROUP (FMP)	EFH (juveniles and adults)	EFH (eggs and larvae)	HAPC
Pelagics	water column down to 1,000 m	water column down to 200 m	water column down to 1,000 m that lies above seamounts and banks.
Bottomfish	water column and bottom habitat down to 400 m	water column down to 400 m	all escarpments and slopes between 40-280 m, and three known areas of juvenile opakapaka habitat
Seamount Groundfish	(adults only): water column and bottom from 80 to 600 m, bounded by 29°-35°N and 171°E - 179°W	(including juveniles): epipelagic zone (0-200 nm) bounded by 29°-35°N and 171°E -179°W	not identified
Precious Corals	Keahole, Makapuu, Kaena, Wespac, Brooks, and 180 Fathom gold/red coral beds, and Milolii, S. Kauai and Auau Channel black coral beds	not applicable	Makapuu, Wespac, and Brooks Bank beds, and the Auau Channel

Table 23. Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) for species managed under the Pelagics, Crustaceans, Bottomfish and Seamount Groundfish, Precious Corals, Crustaceans, and Coral Reef Ecosystems, Western Pacific Fishery Management Plans. All areas are bounded by the shoreline, and the outward boundary of the EEZ, unless otherwise indicated.

SPECIES GROUP (FMP)	EFH (juveniles and adults)	EFH (eggs and larvae)	HAPC
Crustaceans	bottom habitat from shoreline to a depth of 100 m	water column down to 150 m	all banks within the Northwestern Hawaiian Islands with summits less than 30 m
Coral Reef Ecosystems	water column and benthic substrate to a depth of 100 m	water column and benthic substrate to a depth of 100 m	all Marine Protected Areas identified in FMP, all PRIAs, many specific areas of coral reef habitat (see FMP)

10.7.4 Threatened and Endangered Species

Current seabird deterrent measures (Alternative 1) and those alternatives that contain current measures as an option (Alternatives 2-8, 10 and 11) are not likely to affect listed sea turtles and other listed species The most recent ESA section 7 consultation for sea turtles impacted by the Hawaii-based longline fishery did not consider the effects of side setting on sea turtles. However, the use of side setting is merely a method of deploying baited hooks into the sea. The mitigation properties of large circle hooks and mackerel bait that have been found to be effective in minimizing sea turtle interactions will not be affected by this deployment method, and therefore side setting is not anticipated to have an adverse impact on sea turtle populations in the Pacific Ocean. To the extent any of the other alternatives would facilitate bait retention on the hook, either through reduced bird depredation or reduced mechanical loss, turtle hookings could increase somewhat for turtles attracted to the bait. On the other hand, leatherback turtles are usually snagged in an extremity, so retained bait could shield the hook. These potential indirect effects would be insignificant. None of the seabird deterrent measure alternatives would directly affect sea turtles.

None of the alternatives are expected to have any negative impacts on humpback whales because they would not modify the way longline hooks are deployed and suspended in the water column, either for deep or shallow sets.

None of the alternatives is expected to have a negative impact on Hawaiian monk seals as they are found close to shore in areas in which longlining will remain prohibited under all alternatives.

All of the action alternatives are expected to have a potentially positive impact on the short-tail albatross population by further reducing the potential for seabirds to interact with Hawaii-based longline vessels. Reducing the potential for the Hawaii fishery to hook, entangle and drown seabirds under these alternatives is not expected to have any real impact on this population as there have never been any interactions with the Hawaii fishery. However the spread of side setting technology to other fleets, would likely greatly lessen the impact of longline fishing on all seabirds in the North and South Pacific.

10.7.5 Marine Mammals

Hawaii-based longline vessels are known to interact with marine mammals when using current seabird deterrent measures (Alternative 1). Direct interactions include bait and catch depredation, hookings, and effects of increased underwater noise. Collisions with fishing vessels are possible, but none have been documented. The other alternatives all involve options or requirements to use alternative methods of delivering the baits to depth and no direct impacts to marine mammals would be expected. To the extent any of the other alternatives would facilitate bait retention on the hook, either through reduced bird depredation or reduced mechanical loss, interactions with marine mammals could increase somewhat. Given however, that hookings of marine mammals are statistically very rare events, such an effect is not likely to be significant.

10.7.6 Biodiversity and Ecosystem Functions

The Hawaii longline fishery at its peak generated a mixed catch of between 15 to 30 million lb of fish (7,000 - 14,000 mt), which is a very small fraction of the topical and subtropical pelagic ecosystem biomass. Because none of the alternatives are expected to significantly affect the fishing operations or catches of the Hawaii-based longline fleet it is anticipated that they would not negatively affect biodiversity or ecosystem functions. The alternatives considered here would implement a range of measures known to deter seabird interactions with longline fishing vessels, which will protect albatross species and actively promote biodiversity. Moreover, it is anticipated that the mitigation technologies being demonstrated on the Hawaii-based longline fleet can be successful transferred to other fishing nations which will increase the positive impacts of these requirements.

10.7.7 Public Health and Safety

None of the alternatives considered would require fishing in ways significantly outside of historical patterns, and public health and safety is not expected to be negatively affected. However there are some concerns about the dangers posed by the use of 60g weights in combination with side setting, and the potential to cause injury in the event of a nylon leader snapping and causing the lead swivel to ricochet backwards with the ballistic properties of a bullet, causing a concomitant injury or risk of mortality as being shot with a firearm.

10.7.8 Seabirds

This section presents a comparison of the anticipated impacts to seabirds under each of the alternatives discussed in this document. Impacts are given in terms of percent reductions in interaction rates attributable to each seabird capture avoidance method (as compared to the no mitigation baseline described below), as well as total anticipated seabird interactions under each alternative.

Quantitative Efficacies for Combinations of Measures for Reduction of Longline-Seabird Interactions

In the alternatives described below, some measures are combined. Experimental data is not available for all combinations of measures therefore several methodologies were considered for calculating the theoretical efficiency for combinations of measures or for a subset of currently required measures. The first approach considered simply used the efficacy value of the measure with the highest efficacy rate. This was rejected as it would result in no added effectiveness when combining clearly independent measures such as blue dyed bait and weighted branch lines, which would appear to have obvious additive effects. The second approach considered was recommended by the Council's Scientific and Statistical Committee and would multiply the efficacy values of independent measures to arrive at a combined efficacy value. This was rejected as it resulted in most combinations having a combined efficacy value of close to 100% . Given available experimental information, these did not appear to be realistic values. Further, they do allow for meaningful comparisons to be made between alternatives. The third approach, which was used here, was to first allow one measure to operate at full efficiency, then allow the second measure to operate at full efficiency on the remaining undeterred portion of the seabirds present. This analysis can be extended to any number of independent measures and provides a systematic approach to comparing combinations of measures that supports a logical middle ground between the first two approaches. However it should be kept in mind that these are theoretical calculations based upon experimental data and the results are not likely to accurately portray the outcome of any alternative. The value of these calculations is that they present a measure of the relative effectiveness of a range of combinations of mitigation measures. Confidence intervals are unavailable for these estimates.

For example, for currently required tuna measures (tuna CM), we calculate the theoretical efficacy as follows: 63% [TBDB efficacy] + (86% [SOD efficacy] x 37% [the undeterred remainder after application of the TBDB measure]) = 94.82%.

The efficacies of the remaining combinations of measures used in the alternatives are as follows.

<u>SF CM</u>

63% [TBD fish] + (86% [SOD] of 37% [remainder after TBDB applied]) = 94.82%
94.82% + (85.5% [night setting] of 5.18% [remainder after TBDB and SOD applied]) = 99.25%

<u>Tuna CM - TBDB</u>

Tuna CM is composed of TBDB and SOD. Removing TBDB leaves SOD. The experimental efficacy of SOD is 86%.

SF CM - TBDB

SF CM is composed of TBDB, SOD and NS. Removing TBDB leaves SOD plus NS. The theoretical efficacy of those two measures is 86% [SOD] + (85.5% [NS] of 14% [remainder after application of SOD]) = 97.97%.

Tuna CM - TBDB&SOD

This removes all mitigation from tuna sets and efficacy goes to 0%.

SF CM - TBDB&SOD

Removing these two measures leaves night setting which has an efficacy of 85.5%

Tuna CM + TL

Tuna CM = 94.82% efficacy. To add TL: 94.82% + (79% [TL] of 5.18% [remainder after application of tuna CM]) = 98.91%

SF CM + TL

SF CM = 99.25% efficacy. To add TL: 99.25% + (79% [TL] of 0.75% [remainder after application of SF CM]) = 99.84%

Tuna CM + SS

Tuna CM = 94.82% efficacy. To add SS: 94.82% + (99.8% [SS] of 5.18% [remainder after application of tuna CM]) = 99.99%

SF CM + SS

SF CM = 99.25% efficacy. To add SS: 99.25% + (99.8% [SS] of 0.75% [remainder after application of SF CM]) = 100.00%

Voluntary NS in the South

The experimental efficacy of NS is 85.5%.

SF CM + TL - TBDB&SOD

This reduces to NS +TL, or, 85.5% [NS] + (79% [TL] of 14.5% [remainder after application of NS]) = 96.96%.

Note: SF=swordfish; CM=current measures; TBDB=thawed blue dyed bait; SOD=strategic offal discards; NS=night setting; TL=tori line.

Table 24 summarizes the expected results of implementation of the various longline-seabird interaction alternatives in terms of seabird catch. Assumptions used in generating this table are as follows. For deep tuna sets north of 23° N, the baseline seabird capture rate, before implementation of any seabird capture avoidance measures, is the rate calculated from observer data collected between 1994 and 1999 (McCracken 2004). For deep sets south of 23° N, however, the comparable 2002-2003 data were used because no seabird capture avoidance measures were required and the more recent data is considered more likely to be representative of current conditions. For the shallow set baseline seabird capture rates, no data are available for the 2002-2003 period, as that segment of the fishery was closed. Therefore, the 1994-1999 data were used for the baseline pre-seabird capture avoidance measure rates. The mitigation choice column represents a subjective estimate of the proportions of vessels that would choose to employ each option under each alternative, based primarily on the estimated cost of each method.

Table 24 presents a comparison of projections of potential seabird interactions under each of the seabird action alternatives. Consistent assumptions are used throughout the analysis, but it is crucial to understand that these are only assumptions, and how the fishery might respond to implementation of any given alternative might be very different from what is here assumed. The following paragraphs explain the individual data columns and calculations that were made to generate the projected interactions under each alternative.

Assumptions

The total number of sets that would be made under each alternative is a constant, 14,285. This is the average number of sets made in the fleet in 2002 and 2003. Sets are apportioned to deep (tuna), shallow (swordfish), north (north of 23°N) and south (south of 23°N). Shallow swordfish sets permitted under the current management regime total 2,120. The expected number of deep tuna sets is therefore 14,285 - 2,120 = 12,165.[39] For deep sets, the 2002-2003 effort data (Appendix D) were used to calculate the percentages of sets north and south of 23°N. The shallow-set sector of the fishery was closed in the 2002-2003 period. Complete effort distribution data from 1994-1998 logbooks were used to generate the comparable percentages of sets north and south of 23°N (NMFS unpub. data). Implicit in these assumptions is that none of the alternatives would afffect overall effort, or its distribution between the two gear types. In reality, the total number of swordfish sets actually made in a given year is likely to be less than 2,120 under the current system of set allocation. After requests are made the maximum possible number of sets is divided by the number of requesters and the resulting share is rounded down into a whole numbers of sets, so the fractional leftover is effectively subtracted from the max possible limit of 2120, resulting in an actual limit in any given year that will in almost all years be less than 2120. Moreover, fewer than 2120 shallow-sets may result in fewer interactions with seabirds, but this would depend on how many deep sets were made, and what proportion of these occurred to the north of the Hawaiian Islands where interactions are expected to be higher. It is

[39]The total number of swordfish sets actually made in a given year is likely to be less than 2,120 under the current system of set allocation. After requests for allocations are made, the maximum possible number of sets is divided by the number of requesters and the resulting share is rounded down into a whole number of sets, so the fractional leftover is effectively subtracted from the maximum possible limit of 2,120, resulting in an actual limit in any given year that will in almost all years be less than 2,120. Moreover, fewer than 2,120 shallow-sets may result in fewer interactions with seabirds, but this would depend on how many deep sets were made, what proportion of these occurred to the north of the Hawaiian Islands where interactions are expected to be higher, and the relative efficacies of seabird interaction avoidance measures in effect in the two sectors of the fleet.

also assumed that all vessels in the fleet could convert to side-setting under those alternatives mandating its use.

Choice %

This column projects the percentages of vessels that would choose each of the various options under each alternative. Percentages were assigned subjectively based on expected implementation costs of each option and a judgment of how the qualitative criteria used in our analysis of the avoidance measures (operational characteristics and compliance) might influence vessel operators in their selection of an option from among those available under each alternative.

No. Sets

This column is the product of "Choice %" times the appropriate percentage for the type of set (from the assumptions above) times the total number of deep or shallow sets (also from the assumptions above). Results are rounded to whole sets, and where necessary due to rounding errors, a set is added or subtracted from the category having the most sets to sum to 14,285.

Base Interaction Rate

For deep tuna sets north of 23° N, the baseline seabird capture rate, before implementation of any seabird capture avoidance measures, is the rate calculated from observer data collected between 1994 and 1999 (McCracken 2004). For deep sets south of 23°N, however, the comparable 2002-2003 data were used because no seabird capture avoidance measures were required and the more recent data is considered more likely to be representative of current conditions. For the shallow set baseline seabird capture rates, no data are available for the 2002-2003 period, as that segment of the fishery was closed. Therefore, the 1994-1999 data were used for the baseline pre-seabird avoidance measure rates. A proportionally blended rate was calculated for options applicable to all areas.

Base Interactions

This column is the product of the "No. Sets" and "Base Interaction Rate" columns, and represents the number of takes in the absence of any seabird interaction avoidance measures.[40]

Efficacy

The rates here are taken from those summarized in Table 3 from experimental longlining using the various seabird interaction avoidance measures. Where combinations of measures are an option, the efficacy values calculated in Section 10.7.7 are used.

Interactions

This column is the product of the "Base Interactions" times "Efficacy."

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[40]Deep-setting tuna vessels use line-shooters and weighted branch lines, which have interaction avoidance properties. However, they are part of standard tuna longlining gear, and were in use during the baseline period for interaction rate calculation. For this exercise, they are not assumed to contribute to interaction avoidance efficacies.

Interactions by Sector
Total "Interactions" for all tuna and all swordfish sets are summed, giving the two values in this column for each alternative.

Interactions by Alternative
The two values for tuna and swordfish interactions shown in the previous column are summed to give the total interactions by alternative.

It should be clearly understood that this table should not be interpreted as predicting the expected seabird captures under any alternative. There are numerous confounding factors that may come into play, including annual seabird density variations, distribution of fishing effort in space and time (there is geographic and seasonal variability to capture rates), the rate of compliance with regulations by fishermen, conditions under which measures are implemented (e.g., night setting under a full moon), etc. The value of these calculations is that they present a measure of the ***relative*** effectiveness of the many alternatives.

Given the size and stable to increasing status of potentially affected seabird populations (327,000 black-footed albatrosses, 3.4 million Laysan albatrosses, and 1,900 short-tailed albatrosses, see Section 10.5) and the low levels of anticipated captures under the alternatives (0 to 311 black-footed and Laysan albatrosses combined), it would appear that none of the alternatives would have a discernable impact on the trajectory of potentially affected seabird populations.

Table 24. Seabird Interactions by Alternative - using 1994-1999 data as baseline interaction rates for all swordfish and north tuna and 2002-2003 data for south tuna based on the efficacies of various mitigation measures from experimental observations.

The following assumptions were made to generate the interaction estimates 1. Total sets = 14,285, 2. Shallow sets = 2,120, 3. Deep sets = 12,165, 4. Deep sets North of 23 deg N = 25.40%, 5. Deep sets South of 23 deg N = 74.60%, 6. Shallow sets North of 23 deg N =86.70%, 7. Shallow sets South of 23 deg N = 13.30%

Note: CM = Current Measures, SS = Side Setting, USC = Underwater Setting Chute, TL = Tori Line, TBDB = Thawed Blue Dyed Bait

Alternative	Sector	Area	Measure	Mit. Choice %	No. Sets	Base Interaction Rate	Interactions before Mit.	Mit. Effect	Interactions	Interactions by Sector	Interactions by Alt
1	Tuna	N '(94-99)'	CM	100.00%	3090	0.07016	217	94.82%	11		
		S '(02-03)	none	100.00%	9075	0.00799	73	0.00%	73	84	
	SF	N '(94-99)'	CM	100.00%	1838	0.54583	1003	99.25%	8		
		S '(94-99)	none	100.00%	282	0.01650	5	0.00%	5	13	97
2A	Tuna	N	CM	10.00%	309	0.07016	22	94.82%	1		
		N	SS	90.00%	2781	0.07016	195	99.80%	0		
	SF	N	CM	10.00%	184	0.54583	100	99.25%	1		
		N	SS	90.00%	1654	0.54583	903	99.80%	2		
	Tuna	S	none	10.00%	908	0.00799	7	0.00%	7		
		S	SS	90.00%	8167	0.00799	65	99.80%	0	8	
	SF	S	none	10.00%	28	0.01650	0	0.00%	0		
		S	SS	90.00%	254	0.01650	4	99.80%	0	3	11
2B	Tuna	All	CM	10.00%	1217	0.02378	29	94.82%	2		
			SS	90.00%	10948	0.02378	260	99.80%	1	3	
	SF	All	CM	10.00%	212	0.47542	101	99.25%	1		
			SS	90.00%	1908	0.47542	907	99.80%	2	3	6
3A	Tuna	N	CM	10.00%	309	0.07016	22	94.82%	1		
			UC	90.00%	2781	0.07016	195	94.00%	12		
	SF	N	CM	10.00%	184	0.54583	100	99.25%	1		
			UC	90.00%	1654	0.54583	903	94.00%	54		
	Tuna	S	none	100.00%	9075	0.00799	73	0.00%	73	86	

Alternative	Sector	Area	Measure	Mit. Choice %	No. Sets	Base Interaction Rate	Interactions before Mit.	Mit. Effect	Interactions	Interactions by Sector	Interactions by Alt
	SF	S	none	100.00%	282	0.01650	5	0.00%	5	60	146
3B	Tuna	All	CM	10.00%	1217	0.02378	29	94.82%	2		
			UC	90.00%	10948	0.02378	260	94.00%	16	18	
	SF	All	CM	10.00%	212	0.47542	101	99.25%	1		
			UC	90.00%	1908	0.47542	907	94.00%	54	55	73
4A	Tuna	N	CM	10.00%	309	0.07016	22	94.82%	1		
			TL	90.00%	2781	0.07016	195	79.00%	41		
	SF	N	CM	10.00%	184	0.54583	100	99.25%	1		
			TL	90.00%	1654	0.54583	903	79.00%	190		
	Tuna	S	none	100.00%	9075	0.00799	73	0.00%	73	115	
	SF	S	none	100.00%	282	0.01650	5	0.00%	5	196	311
4B	Tuna	All	CM	10.00%	1217	0.02378	29	94.82%	2		
			TL	90.00%	10948	0.02378	260	79.00%	55	57	
	SF	All	CM	10.00%	212	0.47542	101	99.25%	1		
			TL	90.00%	1908	0.47542	907	79.00%	190	191	248
5A	Tuna	N	CM	10.00%	309	0.07016	22	94.82%	1		
			SS	80.00%	2472	0.07016	173	99.80%	0		
			UC	10.00%	309	0.07016	22	94.00%	1		
	SF	N	CM	10.00%	184	0.54583	100	99.25%	1		
			SS	80.00%	1470	0.54583	802	99.80%	2		
			UC	10.00%	184	0.54583	100	94.00%	6		
	Tuna	S	none	20.00%	1815	0.00799	15	0.00%	15		
			SS	80.00%	7260	0.00799	58	99.80%	0	17	
	SF	S	none	20.00%	56	0.01650	1	0.00%	1		
			SS	80.00%	226	0.01650	4	99.80%	0	10	27
5B	Tuna	All	CM	10.00%	1217	0.02378	29	94.82%	2		
			SS	80.00%	9731	0.02378	231	99.80%	0		
			UC	10.00%	1217	0.02378	29	94.00%	2	4	
	SF	All	CM	10.00%	212	0.47542	101	99.25%	1		
			SS	80.00%	1696	0.47542	806	99.80%	2		
			UC	10.00%	212	0.47542	101	94.00%	6	9	13
6A	Tuna	N	CM	10.00%	309	0.07016	22	94.82%	1		
			SS	70.00%	2162	0.07016	152	99.80%	0		

Alternative	Sector	Area	Measure	Mit. Choice %	No. Sets	Base Interaction Rate	Interactions before Mit.	Mit. Effect	Interactions	Interactions by Sector	Interactions by Alt
			UC	10.00%	309	0.07016	22	94.00%	1		
			TL	10.00%	309	0.07016	22	79.00%	5		
	SF	N	CM	10.00%	184	0.54583	100	99.25%	1		
			SS	70.00%	1287	0.54583	702	99.80%	1		
			UC	10.00%	184	0.54583	100	94.00%	6		
			TL	10.00%	184	0.54583	100	79.00%	21		
	Tuna	S	none	30.00%	2723	0.00799	22	0.00%	22		
			SS	70.00%	6352	0.00799	51	99.80%	0	29	
	SF	S	none	30.00%	85	0.01650	1	0.00%	1		
			SS	70.00%	197	0.01650	3	99.80%	0	30	59
6B	Tuna	All	CM	10.00%	1217	0.02378	29	94.82%	2		
			SS	70.00%	8514	0.02378	202	99.80%	0		
			UC	10.00%	1217	0.02378	29	94.00%	2		
			TL	10.00%	1217	0.02378	29	79.00%	6	10	
	SF	All	CM	10.00%	212	0.47542	101	99.25%	1		
			SS	70.00%	1484	0.47542	706	99.80%	1		
			UC	10.00%	212	0.47542	101	94.00%	6		
			TL	10.00%	212	0.47542	101	79.00%	21	29	39
7A	Tuna	N	CM	10.00%	309	0.07016	22	94.82%	1		
			SS	80.00%	2472	0.07016	173	99.80%	0		
			TL	10.00%	309	0.07016	22	79.00%	5		
	SF	N	CM	10.00%	184	0.54583	100	99.25%	1		
			SS	80.00%	1470	0.54583	802	99.80%	2		
			TL	10.00%	184	0.54583	100	79.00%	21		
	Tuna	S	none	20.00%	1815	0.00799	15	0.00%	15		
			SS	80.00%	7260	0.00799	58	99.80%	0	21	
	SF	S	none	20.00%	56	0.01650	1	0.00%	1		
			SS	80.00%	226	0.01650	4	99.80%	0	25	46
7B	Tuna	All	CM	10.00%	1217	0.02378	29	94.82%	2		
			SS	80.00%	9731	0.02378	231	99.80%	0		
			TL	10.00%	1217	0.02378	29	79.00%	6	8	
	SF	All	CM	10.00%	212	0.47542	101	99.25%	1		
			SS	80.00%	1696	0.47542	806	99.80%	2		
			TL	10.00%	212	0.47542	101	79.00%	21	24	32

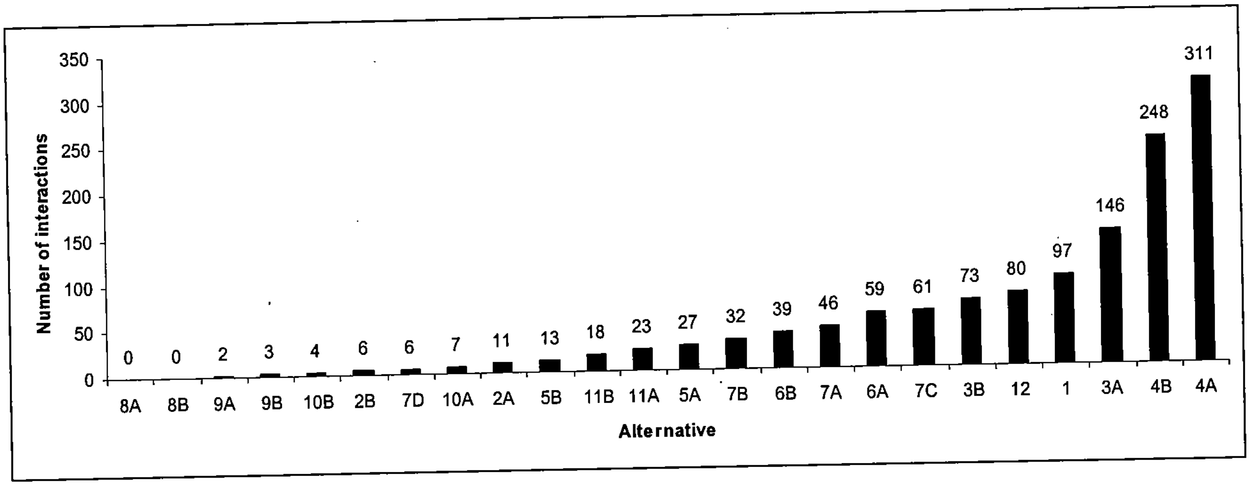
Alternative	Sector	Area	Measure	Mit. Choice %	No. Sets	Base Interaction Rate	Interactions before Mit.	Mit. Effect	Interactions	Interactions by Sector	Interactions by Alt
7C	Tuna	N	CM-TBDB	10.00%	309	0.07016	22	86.00%	3		
			SS	70.00%	2163	0.07016	152	99.80%	0		
			UC	10.00%	309	0.07016	22	94.00%	1		
			TL	10.00%	309	0.07016	22	79.00%	5		
	Tuna	S	none	30.00%	2723	0.00799	22	0.00%	22		
			SS	70.00%	6352	0.00799	51	99.80%	0	31	
	SF	All	CM-TBDB	10.00%	212	0.47542	101	97.97%	2		
			SS	70.00%	1484	0.47542	706	99.80%	1		
			UC	10.00%	212	0.47542	101	94.00%	6		
			TL	10.00%	212	0.47542	101	79.00%	21	30	61
7D	Tuna	N	CM+TL	5.00%	155	0.07016	11	98.91%	0		
			SS	95.00%	2937	0.07016	206	99.80%	0		
	Tuna	S	none	5.00%	454	0.00799	4	0.00%	4		
			SS	95.00%	8621	0.00799	69	99.80%	0	4	
	SF	All	CM+TL	5.00%	106	0.47542	50	99.84%	0		
			SS	95.00%	2014	0.47542	957	99.80%	2	2	6
8A	Tuna	N	CM+SS	100.00%	3090	0.07016	217	99.99%	0		
	SF	N	CM+SS	100.00%	1838	0.54583	1003	100.00%	0		
	Tuna	S	SS	100.00%	9075	0.00799	73	99.80%	0	0	
	SF	S	SS	100.00%	282	0.01650	5	99.80%	0	0	0
8B	Tuna	All	CM+SS	100.00%	12165	0.02378	289	99.99%	0	0	
	SF	All	CM+SS	100.00%	2120	0.47542	1008	100.00%	0	0	0
9A	Tuna	N	SS	100.00%	3090	0.07016	217	99.80%	0		
	SF	N	SS	100.00%	1838	0.54583	1003	99.80%	2		
	Tuna	S	SS	100.00%	9075	0.00799	73	99.80%	0	0	
	SF	S	SS	100.00%	282	0.01650	5	99.80%	0	2	2
9B	Tuna	All	SS	100.00%	12165	0.02378	289	99.80%	1	1	
	SF	All	SS	100.00%	2120	0.47542	1008	99.80%	2	2	3
10A	Tuna	N	SS if feasible	95.00%	2935	0.07016	206	99.80%	0		
			CM	5.00%	155	0.07016	11	94.82%	1		
	SF	N	SS if feasible	95.00%	1746	0.54583	953	99.80%	2		
			CM	5.00%	92	0.54583	50	99.25%	0		
	Tuna	S	SS if feasible	95.00%	8621	0.00799	69	99.80%	0		

Alternative	Sector	Area	Measure	Mit. Choice %	No. Sets	Base Interaction Rate	Interactions before Mit.	Mit. Effect	Interactions	Interactions by Sector	Interactions by Alt
			none	5.00%	454	0.00799	4	0.00%	4	5	
	SF	S	SS if feasible	95.00%	268	0.01650	4	99.80%	0		
			none	5.00%	14	0.01650	0	0.00%	0	2	7
10B	Tuna	All	SS if feasible	95.00%	11557	0.02378	275	99.80%	1		
			CM	5.00%	608	0.02378	14	94.82%	1	2	
	SF	All	SS if feasible	95.00%	2014	0.47542	957	99.80%	2		
			CM	5.00%	106	0.47542	50	99.25%	0	2	4
11A	Tuna	N	SS if feasible	95.00%	2935	0.07016	206	99.80%	0		
			CM-TBDB&SOD	2.00%	62	0.07016	4	0.00%	4		
			UC	1.00%	31	0.07016	2	94.00%	0		
			TL	2.00%	62	0.07016	4	79.00%	1		
	SF	N	SS if feasible	95.00%	1746	0.54583	953	99.80%	2		
			CM-TBDB&SOD	2.00%	37	0.54583	20	85.50%	3		
			UC	1.00%	18	0.54583	10	94.00%	1		
			TL	2.00%	37	0.54583	20	79.00%	4		
	Tuna	S	none	5.00%	454	0.00799	4	0.00%	4		
			SS if feasible	95.00%	8621	0.00799	69	99.80%	0	9	
	SF	S	none	5.00%	14	0.01650	0	0.00%	0		
			SS if feasible	95.00%	268	0.01650	4	0.00%	4	14	23
11B	Tuna	All	SS if feasible	95.00%	11558	0.02378	275	99.80%	1		
			CM-TBDB&SOD	2.00%	243	0.02378	6	0.00%	6		
			UC	1.00%	122	0.02378	3	94.00%	0		
			TL	2.00%	243	0.02378	6	79.00%	1	8	
	SF	All	SS if feasible	95.00%	2014	0.47542	957	99.80%	2		
			CM-TBDB&SOD	2.00%	42	0.47542	20	85.50%	3		
			UC	1.00%	21	0.47542	10	94.00%	1		
			TL	2.00%	42	0.47542	20	79.00%	4	10	18
12	Tuna	S	SS	10.00%	908	0.00799	7	99.80%	0		
			UC	1.00%	91	0.00799	1	94.00%	0		
			TL	5.00%	454	0.00799	4	79.00%	1		
			none (Line	84.00%	7623	0.00799	61	0.00%	61		

Alternative	Sector	Area	Measure	Mit. Choice %	No. Sets	Base Interaction Rate	Interactions before Mit.	Mit. Effect	Interactions	Interactions by Sector	Interactions by Alt
			Shooter)								
	SF	S	SS	10.00%	28	0.01650	0	99.80%	0		
			UC	1.00%	3	0.01650	0	94.00%	0		
			TL	5.00%	14	0.01650	0	79.00%	0		
			none (Night Set)	84.00%	236	0.01650	4	85.50%	1		
	Tuna	N	CM	90.00%	2781	0.07016	195	94.82%	10		
			SS	10.00%	309	0.07016	22	99.80%	0	72	
	SF	N	CM	90.00%	1654	0.54583	903	99.25%	7		
			SS	10.00%	184	0.54583	100	99.80%	0	8	80

A summary of the anticipated interactions of seabirds by each alternative, in ranking order, is shown in Figure 13. It is important to note that all alternatives greatly reduce the number of seabirds caught compared to the fishery operating prior to 2000, when between 2,000-4,000 Laysan and black-footed albatrosses were caught annually (Table 14).

Figure 13. Seabird Alternatives Ranked by Projected Number of Interactions



Alternative 1: No Action

Alternative 1 is considered the baseline case against which all other alternatives are compared. Alternative 1 reflects the current regulations which implemented the Terms and Conditions outlined in the USFWS 2000 BiOp for short-tailed albatrosses (subsequently updated on October 18, 2001 and November 18, 2002) (Table 25). A new BiOp was issued by the USFWS on October 8, 2004 but has yet to be implemented.

In general, under Alternative 1 the operators of all vessels registered for use under a Hawaii longline limited access permit operating with longline gear north of 23 °N, must ensure the use of thawed blue-dyed bait and strategic offal discards to distract birds during setting and hauling of longlines. The offal discard must be made from the opposite side of the vessel from which the longline is being set or hauled (no fish, fish parts, or bait may be discarded from the side of the vessel where the longline is being set or hauled), and all hooks must be removed from discarded fish, fish parts or bait prior to its discard. When making deep-sets (targeting tuna) north of 23 °N, Hawaii longline vessel operators must employ a line-setting machine with weighted branch lines (minimum weight = 45 g), or employ basket-style longline gear. Other mitigation measures such as tori lines, use of weighted branch lines without a line-setting machine (in the case of swordfish or mixed-sets) are optional. If a short-tailed albatross is brought onboard alive, vessel operators and crew must ensure that the albatross displays four traits before release, and they must notify NMFS immediately. Included in this alternative is a requirement that all seabirds brought onboard alive must be handled in a manner that maximizes the probability of their long-term survival once released. Also, vessel captains, as well as vessel owners, must annually complete a protected species workshop conducted by NMFS. Current regulations (69 FR 17329, April 2, 2004) allow a limited amount of shallow-set longline effort (2,120 sets annually) by Hawaii-based longline vessels using circle hooks with mackerel-type bait. Vessel operators making shallow-sets must begin setting the longline at least one hour after local sunset and complete the setting process by local sunrise, using only the minimum vessel lights necessary.

Table 25. Current seabird capture avoidance methods contained in the 2000 and 2002 USFWS BiOps on the Effects of the Hawaii Longline Fishery on the Short-tailed Albatross; November 28, 2000 (amended October 18, 2001) and November 18, 2002.

Seabird Measures	Above 23°N Lat.	
A. Seabird capture avoidance methods	Tuna (deep) set	Swordfish/Mixed (shallow) set
1. Thawed, blue- dyed bait	Required	Required
2. Strategic Offal Discharge	Required	Required
3. Line-Setting machine with weighted branch lines (minimum wt. = 45 gm); or employ basket-style longline gear [a]	Required	Not Required (Optional)
4. Night Setting	Not Required (Optional)	Required
5. Towed deterrent (buoy/tori line)	Not Required (Optional)	Not Required (Optional)
6. Weighted branch lines (min wt =45 gm)	Not Required (Optional)	Not Required (Optional)
B. Careful handling of hooked seabirds	Vessel operators must contact NMFS immediately if they have a hooked/entangled STAL. Specific handling guidelines required for STAL. Other hooked seabirds must be handled in a manner to maximize survival.	
C. Annual Protected Species Workshops	Required	

[a] The October 18, 2001 amendment allowed basket-style, tarred mainline gear as an alternative to monofilament gear set with a line-setting machine and weighted branch lines. Only one vessel in the Hawaii longline fleet uses basket-style, tarred mainline gear.

Any one measure employed north of 23 °N is estimated to reduce the catch of black-footed and Laysan albatrosses in the Hawaii-based longline fishery by 51% to 100% as compared to the 1994-1999 average (Table 24). As no short-tailed albatrosses have been reported captured in the Hawaii-based longline fishery the potential reduction rate is unknown. Further, the mitigation measures described in this document were only tested on black-footed and Laysan albatrosses, and no observations were made of short-tailed albatrosses. However, is assumed that the measures prescribed by the USFWS BiOp will be as effective in ensuring the short-tailed albatross is not captured by Hawaii longline vessels.

Still, each seabird capture avoidance method listed under Alternative 1 and currently required to be employed or optionally employed by Hawaii-based longline vessels north of 23 °N (Table 25) has some limitations to its effectiveness. For instance, researchers noted that some individual seabirds either are not scared away from baited hooks at the water's surface during their initial encounter with tori lines or towed buoys or lose their fear of these devices over time (McNamara et al., 1999). Also, tori lines are less effective in reducing mortalities of Laysan albatross than mortalities of black-footed albatross, possibly because Laysan albatross have a more aggressive or methodical foraging behavior that causes them to continue to dive on baited hooks (McNamara et al., 1999). The effectiveness of tori lines may be greatly reduced in rough weather, and tori lines may become entangled with fishing gear if not closely monitored. An entanglement leaves baited hooks accessible to seabirds unless another tori line is immediately deployed (McNamara et al., 1999).

With regards to using strategic offal discards as a mitigation method, there is little or no offal generally available during setting operations. Also, the supply of offal may be low when fish catch rates are low or tuna are the target species. Consequently, this mitigation method requires the preparation and storage of offal for use during the longline set, especially when catches are low. Further, this mitigation measure may have the negative effect of teaching seabirds that longline fishing vessels are a source of fast food.

Night setting is less effective in reducing interactions with Laysan albatross than with black-footed albatross, possibly because Laysan albatross are more likely to forage at night (Harrison and Seki, 1987). Aft-facing deck lights aboard the vessel or bright moonlight also can reduce the effectiveness of this measure by illuminating baited hooks at the water's surface.

Although the actual sink rate of a baited hook deployed with a line-setting machine has not been measured, use of a line-setting machine is likely to increase the hook sink rate by removing line tension during the set. NMFS' observer records from 1994 to 1999 show that Hawaii-based longline vessels targeting tuna had substantially lower seabird interactions than those that vessels targeted swordfish. However, a rigorous comparative test will need to be performed before a conclusion about the effects of using a line-setting machine can be made. Anecdotal accounts from longline fishermen deploying longline gear with a line-setting machine and weighted branch lines in areas of high seabird abundance suggest that birds still have opportunities to dive on baited hooks. In areas of high seabird abundance, these fishermen advocated using a second mitigation measure like a tori line or towed buoy to avoid incidentally catching seabirds.

Tuna-targeting vessels in the Hawaii-based longline fleet already use line-setting machines and weighted branch lines as part of their standard operating procedures. Tuna vessels, however, are likely to have less opportunity to accumulate quantities of offal in the same manner as swordfish-targeting vessels, which dress the swordfish carcasses, removing bill, fins, tails, gills and guts before storing the trunk in the hold. A swordfish head, when frozen and split, makes an ideal offal discard for seabirds, since it is a sizeable oily morsel which floats and around which the albatrosses can flock and feed. Longline fishermen targeting tuna store their fish whole, apart from removing fins, so these fishermen may need to store some of their normal discards, such as unmarketable species or shark damaged fish to be able to conduct strategic offal discards.

The targeting of swordfish by the Hawaii-based longline fishery was greatly constrained from late August 2000, to the outright ban on shallow-setting north of the equator in the NMFS emergency rule published June 12, 2001. The impacts of these constraints on albatross takes after August 2000 led to a significant decline in the incidental catch of albatrosses by Hawaii-based longline vessels. Further, between July and September 2001, there were no observed interactions with seabirds by the Hawaii longline fishery (with over 20% coverage of the fleet) following the complete ban on shallow-set longline fishing for swordfish north of the equator. It is unknown if the incidental catch of seabirds by Hawaii-based longline vessels using circle hooks with mackerel-type bait will be similar to or less than that of vessels setting shallow and operating as they did prior to 1999 (i.e, targeting swordfish using J-hooks with squid as bait). No studies have been conducted to quantify the combined success of the current required measures in conjunction with night-setting for shallow-sets, as required under the preferred alternative. However, the use of 18/0 or larger circle hooks which are at least 2" in diameter and thus, if hook size has the same influence on seabirds as on turtles in terms of hook ingestion, will be less likely to be swallowed - and if swallowed the curve of the hook makes it less likely than current J hooks to lodge in seabird's gullet (seabirds are known to have an ability to regurgitate some metal objects) - may reduce the severity of interactions that result in the ingestion of hooks. Although no research on seabirds has been conducted, circle hooks are also believed to lessen the likelihood of external hookings of seabirds as their barbs are turned inwards as compared to J hooks. However, any birds that are hooked will likely die through drowning unless they can reach the surface.

For the purposes of this assessment it is assumed that vessels setting shallow will have similar seabird interaction rates as those vessels that set shallow between 1994 and 1999. Under this alternative it is projected that a total of 97 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations.

Alternative 2A: Use either current methods or side-setting north of 23°N

Under this alternative, operators of Hawaii longline vessels could elect to either (a) continue to use the current measures described under Alternative 1, or (b) employ side-setting when fishing north of 23°N. Hawaii longline vessel operators opting to side-set would be required to comply with the following specifications:

1. Side set as far forward from the stern as possible;
2. Deploy a bird curtain between the setting position and the stern, constructed consistent with the specifications given by NOAA Fisheries;
3. Throw baited hooks forward as close to the vessel hull as possible; and,
4. Clip deployed branchlines to the mainline the moment that the vessel passes the baited hook to minimize tension in the branchline, which could cause the baited hook to be pulled towards the sea surface.
5. Use 60 g. weights within 1 m of the hook

Alternative 2A offers Hawaii-based longline fishermen greater flexibility to achieve the regulatory objective (i.e., fishermen can elect to maintain operating under the current suite of measures or use side setting). The side-setting method requires the use of 60 g of weight within one meter of the hooks as well as the deployment of a bird curtain. Researchers did not test how much the bird curtain contributed to the effectiveness of the side-setting method (Gilman et al., 2003), nor did the researchers note seabirds becoming acclimated to the bird curtain. If used as specified, the side-setting seabird capture avoidance method could reduce the incidental catch of seabirds by the Hawaii-based longline fishery by 99-100% (Gilman et al., 2003).

This alternative would continue to focus seabird deterrent measures in the area above 23° N where interaction rates for both sectors (shallow and deep setting) are the highest. Under this alternative it is projected that a total of 11 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent an 89% reduction as compared to Alternative 1 (No Action).

Alternative 2B: Use either current methods or side-setting in all areas
Under this alternative it is projected that a total of 6 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 94% reduction as compared to Alternative 1 (No Action).

Alternative 3A: Use either current methods or an underwater setting chute north of 23°N
In comparison to Alternative 1, this alternative offers fishermen flexibility to achieve the regulatory objective by allowing them to choose to use either the current seabird capture avoidance methods (Table 24) or to set the longline using an underwater setting chute. This alternative would focus seabird deterrent measures in the area above 23° N where interaction rates for both sectors (shallow and deep setting) are the highest. Under this alternative it is projected that a total of 146 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 146% increase as compared to Alternative 1 (No Action).

Alternative 3B: Use either current methods or an underwater setting chute in all areas
Under this alternative it is projected that a total of 73 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 25% reduction as compared to Alternative 1 (No Action).

Alternative 4A: Use either current methods or a tori line (i.e., paired streamer lines) north of 23°N
This alternative differs from Alternative1 by offering longline fishermen the option to either use the suite of mitigation measures as described in Table 25 or to use one or more tori lines. There is a risk of entanglements between tori lines and the longline. Rough seas and high winds also reduce the effectiveness of tori lines and increase the risk of entanglements. Further, when a longline vessel stops during hauls, the streamers attached to the tori line may cause the tori line to sink, increasing the risk of entanglement with the fishing gear or the vessel's propeller. This also reduces the effectiveness of the tori line to deter birds from the gear. This alternative would focus seabird deterrent measures in the area above 23° N where interaction rates for both sectors (shallow and deep setting) are the highest. Under this alternative it is projected that a total of 311 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 221% increase as compared to Alternative 1 (No Action).

Alternative 4B: Use either current methods or a tori line (i.e., paired streamer lines) in all areas
Under this alternative it is projected that a total of 248 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 156% increase as compared to Alternative 1 (No Action).

Alternative 5A: Use either current methods or side-setting or an underwater setting chute north of 23°N
This alternative would provide fishermen with flexibility to achieve the regulatory objective (e.g., fishermen that have vessels unsuitable for side-setting may install an underwater setting chute). This alternative would focus seabird deterrent measures in the area above 23° N where interaction rates for both sectors (shallow and deep setting) are the highest. Under this alternative it is projected that a total of 27 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 72% reduction as compared to Alternative 1 (No Action).

Alternative 5B: Use either current methods or side-setting or underwater chute in all areas
Under this alternative it is projected that a total of 13 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent an 87% reduction as compared to Alternative 1 (No Action).

Alternative 6A: Use either current methods or side-setting or an underwater chute or a tori line north of 23°N
This alternative would provide fishermen with even greater flexibility to achieve the regulatory objective (e.g., fishermen that have vessels unsuitable for side-setting may install an underwater setting chute or use a tori line). This alternative would focus seabird deterrent measures in the area above 23° N where interaction rates for both sectors (shallow and deep setting) are the highest. Under this alternative it is projected that a total of 59 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 39% reduction as compared to Alternative 1 (No Action).

Alternative 6B: Use either current methods or side-setting or an underwater chute or a tori line in all areas
Under this alternative it is projected that a total of 39 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 60% reduction as compared to Alternative 1 (No Action).

Alternative 7A: Use either current measures or side-setting or a tori line north of 23°N
This alternative would provide fishermen with even greater flexibility to achieve the regulatory objective (e.g., fishermen that have vessels unsuitable for side-setting may use current measures or use a tori line). This alternative would focus seabird deterrent measures in the area above 23° N where interaction rates for both sectors (shallow and deep setting) are the highest. Under this alternative it is projected that a total of 46 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 53% reduction as compared to Alternative 1 (No Action).

Alternative 7B: Use either current measures or side setting or a tori line in all areas
Under this alternative it is projected that a total of 32 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 67% reduction as compared to Alternative 1 (No Action).

Alternative 7C: For shallow-sets: use either current measures (without blue-dyed bait) or an underwater chute or side-setting or a tori line in all areas. For deep-sets: use either current measures (without blue-dyed bait) or an underwater chute or side-setting or a tori line north of 23°N

This alternative would provide fishermen with even greater flexibility to achieve the regulatory objective (e.g., fishermen that have vessels unsuitable for side-setting may use current measures or use a tori line). This alternative would apply seabird deterrent measures in the area above 23° N where interaction rates for both sectors (shallow and deep setting) are the highest, as well as applying deterrent measures to shallow setting vessels (which have higher interaction rates than deep setting vessels) in the south. Under this alternative it is projected that a total of 61 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 37% reduction as compared to Alternative 1 (No Action).

Alternative 7D: For shallow-sets: use either side-setting, or use a tori line plus the currently required measures (night setting, blue dyed thawed bait and strategic offal discards) - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present – in all areas. For deep-sets: use either side-setting or use a tori line plus the currently required measures (line shooter with weighted branch lines, blue dyed thawed bait and strategic offal discards) - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present - when fishing north of 23°N

This alternative is similar to 7C except that it retains the use of blue-dyed bait and modifies the requirements for the use of strategic offal discard. This alternative would apply seabird deterrent measures in the area above 23° N where interaction rates for both sectors (shallow and deep setting) are the highest, as well as applying deterrent measures to shallow setting vessels (which have higher interaction rates than deep setting vessels) in the south. Under this alternative it is projected that a total of 6 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 94% reduction as compared to Alternative 1 (No Action).

Alternative 8A: Use current mitigation measures plus side-setting north of 23°N

Under this alternative all mitigation measures are non-discretionary. The requirement to side-set may eliminate fishing opportunities north of 23°N for some longline vessels in the fleet which can not be readily reconfigured for side-setting. Some smaller vessels may be unable to be reconfigured for side-setting because of structural limitations. This alternative would focus seabird deterrent measures in the area above 23° N where interaction rates for both sectors (shallow and deep setting) are the highest. Under this alternative it is projected that no albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 100% reduction as compared to Alternative 1 (No Action).

Alternative 8B: Use current mitigation measures plus side-setting in all areas

Under this alternative all mitigation measures are non-discretionary. The requirement to side-set on all areas may eliminate all Hawaii-based longline fishing opportunities for some longline vessels in the fleet which can not be readily reconfigured for side-setting. Under this alternative it is projected that no albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 100% reduction as compared to Alternative 1 (No Action).

Alternative 9A: Use side-setting north of 23°N

Under this alternative side-setting is required. This requirement may eliminate fishing opportunities north of 23°N for some longline vessels in the fleet which can not be readily reconfigured for side-setting. Some smaller vessels may be unable to be reconfigured for side-setting because of structural limitations. This alternative would focus seabird deterrent measures in the area above 23° N where interaction rates for both sectors (shallow and deep setting) are the highest. Under this alternative it is projected that a total of 2 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 98% reduction as compared to Alternative 1 (No Action).

Alternative 9B: Use side-setting in all areas

Under this alternative side-setting is required. This requirement may eliminate all fishing opportunities for some longline vessels in the fleet which can not be readily reconfigured for side-setting. Under this alternative it is projected that a total of 3 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 97% reduction as compared to Alternative 1 (No Action).

Alternative 10A: Use-side setting unless technically infeasible in which case use current measures north of 23°N

This alternative would allow those longline vessel operators that are unable to adapt their vessels to side-setting to still fish using the current measures. This alternative would focus seabird deterrent measures in the area above 23° N where interaction rates for both sectors (shallow and deep setting) are the highest. Under this alternative it is projected that a total of 7 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 93% reduction as compared to Alternative 1 (No Action).

Alternative 10B: Use side-setting unless technically infeasible in which case use current measures in all areas

Under this alternative it is projected that a total of 4 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 96% reduction as compared to Alternative 1 (No Action).

Alternative 11A: Use side setting unless technically infeasible, in which case use an underwater setting chute or a tori line or current measures without blue bait or strategic offal discards (shallow-setting vessels set at night, deep-setting vessels use line shooters with weighted branch lines), when fishing north of 23°N

Under this alternative fishermen choosing to use current measures will avoid the operational difficulties of using blue-dyed bait and strategic offal discard. This alternative would focus seabird deterrent measures in the area above 23° N where interaction rates for both sectors (shallow and deep setting) are the highest. Under this alternative it is projected that a total of 23albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 76% reduction as compared to Alternative 1 (No Action).

Alternative 11B: Use side setting unless technically infeasible, in which case use an underwater setting chute or a tori line or current measures without blue bait or strategic offal discards (shallow-setting vessels set at night, deep-setting vessels use line shooters with weighted branch lines), in all areas
Under this alternative it is projected that a total of 18 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent a 81% reduction as compared to Alternative 1 (No Action).

Alternative 12: Voluntarily use night-setting or underwater chute or tori line or line-shooter with weighted branch lines south of 23°N
This alternative is not projected to further reduce seabird interactions north of 23°N, where the majority of interactions occur and seabird deterrent measures are already required. The majority of Hawaii-based longline vessels fishing south of 23°N already use a line-shooter with weighted branch lines, as this gear increases the speed at which the mainline is set, which causes the mainline to sag in the middle (more line between floats), allowing the middle hooks to fish deeper. Under this alternative it is projected that a total of 80 albatrosses would be captured by the entire Hawaii-based longline fleet in the course of a year's fishing operations. This would represent an 18% reduction as compared to Alternative 1 (No Action).

10.7.9 Fishery Participants and Fishing Communities

None of the alternatives are anticipated to significantly change fish catch rates for either shallow or deep setting vessels, however there are direct costs associated with each of the different alternatives methods considered here and these are described below. In addition, impacts on potentially affected fishing communities are also discussed.

Alternative 1: No Action
Alternative 1 is considered the baseline case against which all other alternatives are compared. In general, the description of Alternative 1 is a projection of the economic performance of the Hawaii-based longline fishery based on the current management regime. The estimation of future economic impacts is difficult because of recent significant regulatory changes, the most notable being the reopening of the swordfish portion of the Hawaii longline fishery in April 2004. The expected conditions are likely to differ from the conditions that prevailed in 2003, but uncertainty both about fishermen's responses to the new measures and about trends in factors external to the fishery management regime, such as the condition of pelagic fish stocks and market demand for pelagic fish, hampers reliable estimations of future economic activity. Nevertheless, a projection of conditions expected to exist in the future in the absence of any additional changes in the management regime has been made based on the best data available. Table 26 summarizes the predicted catches of the Hawaii-based longline fleet under Alternative 1 for a one-year period.

Table 26 Predicted Annual Catch of the Hawaii-based Longline Fleet Under Alternative 1 for the foreseeable future. (Sources: WPRFMC 2004b and NMFS PIRO)

	Predicted Catch (million lb)	Percent Change from 1994-1999 Average	Percent Change from 2002[1]
Bigeye tuna	5.9	+ 12.8%	- 39.0%
Albacore tuna	3.0	+ 18.6%	+ 159.5%
Yellowfin tuna	1.9	+ 12.1%	+ 51.2%
Swordfish	3.6[2]	- 44.8%	+ 700.0%
Miscellaneous	4.2	+ 6.9%	+ 6.1%
Sharks	2.8	- 37.1%	+ 621.6%

[1] 2003 data were not used because the data for that year are still preliminary. [2] Modeling for this estimate did not take into account a possible increase in swordfish catches when circle hooks with mackerel bait are used. Swordfish catches increased by 30% when this gear and bait were used in the Atlantic longline fishery.

As a result of the predicted change in pelagic fish landings, ex-vessel revenues in the Hawaii longline fishery are anticipated to increase to $38.9 million, a 4% increase over revenues in 2002. The impact on the seafood marketing sector, fishing supply businesses, and other associated businesses is expected to be proportional to the impact on ex-vessel revenue.

It is possible that the increase in landings and revenues in the Hawaii longline fishery will be even larger if the swordfish vessels that relocated in California after the closure of the swordfish component of the Hawaii longline fishery return to Hawaii. Under the regulations for the re-opened swordfish fishery, a total of 2,120 swordfish sets will be allowed per calendar year, or about half of the 1994-1998 average annual number of longline sets targeting swordfish. The average number of vessels targeting swordfish during the 1994-1998 period was 42 (NMFS 2001a). Should the 20 or so California-based longline vessels return to Hawaii, they could conceivably harvest the entire effort limit. Under this scenario the predicted decrease in catch of bigeye tuna would be less, as no Hawaii-based tuna vessels would switch to swordfish fishing.

The estimated economic effects of current and proposed methods to mitigate seabird interactions are summarized in Table 27. The current methods are expected to continue to have a low economic impact on fishing operations. Vessels targeting tuna (i.e., making deep sets) routinely use a line-shooter and weighted branch lines. Although vessels targeting swordfish (i.e., making shallow sets) routinely set at night, the requirement to begin setting the longline at least one hour after local sunset and complete the setting process by local sunrise could potentially have a negative effect on catch rates. Some fishermen claim that hooks set before dusk are more effective. In addition, the night-setting requirement may provide less soak time for vessels fishing at high latitudes during summer months. While there is insufficient information to quantify these effects on catch rates, the impact on the overall economic performance of individual fishing enterprises is expected to be low.

The investment and operational costs of dying bait are small, although some preparation time is required (pre-dyed bait is not commercially available, requiring fishermen to dye the bait blue as it is thawed before each set). The cost of dyeing bait blue using a dye such as Virginia Dare FDC No. 1 Blue Food Additive is about $14 per set (Gilman et al. 2003). Assuming a typical longline vessel makes 100 sets per year, the total annual cost of dyeing bait is about $1,400. Dyeing bait requires that crew spend significant extra time preparing the bait in lieu of personal time. In addition, blue-dyed bait is messy, dying the crew's hands and clothes and the vessel deck. Notwithstanding these difficulties, some participants in the Hawaii-based longline fishery routinely dye a portion of their bait blue in order to increase its allure to target fish species.

There are no costs associated with strategic offal discards other than the need to purchase containers to store offal for discarding on the set; the container costs are estimated to be about $150 per year (McNamara et al. 1999). Operationally, however, offal discards are more appropriate for vessels targeting swordfish, since the carcasses of swordfish are headed and gutted before being packed on ice in the ships hold. A supply of offal is therefore generated for the next set. On most tuna-targeting longliners tuna are not dressed like swordfish, with only fins and tails cut off for storage. Accumulating offal for the next set on tuna targeting vessels is more problematic. Tuna vessels have to retain some valueless bycatch species to convert to offal, or gut and gill the fish to have a supply of offal for strategically discarding.

The equipment required for careful handling of hooked seabirds, including bolt cutters, pliers, knives, and long-handled dip nets, is routinely carried aboard fishing vessels (purchase costs are about $100) (WPRFMC 2004c). The costs to vessel operators of participating in annual protected species workshops are the costs of the participants' time spent at the meetings. The alternatives considered here would not affect these two measures.

Based on a projection of the number of sets that will occur north of 23 °N, the costs of continuing to use current mitigation methods can be estimated for the Hawaii-based longline fleet (Table 27). Current mitigation methods do not entail any installation or set-up costs. Moreover, the costs of a line-shooter, weighted branch lines, and equipment required for handling of hooked seabirds should not be considered compliance costs, as these costs are routinely incurred by all Hawaii longline vessels targeting tuna. However, current mitigation methods do involve some annual costs. The fleet-wide annual cost of using blue-dyed bait is anticipated to be about $68,992, assuming a cost of $14 per set. This estimate likely overstates bait-related compliance costs because, as noted above, a number of vessels routinely dye a portion of their bait blue in order to increase its allure to target fish species.

Table 27. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 1 (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Predicted No. of Affected Vessels	Predicted No. of Affected Sets	Predicted Installation/ Set-up Costs	Predicted Annual Costs
Tuna	North of 23 °N	Current Methods	100	111	3,090	$0	$59,910
Swordfish	North of 23 °N	Current Methods	100	21	184	$0	$28,882
					Total	$0	$88,792

Based on the total number of predicted sets (14,285), the total number of active longline vessels is expected to be about 143, assuming a typical longline vessel makes 100 sets per year. Further, based on the number of predicted deep-sets (12,165) and shallow-sets (2,120), the number of tuna vessels and swordfish vessels is expected to be 121 and 21, respectively.

However, not all of these vessels may fish north of 23 °N. This analysis assumed that all 21 swordfish vessels fish north of 23 °N at least once a year, but only 111 (91%) of the 121 tuna boats fish above this latitude. The basis for this assumption is discussed in Appendix D. The analysis further assumed that from year to year it will be same vessels that restrict their fishing effort to grounds south of 23 °N. All vessels that fish north of 23 °N at least once would incur the costs of buying containers to store offal for discarding under Alternative 1. Assuming an annual cost of $150 per vessel for containers, the cost for all affected vessels is estimated to be about $19,800.

As shown in Table 27, the total annual compliance costs for the Hawaii-based longline fleet is estimated to be $88,792 under Alternative 1. These costs can be compared to an estimate of the fleet-wide annual costs. The cost-earnings study by O'Malley and Pooley (2003) reports that the average annual total costs of operating a swordfish vessel and tuna vessel are about $462,000 and $441,000, respectively. Assuming a future affected fleet size of 111 tuna boats and 21 swordfish boats, the total annual costs of the fleet would be $59 million.

As noted above, the compliance costs of current measures to mitigate seabird interactions are not evenly distributed across the fleet. In 2003, fishing grounds north of 23 °N accounted for 19% of the fishing effort of small vessels (<56 ft), 25% of the effort of medium vessels (56.1 ft-73.9 ft), and 30% of the effort of large vessels (>74 ft).Consequently, small vessels are expected to bear the lowest proportion of the predicted fleet-wide compliance costs under Alternative 1, and large vessels are anticipated to bear the highest share.

Up until April 2004, the only Hawaii limited access longline permit holders affected by the seabird interaction mitigation measures were those making deep-sets, as shallow "swordfish-style" setting was prohibited to protect sea turtles. With the reopening of the swordfish targeting segment of the Hawaii longline fishery under new regulations, it is anticipated that the impacts of employing the current methods to reduce seabird interactions will affect all vessels targeting swordfish. As indicated above, the fishing effort of swordfish vessels has historically been concentrated above 23 °N.

Oahu is the relevant fishing community to assess with respect to seabird interaction measures, as it the home port for nearly the entire Hawaii-based longline fleet. Other fishing communities in Hawaii and the fishing communities of American Samoa, Guam and the Northern Mariana Islands would not be affected by any of the alternatives considered. Fishing vessels and seafood processors based in those communities would not benefit from the alternatives, nor would they experience any adverse effects.

Under Alternative 1 the sustained participation of Oahu in the Hawaii longline fishery would be unaffected and Oahu would continue to benefit from the fishery as described in Sections 3.7 and 3.8.

Alternative 2A: Use either current methods or side setting north of 23°N
In comparison to Alternative 1, this alternative is not expected to result in a significant change in the economic performance of the Hawaii-based longline fishery in terms of fleet size and composition, fishing trips, quantities produced, gross revenue or fishing costs.

However, by offering fishermen a seabird interaction mitigation method option this alternative provides regulated vessels greater flexibility to achieve the regulatory objective in a more cost-effective way in comparison to Alternative 1 (i.e., fishermen can elect to maintain operating under the current suite of mitigation methods or use side setting). Several vessels in the fleet have already converted to side setting because of perceived operational benefits (beyond the minimization of bait theft and bird capture) (WPRFMC 2004c). Given the comparative benefits of side setting versus current mitigation methods, it is likely that many, if not most, of the vessels in the Hawaii longline fleet would adopt side setting as their mitigation method of choice. By allowing vessel operators to choose between employing current mitigation methods or side setting, this alternative addresses potential safety concerns associated with side setting and recognizes that configuring some vessels for side setting may be costly.

The estimated economic effects of side setting are summarized in Table 28. All boats that choose side setting would be required to employ a bird curtain, which Gilman et al.(2003) estimated to cost about $50. The bird curtain prevents birds from establishing a flight path along the side of the boat where baited hooks are deployed. In addition, all vessels would need to switch from 45 g to 60 g weighted swivels. The higher swivel weight is recommended by Gilman et al. to increase the bait sink rate. The cost of new swivels and crimps is about $2,500 (WPRFMC 2004c). It is estimated that about 70% of the longline vessels currently fishing in Hawaii already use 60 g weighted swivels (WPRFMC 2004c), with the remaining vessels using the required 45 g weight when deep set fishing north of 23°N.

Converting to side setting would also generally require some adjustment of the deck design. According to WPRFMC (2004c), a typical vessel in the Hawaii longline fleet would have to spend about $1,500 to alter its deck design for side setting. Gilman et al. (2003) noted that several aspects of a vessel's layout need to be considered when planning to convert to side setting, including the feasibility of setting from the port versus starboard side; new position for the line-shooter; and location for buoy, radio beacon, and branch line tote storage. A central principle is that the further forward the setting position is from the vessel stern, the more effective side setting is at avoiding seabird interactions (also, the further forward the setting position, the easier it is to contend with tote tangles and inadvertently badly thrown baits). According to Gilman et al., a vessel needs a minimum of 0.5 m from the stern corner to allow space to mount a bird curtain aft of the line-shooter. Sea trials described by Gilman et al. demonstrated that it is possible to adjust the gear to side set from various deck positions without any apparent compromise to the effectiveness of the method at avoiding seabird interactions, indicating that it is most likely a feasible seabird avoidance method on a variety of vessel deck designs.

Gilman et al. (2003) concluded that it is likely that side setting can be employed on all vessels in the Hawaii-based longline fleet; however, the researchers noted that a small number of vessels in the fleet may have limited options to mount line-shooters for side setting from a position far forward from the stern. Industry representatives indicated that some boat owners may need to reconfigure the entire deck of their vessels before they could employ side setting, including moving the mainline spool (personal communication , Karla Gore, NMFS PIRO) . Such a reconfiguration could entail substantial expenses for labor and materials as well as lost fishing time. Smaller vessels, in particular, may find it costly to convert to side setting because of structural limitations (personal communication, Karla Gore, NMFS PIRO, WPRFMC 2004c). Because reconfiguring some vessels for side setting may be expensive, the WPFMC has recommended that NMFS provide low-interest loans or State of Hawaii Fisheries Disaster Relief Program funds to fishermen to reduce these costs (WPFMC, 123rd Meeting, June 21-24, 2004).[3]

Gilman et al. (2003) noted that, in comparison to conventional stern setting, side setting may improve fishing efficiency by increasing the hook setting rate. Moreover, the increased retention of bait by avoiding bird interactions may increase target fish catch rates.

In addition, Gilman et al. state that there may be fewer gear tangles when side setting compared to conventional stern setting. During sea trials there were no incidences of gear being fouled in the propeller while side setting from various setting positions. On a few occasions, researchers had the vessel turn hard to starboard and hard to port in an attempt to determine of this would foul the gear during side setting, and found that it did not. However, Gilman et al. recommend that sea trials be conducted on a variety of vessel lengths and designs to determine if bait loss off hooks and line tangling or cutting such as from contact with propellers are problematic.

Gilman et al. indicate that there may be occasional inconvenience and discomfort for crew when side setting in heavy weather when it cannot be avoided to have the swell come onto the side where setting is occurring. This would be a more noticeable problem on smaller vessels.

Based on a projection of the number of sets that will occur north of 23 °N and an estimate of the percentage of vessels that would employ each of the available mitigation method options, the costs of Alternative 2A can be estimated for the Hawaii-based longline fleet (Table 28). The number of affected vessels and costs of current methods were estimated as in Alternative 1. The installation/set-up costs of side setting is estimated to be about $4,000 for a typical vessel, including deck reconfiguration and new swivels and crimps (WPRFMC 2004c). (Many vessels will not need to purchase new swivels and crimps because they already use 60 g weighted swivels; on the other hand, the estimated reconfiguration costs do not include possible lost fishing time as a result of extra time spent in port during deck modifications.) In addition, each vessel employing side setting would incur an annual cost of $50 to replace its bird curtain. As shown in Table 28, the predicted compliance costs for the longline fleet under Alternative 2A include $476,000 for installation/set-up costs and $14,802 for annual costs. In comparison to Alternative 1, this represents a $476,000 increase in installation/set-up costs and a $73,990 decrease in annual costs.

[3] The 2003 Omnibus Appropriations bill appropriated a lump sum of $5 million for economic assistance to Hawaii fisheries affected by federal fishery management regulations.

Table 28. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 2A. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Predicted No. of Affected Vessels	Predicted No. of Affected Sets	Predicted Installation/ Set-up Costs	Predicted Annual Costs
Tuna	North of 23°N	Current Methods	10	11	309	$0	$5,976
		Side Setting	90	100	2,781	$400,000	$5,000
Swordfish	North of 23°N	Current Methods	10	2	184	$0	$2,876
		Side Setting	90	19	1,654	$76,000	$950
					Total	$476,000	$14,802

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 2B: Use either current methods or side setting in all areas

The economic effects of this alternative would be similar to those described under Alternative 2A; the primary differences would be that some vessels that choose to use current methods will incur additional costs and those vessels that fish exclusively south of 23°N would be affected by the regulations. As a result of these differences, the predicted compliance costs for the Hawaii-based longline fleet under Alternative 2B include $516,000 for installation/set-up costs and $28,556 for annual costs (Table 29). In comparison to Alternative 1, this represents a $516,000 increase in installation/set-up costs and a $60,236 decrease in annual costs.

Table 29. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 2B. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna	All	Current Methods	10	12	1,217	$0	$18,838
		Side Setting	90	110	10,948	$440,000	$5,500
Swordfish	All	Current Methods	10	2	212	$0	$3,268
		Side Setting	90	19	1,908	$76,000	$950
					Total	$516,000	$28,556

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 3A: Use either current methods or an underwater chute north of 23°N
In comparison to Alternative 1, this alternative is not expected to result in a significant change in the economic performance of the Hawaii-based longline fishery in terms of fleet size and composition, fishing trips, quantities produced, gross revenue or fishing costs.

However, by offering fishermen an option this alternative provides regulated vessels greater flexibility to achieve the regulatory objective in a more cost-effective way in comparison to Alternative 1 (i.e., fishermen can elect to maintain operating under the current suite of mitigation methods or use an underwater setting chute). Given the comparative costs of the underwater chute versus current mitigation methods, it is likely that most of the Hawaii longline fleet would continue to choose to employ the current methods. By allowing vessel operators to choose between employing current mitigation methods or an underwater setting chute, this alternative addresses the high initial costs and potential operational difficulties associated with using underwater setting chutes.

The estimated economic effects of employing an underwater setting chute are summarized in Table 30. The Mustad funnel and Albi Save are two commercially available underwater setting devices. Both are large metal chutes attached to the stern, which deliver the line into the water up to 2 m below the surface. According to Gilman et al. (2003), the cost of the Mustad underwater setting funnel is $5,000 for the hardware. However, the underwater setting chute manufactured by Albi Save for use by pelagic longliners is about $2,500 (personal communication, Eric Gilman, Blue Ocean Institute). There is an additional cost associated with installation, and a chute may require periodic maintenance (personal communication, Eric Gilman, Blue Ocean Institute). Use of the underwater setting device is expected to increase fishing efficiency due to increased bait retention from avoiding bird interactions and mechanical effectiveness. But these positive effects would be offset to a degree by the slower hook setting rate in the tuna longline fishery compared to conventional setting (Gilman et al. 2003). The hook setting rate with the chute is expected to be suitable for the swordfish fishery where the conventional hook set interval is slower.

During sea trials described by Gilman et al. (2003) crew perceived the underwater chute to be unwieldy to deploy and retract. However, a more efficient system to deploy and retract the chute could be designed and installed if a vessel were to install a chute for permanent use. Crew found setting with the chute to be less messy than conventional setting, as bait does not splatter and hit the crew when setting bait through the chute.

Gilman et al. note that there is concern that, even if all the chute's engineering deficiencies were fixed, it may be an insurmountable problem to avoid having gear getting occasionally tangled around the chute for vessels that set their main line slack, such as in the Hawaii longline tuna fleet. In particular, when there is a large swell use of the chute causes fouled hooks and gear tangles. When tangles cause hooks to come up prong first during hauling a safety hazard is created for crew. The two causes of the increased incidence of gear tangles when using the chute, timing of crew clipping branch lines to the main line and bin tangles, are avoidable, but they may be frequent with new and inattentive crew. An additional potential drawback of the underwater chute is that it requires substantial deck space to stow, which may be a significant problem on smaller vessels.

Based on a projection of the number of sets that will occur north of 23 °N and an estimate of the percentage of vessels that would employ each of the available mitigation method options, the costs of Alternative 3A can be estimated for the Hawaii-based longline fleet (Table 30). The number of affected vessels and costs of current methods were estimated as in Alternative 1. To be conservative (i.e., more likely to overstate impacts than understate them), this analysis assumed that the cost of an underwater setting funnel is $5,000. The life expectancy of an underwater setting chute is about 20 years (pers. comm., Eric Gilman, Blue Ocean Institute, 6/13/04). Based on a straight-line method of calculating depreciation, the annual cost for the chute is estimated to be about $250. The installation/set-up costs for an underwater chute are estimated to be about $1,000 for a typical vessel. As shown in Table30, the predicted compliance costs for the Hawaii-based longline fleet under Alternative 3A include $119,000 for installation/set-up costs and $38,602 for annual costs. In comparison to Alternative 1, this represents a $119,000 increase in installation/set-up costs and a $50,190 decrease in annual costs.

Table 30. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 3A. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna		Current Methods	10	11	309	$0	$5,976
	North of 23 °N	Underwater Chute	90	100	2,781	$100,000	$25,000
Swordfish		Current Methods	10	2	184	$0	$2,876
	North of 23 °N	Underwater Chute	90	19	1,654	$19,000	$4,750
					Total	$119,000	$38,602

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 3B: Use either current methods or an underwater chute in all areas

The economic effects of this alternative would be similar to those described under Alternative 3A; the primary differences would be that some vessels that choose to use current methods will incur additional costs and those vessels that fish exclusively south of 23 °N would be affected by the regulations. As a result of these differences, the predicted compliance costs for the Hawaii-based longline fleet under Alternative 3B include $129,000 for installation/set-up costs and $54,356 for annual costs (Table 31). In comparison to Alternative 1, this represents a $129,000 increase in installation/set-up costs and a $34,436 decrease in annual costs.

Table 31. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 3B. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna		Current Methods	10	12	1,217	$0	$18,838
	All	Underwater Chute	90	110	10,948	$110,000	$27,500
Swordfish		Current Methods	10	2	212	$0	$3,268
	All	Underwater Chute	90	19	1,908	$19,000	$4,750
					Total	$129,000	$54,356

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 4A: Use either current methods or a tori line north of 23°N
In comparison to Alternative 1, this alternative is not expected to result in a significant change in the economic performance of the Hawaii-based longline fishery in terms of fleet size and composition, fishing trips, quantities produced, gross revenue or fishing costs.

However, by offering fishermen a seabird interaction mitigation method option this alternative provides regulated vessels greater flexibility to achieve the regulatory objective in a more cost-effective way in comparison to Alternative 1 (i.e., fishermen can elect to maintain operating under the current suite of mitigation methods or use a tori line (e.g., paired streamer lines)). Given the comparative costs and benefits of tori lines versus current mitigation methods, it is likely that most of the Hawaii longline fleet would continue to choose to employ the current methods. According to WPRFMC (2004c), the cost of a tori line is about $2,000 for the fiberglass pole and $300 for the streamer line. However, McNamara et al. (1999) state that several on-board replacements may be required because of the high likelihood of breakage due to entanglements. While the costs of maintaining a supply of tori lines would represent a small fraction of the total annual operating costs of a Hawaii longline vessel, these additional costs and other factors are likely to create a disincentive for vessel owners to adopt this deterrent method. By allowing vessel operators to choose between employing current mitigation methods or a tori line, this alternative addresses the potential costs and operational difficulties associated with using a tori line.

The estimated economic effects of employing a tori line are summarized in Table 32. McNamara et al. (1999) noted that rough weather may substantially decrease the effectiveness of tori lines, and these devices can quickly become entangled with fishing gear if not closely monitored. An entanglement leaves baited hooks accessible to seabirds unless another tori line is immediately deployed. The problem of keeping the bird scaring line clear of fishing gear and positioned over the baited hooks is particularly acute at night because of reduced visibility and during the haul back because of frequent changes in the vessel's direction. The slack put into the main line by a line shooter increases the risk of it tangling with the tori line under rough or windy conditions. Incorporating break-aways (weak links) of about 100 to 200 pound tensile strength into the streamer line is highly recommended should the streamer line foul on the groundline. Break-aways at drag buoys are a minimum precaution.

Based on a projection of the number of sets that will occur north of 23 °N and an estimate of the percentage of vessels that would employ each of the available mitigation method options, the costs of Alternative 4A can be estimated for the Hawaii-based longline fleet (Table 32). The number of affected vessels and costs of current methods were estimated as in Alternative 1. The cost of a fiberglass pole with a streamer line was assumed to be $2,300. Because vessels may need to replace the pole due to breakage, the total annual costs were estimated to be $4,600. Installation of a mount for the tori line is expected to cost $1,000 (WPRFMC 2004c). As shown in Table 32, the predicted compliance costs for the Hawaii-based longline fleet under Alternative 4A include $119,000 for installation/set-up costs and $556,252 for annual costs. In comparison to Alternative 1, this represents a $119,000 increase in installation/set-up costs and a $467,460 increase in annual costs.

Table 32. Predicted Costs Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 4A. (Source NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna		Current Methods	10	11	309	$0	$5,976
	North of 23 °N	Tori Line	90	100	2,781	$100,000	$460,000
Swordfish		Current Methods	10	2	184	$0	$2,876
	North of 23 °N	Tori Line	90	19	1,654	$19,000	$87,400
					Total	$119,000	$556,252

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 4B: Use either current methods or a tori line in all areas

The economic effects of this alternative would be similar to those described under Alternative 3A; the primary differences would be that some vessels that choose to use current methods will incur additional costs and those vessels that fish exclusively south of 23 °N would be affected by the regulations. As a result of these differences, the predicted compliance costs for the Hawaii-based longline fleet under Alternative 4B include $129,000 for installation/set-up costs and $615,506 for annual costs (Table 33). In comparison to Alternative 1, this represents a $129,000 increase in installation/set-up costs and a $526,714 increase in annual costs.

Table 33. Predicted Costs Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 4B. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna		Current Methods	10	12	1,217	$0	$18,838
	All	Tori Line	90	110	10,948	$110,000	$506,000
Swordfish		Current Methods	10	2	212	$0	$3,268
	All	Tori Line	90	19	1,908	$19,000	$87,400
					Total	$129,000	$615,506

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 5A: Use either current methods or side setting or an underwater chute north of 23°N

The economic effects of this alternative would be similar to those described for Alternatives 2A and 3A; the primary difference would be that this alternative would provide fishermen with even greater flexibility to achieve the regulatory objective in a more cost-effective way (e.g., fishermen that have vessels unsuitable for side setting may find the installation of an underwater setting chute to be cost-effective). The predicted compliance costs for the Hawaii-based longline fleet under Alternative 5A include $437,000 for installation/set-up costs and $17,402 for annual costs (Table 34). In comparison to Alternative 1, this represents a $437,000 increase in installation/set-up costs and a $71,390 decrease in annual costs.

Table 34. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 5A. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna		Current Methods	10	11	309	$0	$5,976
		Side Setting	80	89	2,472	$356,000	$4,450
	North of 23°N	Underwater Chute	10	11	309	$11,000	$2,750
Swordfish		Current Methods	10	2	184	$0	$2,876
		Side Setting	80	17	1,470	$68,000	$850
	North of 23°N	Underwater Chute	10	2	184	$2,000	$500
					Total	$437,000	$17,402

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 5B: Use either current methods or side setting or an underwater chute in all areas

The economic effects of this alternative would be similar to those described under Alternative 3A; the primary differences would be that some vessels that choose to use current methods will incur additional costs and those vessels that fish exclusively south of 23°N would be affected by the regulations. As a result of these differences, the predicted compliance costs for the Hawaii-based longline fleet under Alternative 5B include $474,000 for installation/set-up costs and $31,356 for annual costs (Table 35). In comparison to Alternative 1, this represents a $474,000 increase in installation/set-up costs and a $57,436 decrease in annual costs.

Table 35. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 5B. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna	All	Current Methods	10	12	1,217	$0	$18,838
		Side Setting	80	98	9,731	$392,000	$4,900
		Underwater Chute	10	12	1,217	$12,000	$3,000
Swordfish	All	Current Methods	10	2	212	$0	$3,268
		Side Setting	80	17	1,696	$68,000	$850
		Underwater Chute	10	2	212	$2,000	$500
					Total	$474,000	$31,356

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 6A: Use either current methods or side setting or an underwater chute or a tori line north of 23°N

The economic effects would be similar to those described for Alternative 5A; the primary difference would be that this alternative would provide fishermen with even greater flexibility to achieve the regulatory objective in a more cost-effective way (e.g., fishermen that have vessels unsuitable for side setting may find the installation of an underwater setting chute or use of a tori line to be cost-effective). The predicted compliance costs for the Hawaii-based longline fleet under Alternative 6A include $398,000 for installation/set-up costs and $76,552 for annual costs (Table 36). In comparison to Alternative 1, this represents a $398,000 increase in installation/set-up costs and a $12,240 decrease in annual costs.

Table 36. Predicted Costs Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 6A. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna	North of 23°N	Current Methods	10	11	309	$0	$5,976
		Side Setting	70	78	2,162	$312,000	$3,900
		Underwater Chute	10	11	309	$11,000	$2,750
		Tori Line	10	11	309	$11,000	$50,600
Swordfish	North of 2 °N	Current Methods	10	2	184	$0	$2,876
		Side Setting	70	15	1,287	$60,000	$750
		Underwater Chute	10	2	184	$2,000	$500
		Tori Line	10	2	184	$2,000	$9,200
					Total	$398,000	$76,552

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 6B: Use either current methods or side setting or an underwater chute or a tori line in all areas

The economic effects of this alternative would be similar to those described under Alternative 6A; the primary differences would be that some vessels that choose to use current methods will incur additional costs and those vessels that fish exclusively south of 23°N would be affected by the regulations. As a result of these differences, the predicted compliance costs for the Hawaii-based longline fleet under Alternative 6B include $428,000 for installation/set-up costs and $95,006 for annual costs (Table 37). In comparison to Alternative 1, this represents a $428,000 increase in installation/set-up costs and a $6,214 increase in annual costs.

Table 37. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 6B.

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna	All	Current Methods	10	12	1,217	$0	$18,838
		Side Setting	70	85	8,514	$340,000	$4,250
		Underwater Chute	10	12	1,217	$12,000	$3,000
		Tori Line	10	12	1,217	$12,000	$55,200
Swordfish	All	Current Methods	10	2	212	$0	$3,268
		Side Setting	70	15	1,484	$60,000	$750
		Underwater Chute	10	2	212	$2,000	$500
		Tori Line	10	2	212	$2,000	$9,200
					Total	$428,000	$95,006

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 7A: Use either current methods or side setting or a tori line north of 23°N
The economic effects would be similar to those described for Alternatives 2A and 4A; the primary difference would be that this alternative would provide fishermen with even greater flexibility to achieve the regulatory objective in a more cost-effective way (e.g., fishermen that have vessels unsuitable for side setting may find the use of a tori line to be cost-effective). The predicted compliance costs for the Hawaii-based longline fleet under Alternative 7A include $437,000 for installation/set-up costs and $73,952 for annual costs (Table 38). In comparison to Alternative 1, this represents a $437,000 increase in installation/set-up costs and a $14,842 decrease in annual costs.

Table 38. Predicted Costs Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 7A. (Source NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna	North of 23°N	Current Methods	10	11	309	$0	$5,976
		Side Setting	80	89	2,472	$356,000	$4,450
		Tori Line	10	11	309	$11,000	$50,600
Swordfish	North of 23°N	Current Methods	10	2	184	$0	$2,876
		Side Setting	80	17	1,470	$68,000	$850
		Tori Line	10	2	184	$2,000	$9,200
					Total	$437,000	$73,952

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 7B: Use either current methods or side setting or a tori line in all areas
The economic effects of this alternative would be similar to those described under Alternative 7A; the primary differences would be that some vessels that choose to use current methods will incur additional costs and those vessels that fish exclusively south of 23°N would be affected by the regulations. As a result of these differences, the predicted compliance costs for the Hawaii-based longline fleet under Alternative 7B include $474,000 for installation/set-up costs and $92,256 for annual costs (Table 39). In comparison to Alternative 1, this represents a $474,000 increase in installation/set-up costs and a $3,464 increase in annual costs.

Table 39. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 7B. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna	All	Current Methods	10	12	1,217	$0	$18,838
		Side Setting	80	98	9,731	$392,000	$4,900
		Tori Line	10	12	1,217	$12,000	$55,200
Swordfish	All	Current Methods	10	2	212	$0	$3,268
		Side Setting	80	17	1,696	$68,000	$850
		Tori Line	10	2	212	$2,000	$9,200
					Total	$474,000	$92,256

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 7C: For shallow-sets: use either current methods (without blue-dyed bait) or an underwater chute or side setting or a tori line in all areas. For deep-sets: use either current methods (without blue-dyed bait) or an underwater chute or side setting or a tori line, north of 23°N

The economic effects of this alternative would be similar to those described for Alternative 6A; the primary difference would be that those fishermen that choose to use the current mitigation methods would not incur the costs and operational difficulties of using blue-dyed bait. The predicted compliance costs for the Hawaii-based longline fleet under Alternative 7C include $398,000 for installation/set-up costs and $69,650 for annual costs (Table 40). In comparison to Alternative 1, this represents a $398,000 increase in installation/set-up costs and a $19,142 decrease in annual costs.

Table 40. Predicted Costs Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 7C. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna	North of 23°N	Current Methods wo/BDB	10	11	309	$0	$1,650
		Side Setting	70	78	2,163	$312,000	$3,900
		Underwater Chute	10	11	309	$11,000	$2,750
		Tori Line	10	11	309	$11,000	$50,600
Swordfish	All	Current Methods wo/BDB	10	2	212	$0	$300
		Side Setting	70	15	1,484	$60,000	$750
		Underwater Chute	10	2	212	$2,000	$500
		Tori Line	10	2	212	$2,000	$9,200
					Total	$398,000	$69,650

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 7D: Alternative 7D: For shallow-sets: use either side-setting, or use a tori line plus the currently required measures (night setting, blue dyed thawed bait and strategic offal discards) - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present – in all areas. For deep-sets: use either side-setting or use a tori line plus the currently required measures (line shooter with weighted branch lines, blue dyed thawed bait and strategic offal discards) - with the requirement to use strategic offal discards modified to require that vessel operators use them only when seabirds are present - when fishing north of 23°N

For vessels targeting swordfish (shallow-setting) the economic effects of this alternative would be similar to those described under Alternative 2B; the primary difference would be that those vessels that do not choose side setting would incur the costs of both current methods and tori lines. For vessels targeting tuna (deep-setting) the economic effects of this alternative would be similar to those described under Alternative 2A; as with swordfish vessels, the primary difference would be that those tuna vessels that do not choose side setting would incur the costs of both current methods and tori lines. The predicted compliance costs for the Hawaii-based longline fleet under Alternative 7D include $507,000 for installation/set-up costs and $43,154 for annual costs (Table 41). In comparison to Alternative 1, this represents a $507,000 increase in installation/set-up costs and a $45,638 decrease in annual costs.

Table 41. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 7D. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna		Current Methods and Tori Line	5	6	155	$,000	$30,670
	North of 23°N	Side Setting	95	105	2,937	$420,000	$5,250
Swordfish	North of 23°N	Current Methods and Tori Line	5	1	106	$1,000	$6,234
		Side Setting	95	20	2,014	$80,000	$1,000
					Total	$507,000	$43,154

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 8A: Use current mitigation methods plus side setting north of 23°

In comparison to Alternative 1, this alternative provides regulated vessels a similar lack of flexibility to achieve the regulatory objective in a cost-effective way. All mitigation methods are non-discretionary. The annual operating costs of longline vessels would not increase significantly under this alternative. As noted above reconfiguring some vessels for side setting may be costly, although it is assumed here for the purposes of this analysis that side setting can be feasibly employed on all vessels in the Hawaii-based longline fleet. Smaller vessels, in particular, may find it costly to convert to side setting because of structural limitations. The WPFMC has recommended that NMFS provide low-interest loans or State of Hawaii Fisheries Disaster Relief Program funds to fishermen to reduce these costs (WPFMC, 123rd Meeting, June 21-24, 2004). If implemented, this financial assistance would mitigate the unusually high costs that some vessels may incur when converting to side setting.

Assuming that side setting is feasible for all vessels in the longline fleet and given the possibility of financial assistance to mitigate conversion costs, this analysis assumed that a requirement to side set would not restrict fishing opportunities for any vessel north of 23 °N. Under this scenario, the predicted compliance costs for the Hawaii-based longline fleet under Alternative 8A include $528,000 for installation/set-up costs and $95,392 for annual costs (Table 42). In comparison to Alternative 1, this represents a $528,000 increase in installation/set-up costs and a $6,600 increase in annual costs. The negative economic impacts of this alternative would be higher if the requirement to side set eliminates pelagic longlining opportunities north of 23 °N for vessels that can not be readily reconfigured for side setting.

Table 42. Predicted Costs Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 8A. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna	North of 23 °N	Current Methods and Side Setting	100	111	3,090	$444,000	$65,460
Swordfish	North of 23 °N	Current Methods and Side Setting	100	21	1,838	$84,000	$29,932
					Total	$528,000	$95,392

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 8B: Use current mitigation methods plus side setting in all areas

The economic effects of this alternative would be similar to those described for Alternative 8A; the primary difference would be that those vessels that fish exclusively south of 23 °N would be affected by the regulations.

Assuming that side setting is feasible for all vessels in the longline fleet and given the possibility of financial assistance to mitigate conversion costs, this analysis assumed that a requirement to side set would not restrict fishing opportunities for any vessel. Under this scenario the predicted compliance costs for the Hawaii-based longline fleet under Alternative 8B include $572,000 for installation/set-up costs and $228,590 for annual costs (Table 43). In comparison to Alternative 1, this represents a $572,000 increase in installation/set-up costs and a $139,798 increase in annual costs. The negative economic impacts of this alternative would be higher if the requirement to side set eliminates pelagic longlining opportunities for vessels that can not be readily reconfigured for side setting.

Table 43. Predicted Costs Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 8B. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna	All	Current Methods and Side Setting	100	122	12,165	$488,000	$194,710
Swordfish	All	Current Methods and Side Setting	100	21	2,120	$84,000	$33,880
					Total	$572,000	$228,590

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 9A: Use side setting north of 23°N

Assuming that side setting is feasible for all vessels in the longline fleet and given the possibility of financial assistance to mitigate conversion costs, this analysis assumed that a requirement to side set would not restrict fishing opportunities for any vessel. Under this scenario the economic effects of this alternative would be similar to those described for Alternative 8A; the primary difference would be that fishermen would not incur the costs and operational difficulties of using the current mitigation methods. The predicted compliance costs for the Hawaii-based longline fleet under Alternative 9A include $528,000 for installation/set-up costs and $6,600 for annual costs (Table 44). In comparison to Alternative 1, this represents a $528,000 increase in installation/set-up costs and a $82,192 decrease in annual costs.

Table 44. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 9A. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna	North of 23°N	Side Setting	100	111	3,090	$444,000	$5,550
Swordfish	North of 23°N	Side Setting	100	21	1,838	$84,000	$1,050
					Total	$528,000	$6,600

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 9B: Use side setting in all areas

Assuming that side setting is feasible for all vessels in the longline fleet and given the possibility of financial assistance to mitigate conversion costs, this analysis assumed that a requirement to side set would not restrict fishing opportunities for any vessel. Under this scenario the economic effects of this alternative would be similar to those described for Alternative 8B; the primary difference would be that fishermen would not incur the costs and operational difficulties of using the current mitigation methods. The predicted compliance costs for the Hawaii-based longline fleet under Alternative 9B include $572,000 for installation/set-up costs and $7,150 for annual costs (Table 45). In comparison to Alternative 1, this represents a $572,000 increase in installation/set-up costs and a $81,642 decrease in annual costs.

Table 45. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 9B. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna	All	Side Setting	100	122	12,165	$488,000	$6,100
Swordfish	All	Side Setting	100	21	2,120	$84,000	$1,050
					Total	$572,000	$7,150

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 10A: Use side setting unless technically infeasible in which case use current methods north of 23°N

As noted above, it is assumed here for the purposes of this analysis that side setting can be employed on all vessels in the Hawaii longline fleet (Gilman et al., 2003); however, reconfiguring some vessels for side setting may be especially costly and was thought to be infeasible on some vessels by some local informants. Consequently, this analysis assumed that 5% of the active longline vessels would choose to use the current methods. Under this scenario the economic effects of this alternative would be similar to those described for Alternative 2A the predicted compliance costs for the Hawaii-based longline fleet under Alternative 10A include $500,000 for installation/set-up costs and $10,758 for annual costs (Table 46). In comparison to Alternative 1, this represents a $500,000 increase in installation/set-up costs and a $78,034 decrease in annual costs.

Table 46. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 10A. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna	North of 23°N	Side Setting	95	105	2,935	$420,000	$5,250
		Current Methods	5	6	155	$0	$3,070
Swordfish	North of 23°N	Side Setting	95	20	1,746	$80,000	$1,000
		Current Methods	5	1	92	$0	$1,438
					Total	$500,000	$10,758

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 10B: Use side setting unless technically infeasible in which case use current methods in all areas

The economic effects of this alternative would be similar to those described for Alternative 2B. The predicted compliance costs for the Hawaii-based longline fleet under Alternative 10B include $544,000 for installation/set-up costs and $17,846 for annual costs (Table 47). In comparison to Alternative 1, this represents a $544,000 increase in installation/set-up costs and a $70,946 decrease in annual costs.

Table 47. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 10B. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna		Side Setting	95	116	11,557	$464,000	$5,800
	All	Current Methods	5	6	608	$0	$9,412
Swordfish	All	Side Setting	95	20	2,014	$80,000	$1,000
		Current Methods	5	1	106	$0	$1,634
					Total	$544,000	$17,846

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 11A: Use side setting unless technically infeasible, in which case use an underwater setting chute or a tori line or current measures without blue bait or strategic offal discards (shallow-setting vessels set at night, deep-setting vessels use line shooters with weighted branch lines), when fishing north of 23°N

The economic effects of this alternative would be similar to those described for Alternative 6A; the primary difference would be that those fishermen that choose to use the current mitigation methods would not incur the costs and operational difficulties of using blue-dyed bait and strategic offal discards. The predicted compliance costs for the Hawaii-based longline fleet under Alternative 11A include $503,000 for installation/set-up costs and $15,700 for annual costs (Table 48). In comparison to Alternative 1, this represents a $503,000 increase in installation/set-up costs and a $73,092 decrease in annual costs.

Table 48. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 11A. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna	North of 23°N	Side Setting	95	105	2,935	$420,000	$5,250
		Current Methods wo/BDB&SOD	2	2	62	$0	$0
		Underwater Chute	1	1	31	$1,000	$250
		Tori Line	2	2	62	$2,000	$9,200
Swordfish	North of 23°N	Side Setting	95	20	1,746	$80,000	$1,000
		Current Methods wo/BDB&SOD[1]	2	0	37	$0	$0
		Underwater Chute[1]	1	0	18	$0	$0
		Tori Line[1]	2	0	37	$0	$0
					Total	$503,000	$15,700

[1]The number of vessels that choose this mitigation method is too small to calculate compliance costs.

Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Alternative 11B: Use side setting unless technically infeasible, in which case use an underwater setting chute or a tori line or current measures without blue bait or strategic offal discards (shallow setting vessels set at night, deep setting vessels use line shooters with weighted branch lines), in all areas

The economic effects of this alternative would be similar to those described for Alternative 6B; the primary differences would be that those fishermen that choose to use the current mitigation methods would not incur the costs and operational difficulties of using blue-dyed bait and strategic offal discards. The predicted compliance costs for the Hawaii-based longline fleet under Alternative 11B include $547,000 for installation/set-up costs and $16,250 for annual costs (Table 49). In comparison to Alternative 1, this represents a $547,000 increase in installation/set-up costs and a $72,540 decrease in annual costs.

Table 49. Predicted Costs of Mitigation Methods to Reduce Seabird Interactions in the Hawaii-based Longline Fishery Under Alternative 11B. (Source: NMFS 2005)

Vessel Type	Area Where Mitigation Method Applies	Mitigation Method	Percentage of Vessels Choosing Mitigation Method	Projected No. of Affected Vessels	Projected No. of Affected Sets	Projected Installation/ Set-up Costs	Projected Annual Costs
Tuna	All	Side Setting	95	116	11,558	$464,000	$5,800
		Current Methods wo/BDB&SOD	2	2	243	$0	$0
		Underwater Chute	1	1	122	$1,000	$250
		Tori Line	2	2	243	$2,000	$9,200
Swordfish		Side Setting	95	20	2,014	$80,000	$1,000
		Current Methods wo/BDB&SOD[1]	2	0	42	$0	$0
		Underwater Chute[1]	1	0	21	$0	$0
	All	Tori Line[1]	2	0	42	$0	$0
					Total	$547,000	$16,250

[1]The number of vessels that choose this mitigation method is too small to calculate compliance costs.

Alternative 12: Voluntarily use night-setting or underwater chute or tori line (e.g., paired streamer lines) or line shooter with weighted branch lines south of 23°N

The economic effects of this alternative would be similar to those described for Alternative 1. It is unlikely that any fishing enterprises that experience significant negative economic effects from the use of voluntary mitigation methods would continue to employ those methods. Given the costs and operational difficulties of using an underwater chute or tori line, it is unlikely that many, if any, vessels would voluntarily adopt these mitigation methods. Vessels that do not already use night-setting would likely be hesitant to adopt this fishing practice because of concerns that it would decrease catch rates of certain target species and could be dangerous if vessels are not suitably equipped. Most longline vessels fishing south of 23°N already use a line shooter with weighted branch lines, as this gear increases the speed at which the mainline is set, thereby causing the mainline to sag in the middle and allowing the middle hooks to fish deeper. Vessels that do not already use a line-shooter with weighted branch lines are unlikely to voluntarily adopt this gear solely for the purpose of reducing seabird interactions because of the high costs of the gear. Impacts on fishing communities would be similar to those under Alternative 1. The sustained participation of MSA fishing communities in Western Pacific pelagic fisheries would be unaffected.

Table 50 summarizes the above information for each deterrent concerning cost to fishery participants. Table 51 presents similar information but costs are presented on a fishery wide basis rather than per vessel.

Table 50. Summary of Costs Per Vessel of Deterrent Measures

Seabird deterrent	Cost per vessel
Thawed blue-dyed bait	$1,400 annual
Strategic offal discards	$150 initial plus $150 annual
Line shooter with weighted branch lines (on tuna vessels)	already purchased ($5,700 initial plus $2,400 annual)
Tori line	$3,300 initial plus $4,600 annual (2 lines)
Night setting (on swordfish vessels)	$0
Underwater setting chute	$6,000 initial
Side setting (+ 60g swivels within 1m of the hook)	$4,000 initial plus $50 annual

Table 51 Summary of Fleet-wide Quantitative Appraisals of the Alternatives

Alternative	Initial costs	Annual costs	Projected number of interactions
1: all vessels set deep or at night and use blue bait and strategic offal discards (SOD), north of 23 °N – (NO ACTION: Current Measures)	$0	$88,792	97
2A: all vessels side-set, or set deep or at night and use blue bait and SOD, north of 23 ° N	$476,000	$14,802	11
2B: all vessels side-set, or set deep or at night and use blue bait and SOD, in all areas	$516,000	$28,556	6
3A: all vessels use underwater setting chute, or set deep or at night and use blue bait and SOD, north of 23 ° N	$119,000	$38,602	146
3B: all vessels use underwater setting chute, or set deep or at night and use blue bait and SOD, in all areas	$129,000	$54,356	73
4A: all vessels use tori lines, or set deep or at night and use blue bait and SOD, north of 23 ° N	$119,000	$556,252	311
4B: all vessels use tori lines, or set deep or at night and use blue bait and SOD, in all areas	$129,000	$615,506	248
5A: all vessels side-set or use underwater setting chute or, set deep or at night and use blue bait and SOD, north of 23 ° N	$437,000	$17,402	27
5B: all vessels side-set or use underwater setting chute or, set deep or at night and use blue bait and SOD, in all areas	$474,000	$31,356	13

Alternative	Initial costs	Annual costs	Projected number of interactions
6A: all vessels side-set or use underwater setting chute or tori lines, or set deep or at night and use blue bait and SOD, north of 23° N	$398,000	$76,552	59
6B: all vessels side-set or use underwater setting chute or tori lines, or set deep or at night and use blue bait and SOD, in all areas	$428,000	$95,006	39
7A: all vessels side-set or use tori lines, or set deep or at night and use blue bait and SOD, north of 23° N	$437,000	$73,952	46
7B: all vessels side-set or use tori lines, or set deep or at night and use blue bait and SOD, in all areas	$474,000	$92,256	32
7C: shallow-set vessels side-set, or use underwater setting chute or tori lines or night set, in all areas; deep-set vessels side-set, or use underwater setting chute or tori lines, north of 23° N	$398,000	$69,650	61
7D: shallow-set vessels side-set or set at night and use tori lines and blue bait and modified SOD, in all areas; deep-set vessels side-set, or use tori lines and blue bait and modified SOD, north of 23° N	$507,000	$43,154	6
8A: all vessels side-set and set deep or at night and use blue bait and SOD, north of 23° N	$528,000	$95,392	0
8B: all vessels side-set and set deep or at night and use blue bait and SOD, in all areas	$572,000	$228,590	0
9A: all vessels side-set north of 23° N	$528,000	$6,600	2
9B: all vessels side-set in all areas	$572,000	$7,150	3
10A: all vessels side-set if feasible, otherwise set deep or at night and use blue bait and SOD, north of 23° N	$500,000	$10,758	7
10B: all vessels side-set if feasible, otherwise set deep or at night and use blue bait and SOD, in all areas	$544,000	$17,846	4
11A: all vessels side-set if feasible, otherwise use underwater setting chute, or tori lines, or set deep or at night, north of 23° N	$503,000	$15,700	23
11B: all vessels side-set if feasible, otherwise use underwater setting chute, or tori lines, or set deep or at night, in all areas	$547,000	$16,250	18
12: all vessels voluntarily night set, use underwater setting chute or tori line, or set deep south of 23° N	$0	$88,792	80

10.7.10 Conclusions

The costs presented in Tables 49 and 50 are summarized from the analyses in Section 10.7.9. The projected numbers of interactions are summarized from Table 24 in Section 10.7.8. The qualitative evaluations of the operational characteristics and compliance criteria for the deterrent measures are presented in Table 1. In comparing the ratings of the qualitative criteria with the projections of interactions, a general correlation is seen. The deterrents rated lowest qualitatively are associated with those alternatives (3A, 3B, 4A and 4B) with the highest projected numbers of seabird interactions (range: 73-311). Deterrents with intermediate qualitative ratings are associated with alternatives (1 and 12) that had lower, but still relatively high, interaction projections (range: 80-97). Alternatives in those two categories were therefore be discounted on the basis of both poor qualitative characteristics and low seabird interaction avoidance efficacy.

The remainder of the deterrents (and associated alternatives) were rated highly against the qualitative criteria, primarily because side-setting had the highest efficacy rate. Within that group of alternatives, those mandating the use of side-setting (8A, 8B, 9A, 9B) had the highest initial costs (range: $528,000-$572,000). These latter alternatives were discounted on the basis of their high initial costs, but perhaps more importantly because they mandate the use of a measure (side-setting) that has undergone only very limited testing. While results with this measure have been very promising, it is appropriate to gather more performance data under actual fleet operating conditions before mandating its universal application.

On the basis of cost-effectiveness, the "B" versions of alternatives 2, 5, 6, 7, 10, and 11 had higher initial and annual costs than the "A" versions, while offering modest reductions of projected seabird interactions, and thus they were discounted.

Several of the remaining alternatives (6A, 7A, and 7C) would permit the use of tori lines without other interaction avoidance measures. Although tori lines may be further developed to function more effectively in the Hawaii longline fishery, the available experimental efficacy value is the lowest of those measures considered here. These alternatives would have the potential to reduce interaction avoidance efficacies compared to currently required measures, and would not satisfy that aspect of the action objective. They were consequently discounted.

That leaves a short-list of three alternatives, 2A, 5A and 7D, that best meet the action objectives. Alternative 2A offers side-setting as an option to using currently required measures. This alternative recognizes the potential operational and seabird interaction reduction benefits of side-setting, while maintaining flexibility for individual vessel operators and recognizing that it may be premature to mandate the use of side-setting throughout the fleet. Alternative 5A is identical to 2A except that it offers the additional option to use underwater setting chutes. Setting chutes have shown high interaction avoidance efficacies in trials, but they have also suffered from structural failures which seriously compromised their interaction avoidance efficacies as well as their fishing efficiencies. It would seem that authorization of their use as a substitute for currently required measures in the Hawaii longline fleet is premature, and should be delayed pending further design development and testing.

That leaves Alternatives 2A and 7D as the best choices. Alternative 7D is the Preferred Alternative. Although its costs are somewhat higher than those of Alternative 2A, its projected seabird interactions are lower. Alternative 7D was designed to improve on Alternative 2A in several ways. Like Alternative 2A, it offers the option of using side-setting in place of currently required interaction avoidance measures. However, it strengthens the incentive to use side-setting by requiring mandatory use of tori lines along with currently required measures if side-setting is not used. Thus, this alternative has the potential to improve upon the efficacy of currently required measures regardless of which option is adopted by a given vessel. In addition, Alternative 7D requires all shallow-setting vessels to use interaction avoidance measures wherever they fish, not just north of 23°N, as in Alternative 2A. As this sector of the fleet will have 100% observer coverage, implementation of Alternative 7D will also provide comprehensive data on the efficacy of the measures employed in areas where seabirds are abundant or not. Alternative 7D also encourages the use of side-setting in the deep-setting sector of the fishery by requiring mandatory use of tori lines along with currently required measures if side-setting is not used at latitudes above 23°N, where seabirds and interactions are most prevalent. On the other hand, it does not impose measures on deep-setting vessels fishing south of 23°N. Cost-effectiveness of the alternative is supported because deep sets in the south are the most common type of set, and they have the lowest historical rate of seabird interaction per set. Deep-setting vessels fishing south of 23°N, a category that includes the smallest vessels in the fleet (Appendix II), would thus retain the option to fish without employing seabird interaction avoidance measures if they fished exclusively south of 23°N.

11.0 Consistency with other Laws and Statutes

11.1 National Standards for fishery conservation and management

National Standard 1 states that conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.

The preferred alternative is not expected to have a significant effect on fish stocks or optimum yield. The deployment of seabird mitigation measures on Hawaii pelagic longline vessels will result in the same or possibly slightly elevated levels of catch of target species, but these are an insignificant fraction of the total harvest of tuna and tuna-like species across the Pacific Ocean.

National Standard 2 states that conservation and management measures shall be based upon the best scientific information available.

The preferred alternative is based on scientifically conducted trials and observations of seabird mitigation measures in the Hawaii longline fishery and in longline fisheries in Australia and New Zealand.

National Standard 3 states that, to the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

The preferred alternative is not expected to have a significant effect on the management of fish stocks as a unit.

National Standard 4 states that conservation and management measures shall not discriminate between residents of different States. If it becomes necessary to allocate or assign fishing *privileges among various United States fishermen, such allocation shall be (A) fair and equitable to all such fishermen; (B) reasonably calculated to promote conservation; and (C) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.*

The preferred alternative does not discriminate between residents of different States or allocate fishing privileges among fishermen.

National Standard 5 *states that conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.*

The preferred alternative is expected to increase fishing efficiency by providing cost-effective alternatives to currently required seabird mitigation measures.

National Standard 6 *states that conservation and management action shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources and catches.*

The preferred alternative considers variation among fisheries by allowing fishermen to choose between several mitigation measures.

National Standard 7 *states that conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.*

The preferred alternative is expected to minimize costs by allowing fishermen to select a mitigation measure based on their vessel's characteristics and operational profile.

National Standard 8 *states that conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities.*

The preferred alternative is not expected to have a significant effect on the sustained participation of fishing communities

National Standard 9 *states that conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided minimize the mortality of such bycatch.*

The preferred alternative is not expected to significantly change the catch composition of the Hawaii longline fleet or increase its levels of fish or other bycatch. It is anticipated to maintain or improve on recent reductions in the incidental catch of seabirds and to have neutral effects on fishery interactions with marine mammals.

National Standard 10 states that conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

Some fishermen have expressed concern about the use of 60g weighted swivels in association with side setting. However, these weights are already being used by many of the vessels currently fishing in Hawaii. The use of equipment such as a tori line requires monitoring to work effectively, which may increase the potential for injury or accidents during longline deployment. However, the preferred alternative is designed to give fishermen the flexibility to choose those measures they prefer, and with which they would feel most comfortable aboard their vessel from a safety perspective.

11.2 Essential Fish Habitat

See section 10.7.3.

11.3 Regulatory Flexibility Act

See Appendix III

11.4 Executive Order 12866

See Appendix III

11.5 Coastal Zone Management Act

The Coastal Zone Management Act requires a determination that a recommended management measure has no effect on the land or water uses or natural resources of the coastal zone or is consistent to the maximum extent practicable with an affected state's approved coastal zone management program. A copy of this document will be submitted to the appropriate state government agency in Hawaii for review and concurrence with a determination that the recommended measure is consistent, to the maximum extent practicable, with the state coastal zone management program.

11.6 Endangered Species Act

Species listed as endangered or threatened under the Endangered Species Act (ESA) that have been observed in the area where fishing vessels managed under the Pelagics FMP operate are as follows:

Species listed as endangered
Short-tailed albatross (*Phoebastria albatrus*)
Hawaiian monk seal (*Monachus schauinslandi*)
Pacific olive ridley turtle *(Lepidochelys olivacea)* –Mexico nesting population
Leatherback turtle (*Dermochelys coriacea*)
Hawksbill turtle (*Eretmochelys imbricata*)
Green turtle (*Chelonia mydas*) - Florida and Pacific coast of Mexico breeding populations only

Humpback whale (*Megaptera novaeangliae*)
North Pacific Right Whale (*Eubalaena japonica*)
Sperm whale (*Physeter macrocephalus*)
Blue whale (*Balaenoptera musculus*)
Fin whale (*B. Physalus*)
Sei whale (*B. Borealis*)

Species listed as threatened
Loggerhead turtle (*Caretta caretta*)
Asian stocks of Pacific olive ridley (*Lepidochelys olivacea*) and green turtles (*Chelonia mydas*)

The only listed or candidate species of seabirds that may interact with the fisheries managed under the Pelagics FMP is the short-tailed albatross, however, no interactions have been observed for any fishery sectors. Other listed species known to interact with the Hawaii longline fishery and which may potentially interact with other fisheries managed under the Pelagics FMP are the leatherback turtle, loggerhead turtle, green turtle, olive ridley turtles, and hawksbill turtles. Several Hawaii-based small troll vessels have reportedly had interactions with humpback whales.

A Biological Opinion completed by NMFS in February 2004 (NMFS 2004b), which applied to turtles and marine mammals listed under the Endangered Species Act (ESA) concluded that the fisheries managed under the Pelagics Fishery Management Plan are not likely to jeopardize the continued existence of threatened and endangered species in the Western Pacific. In October 2004, the USFWS published a section 7 consultation under the ESA on the reopening of the swordfish segment of the Hawaii-based longline fishery. Although the consultation was concerned primarily with the introduction of circle hooks and mackerel bait in the fishery, and its likely potential impact on the short-tailed albatross, the BiOp also took into consideration the development of new mitigation techniques such as side setting. Consequently, despite a no jeopardy conclusion, the reasonable and prudent measures in the October 2004 BiOp require NMFS to implement side setting, or other equally more effective measures to minimize the risk of incidental takes of short tailed albatrosses by August 30, 2005. Although developed prior to the release of the USFWS 2004 BiOp, the Council, believes that this regulatory amendment will bring the Pelagics FMP into compliance with that BiOp.

11.7 Marine Mammal Protection Act

The Hawaii-based longline fishery is classified as Category I under section 118 of the Marine Mammal Protection Act of 1972. As a Category I fishery, operators of vessels registered to Hawaii longline permits must submit federal logbooks and reports of injuries to marine mammals to NMFS, and carry observers if requested by NMFS.

Marine mammals not listed as endangered or threatened under the Endangered Species Act that have been observed in the area where fisheries managed under the Pelagics FMP operate are as follows:

Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)
Rough-toothed dolphin (*Steno bredanensis*)
Risso's dolphin (*Grampus griseus*)
Bottlenose dolphin (*Tursiops truncatus*)
Pantropical spotted dolphin (*Stenella attenuata*)
Spinner dolphin (*Stenella longirostris*)
Striped dolphin (*Stenella coeruleoalba*)
Melon-headed whale (*Peponocephala electra*)
Pygmy killer whale (*Feresa attenuata*)
False killer whale (*Pseudorca crassidens*)
Killer whale (*Orcinus orca*)
Pilot whale, short-finned (*Globicephala melas*)
Blainville's beaked whale (*Mesoplodon densirostris*)
Cuvier's beached whale (*Ziphius cavirostris*)
Pygmy sperm whale (*Kogia breviceps*)
Dwarf sperm whale (*Kogia simus*)
Bryde's whale (*Balaenoptera edeni*)

As noted in Section 9.1.4.2, it is unlikely that the proposed management measure in this document would have an impact on any species of marine mammals that occur in the Western Pacific region. Additionally, based on a review of the available scientific and commercial data, the current status of marine mammals, and the environmental baseline for the action area presented in other sections of this document, the preferred alternative is not anticipated to result in adverse impacts to these marine mammal populations. A Biological Opinion completed by NMFS in February 2004 (NMFS 2004b), which applied to marine mammals listed under the ESA, as well as turtles, concluded that the fisheries managed under the Pelagics Fishery Management Plan are not likely to jeopardize the continued existence of threatened and endangered species in the Western Pacific.

12.0 References

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