Western Pacific
Regional Fishery
Management Council

MANAGEMENT MEASURES TO IMPLEMENT NEW TECHNOLOGIES FOR THE WESTERN PACIFIC PELAGIC LONGLINE FISHERIES

A REGULATORY AMENDMENT TO THE FISHERY MANAGEMENT PLAN FOR THE PELAGIC FISHERIES OF THE WESTERN PACIFIC REGION

INCLUDING A FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

March 5, 2004

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Western Pacific Regional Fishery Management Council

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Abstract: This document considers management measures for the longline fisheries managed under the Pelagic Fisheries Management Plan of the Western Pacific Region, with the objective of achieving optimum yields from these fisheries without being likely to jeopardize the continued existence of sea turtles or other listed species. The range of alternatives includes time/area closures, as well as the implementation of a limited model shallow-set swordfish fishery using circle hooks with mackerel bait which in combination have been found to reduce interactions with leatherback and loggerhead turtles by 67% and 92% respectively in the U.S. Atlantic longline fishery. In addition the document considers a suite of conservation projects to protect sea turtles in their nesting and coastal habitats.

March 5, 2004

2.0 Summary

The regulatory aspects of this amendment to the regulations implementing the Fishery Management Plan for the Pelagics Fisheries of the Western Pacific Region would:

1) Establish an annual limit on the amount of shallow-set longline fishing effort north of the equator that may be collectively exerted by Hawaii-based longline vessels (2,120 shallow-sets per year);
2) divide and distribute this shallow-set effort limit each calendar year in equal portions (in the form of transferable single-set certificates valid for a single calendar year) to all holders of Hawaii longline limited access permits that respond positively to an annual solicitation of interest from NMFS;
3) prohibit any Hawaii-based longline vessel from making more shallow-sets north of the equator during a trip than the number of valid shallow-set certificates on board the vessel;
4) require that operators of Hawaii-based longline vessels submit to the Regional Administrator within 72 hours of each landing of pelagic management unit species one valid shallow-set certificate for every shallow-set made north of the equator during the trip;
5) require that Hawaii-based longline vessels, when making shallow-sets north of the equator, use only circle hooks sized 18/0 or larger with a 10-degree offset;
6) require that Hawaii-based longline vessels, when making shallow-sets north of the equator, use only mackerel-type bait;
7) establish annual limits on the numbers of interactions between leatherback and loggerhead sea turtles and Hawaii-based longline vessels while engaged in shallow-setting (set equal to the annual estimated incidental take for the respective species in the shallow-set component of the Hawaii-based fishery, as established in the prevailing biological opinion issued by the National Marine Fisheries Service (NMFS, also known as NOAA Fisheries) pursuant to section 7 of the Endangered Species Act);
8) establish a procedure for closing the shallow-setting component of the Hawaii-based longline fishery for the remainder of the calendar year when either of the two limits is reached, after giving 1 week advanced notice of such closure to all holders of Hawaii longline limited access permits (the numbers of interactions will be monitored with respect to the limits using year-to-date estimates derived from data recorded by NMFS vessel observers);
9) require that operators of Hawaii-based longline vessels notify NMFS in advance of every trip whether the longline sets made during the trip will involve shallow-setting or deep-setting and require that Hawaii-based longline vessels make sets only of the type declared (i.e., shallow-sets or deep-sets);
10) require that operators of Hawaii-based longline vessels carry and use NMFS-approved de-hooking devices; and
11) require that Hawaii-based longline vessels, when making shallow-sets north of 23° N. start and complete the line-setting procedure during the nighttime (specifically, no earlier than one hour after local sunset and no later than local sunrise).

On March 29, 2001, the National Marine Fisheries Service (NMFS) issued a Biological Opinion under section 7 of the Endangered Species Act for the authorization of fisheries under the Pelagics Fishery Management Plan (FMP) of the Western Pacific Region. The Biological Opinion (BiOp) contained a series of non-discretionary actions (Reasonable and Prudent Alternative) to mitigate interactions between the Hawaii-based longline fishery and sea turtles. At the 110th Council Meeting held June 18-21, 2001, staff of the Western Pacific Regional Fishery Management Council (WPRFMC or Council) were directed to prepare a regulatory amendment recommending implementation of the Reasonable and Prudent Alternative (RPA) as required under the Endangered Species Act (ESA). This recommendation was prepared, and it was implemented by NMFS on June 12, 2002. New measures included a ban on the use of shallow-set swordfish longline fishing north of the equator and a seasonal area closure from 15° N. lat. to the equator and from 145° W. long. to 180° long. during April and May for any longline vessel fishing under the authority of the FMP.

On December 12, 2001, NMFS reinitiated section 7 consultation on the Western Pacific Region's pelagic fishery. This reinitiation was based on new information that could improve the agency's ability to quantify and evaluate the effects of the fishery on listed sea turtle populations, as well the economic impacts of the implementation of the March 2001 RPA. At the conclusion of this reconsultation NMFS issued a new BiOp (November 15, 2002), which maintained the June 12, 2002 regulations including the ban on shallow-setting north of the equator and the April-May southern area closure.

At its 118th meeting in June 2003, the Council reviewed a number of potential modifications to the southern area closure to determine whether modifications could be made to support the economic viability of the fleet without jeopardizing sea turtles. The Council subsequently directed its staff to continue its preparation of a regulatory amendment to the Pelagics FMP containing a further range of alternatives and the impacts of those alternatives on sea turtles, fisheries, and the environment. The Council anticipated selecting a final preferred alternative at its 119th Council meeting, which would then be transmitted to NMFS for review and approval with the intention of implementing this change prior to the 2004 seasonal longline area closure.

However, on August 31, 2003, the Federal Court vacated the 2002 BiOp and the regulations put in place in June 2002. Consequently at its 119th meeting on September 23, 2003, the Council voted to recommend an emergency action which would allow a model swordfish longline fishery north of the equator at 75% of historic (1994-1998 average annual) swordfish levels of effort (sets) in conjunction with fishing experiments that stay within the anticipated takes in the model fishery. The fishery would only be allowed to operate with circle hooks instead of J-hooks and mackerel bait instead of squid, measures proven successful in minimizing leatherback and loggerhead interactions in the Atlantic Ocean. The emergency action would also require mandatory night setting for vessels shallow-setting fishing north of 23° N, implement a "hard limit" for turtle interactions, and would not include any time/area closures. Under this approach, the swordfish fishery would be closed annually upon exceeding its incidental take statement (rather than just reinitiating consultation) or when it reaches its effort limit (75% of historic effort or 3,200 sets). In addition, the Hawaii-based tuna and swordfish fisheries would have separate incidental take statements, the hard limit detailed above would apply only to the swordfish fishery. All longline vessels (tuna and sword) would be obliged to carry and use effective dehooking devices. Finally, a series of non-regulatory conservation measures designed to protect sea turtles on nesting beaches and in coastal waters would be pursued to mitigate fishery impacts. Looking ahead, the Council also created a special advisory committee to include scientists, managers, industry and conservation groups who would work together to develop and recommend to the Council measures for the long-term management of this fishery.

On October 6, 2003, the Federal Court stayed the execution of the August 31, 2003 order until April 1, 2004 to allow NMFS time to develop a new BiOp and hopefully render a more permanent solution than interim or emergency measures. The purpose of this amendment is thus to provide recommended measures for the long-term management of the Hawaii-based longline fishery.

At its 120th meeting (October 20, 2003), the Council rejected a request from NMFS that it withdraw its recommendation for emergency measures (transmitted to NMFS for implementation on October 10, 2003) on the basis that the stay through April 1, 2004 eliminated the need for emergency action. NMFS also requested that the Council work to develop and transmit a complete long-term rule package to NMFS by December 1, 2003 so that it could be processed and implemented by April 1, 2004. In response, the Council directed its staff to continue development of this long-term rule package through a series of meetings of the special advisory committee, workshops and seminars, and preparation of an appropriate NEPA document, with the goal of meeting the December 1 deadline. However, given the abbreviated time available, the Council declined to withdraw the emergency rule package, instead recommended that if the long-term rule package is not completed according to NMFS' schedule, NMFS should process the Council's emergency rule for implementation by April 1, 2004.

The Council's Sea Turtle Conservation Special Advisory Committee held a series of three meetings to craft recommendations for further analysis and possible Council action. Committee membership included representation from fishery managers, scientists, industry, and environmental organizations. The Committee's first two meetings resulted in five potential alternatives that were submitted to NMFS' Office of Protected Resources (OPR) for their review and feedback. At the Committee's third and last meeting, OPR's comments were circulated and discussed. In summary, OPR ranked the proposed action as representing the second lowest risk of the five alternatives considered. This assessment was based on the fact that although other alternatives would have similar anticipated interactions, under the proposed action a greater percent of loggerhead and green turtle interactions would be expected to involve shallow-set longline gear (with circle hooks and mackerel-type bait) which would minimize potential harm to these species.

Because the impetus for this action is concern for fishery interactions with sea turtles, and because the FMP's Hawaii-based longline fishery is the only one thought to interact significantly with sea turtles (see Sections 9.1.4.9 to 9.1.4.11) these alternatives focus on that fishery. No alternatives would allow general longline permit holders to participate in the Hawaii-based longline fishery (meaning to fish in Hawaii's EEZ or to land fish in Hawaii) without obtaining a Hawaii longline limited access permit. Thus, under all alternatives, the management of all other fisheries would remain unchanged, except for general longline permit holders.

This document includes a range of alternatives for the long-term management of the longline fisheries managed under the Council's Pelagics Fishery Management Plan. These alternatives supplement those described in NMFS' 2001 Final Environment Impact Statement (FEIS) for the Pelagic Fisheries of the Western Pacific Region through the examination of an additional range of levels of swordfish fishing, in conjunction with circle hooks and mackerel-type bait which have recently been shown to be effective in reducing sea turtle interactions, while maintaining swordfish catch rates.

A number of alternatives previously considered by the Council are also described in this document, but not analyzed in detail, as the Council's focus for final action at its 121st meeting was those alternatives recently recommended by its Turtle Conservation Special Advisory Committee. Please see the Council's October 9, 2003 document *Emergency Rule Package of the Management of Pelagic Fisheries under the Pelagic Fisheries Management Plan of the Western Pacific Region* for a detailed description and analysis of 18 additional action alternatives recently considered by the Council. A total of six alternatives were recommended for detailed analysis by Committee members, and a seventh, a 'no action' alternative, was added at the request of NMFS' acting Regional Administrator for the Pacific Islands Region. These seven alternatives are the subject of this document. These alternatives range from a tuna only (no swordfish fishing) fishery (Committee Alternative 6), to one in which there are no constraints on swordfish fishing beyond the existing limited entry program and maximum vessel size limits (Alternative 7, the no action alternative). Those aspects of the alternatives related to fishery management are summarized in Table 1, while the non-regulatory continuing conservation measures that are part of all action alternatives are presented in Section 8.2.

On November 25, 2003, the Council held its 121st meeting via teleconference at the Council's Honolulu office. This was an emergency meeting and the measures discussed here were its sole focus. The Council's November 18, 2003 draft document *An Amendment to the Pelagics Fishery Management Plan of the Western Pacific Region, Long-Term Management Measures of the Western Pacific Pelagic Fisheries (Including a Draft Preliminary Draft Supplemental Environmental Impact Statement)* was distributed at this meeting as well as made available on the Council's website. The Council also reviewed the Committee's alternatives and estimates of their relative impacts. The Council's final action on this measure was to recommend that NMFS now allow 2,120 swordfish sets to be made annually by Hawaii longline limited access permit holders to model the use of circle hooks with mackerel-type bait, dehookers and other new technologies shown to reduce and mitigate interactions with sea turtles, in addition to a continued

Table 1. Summary of Hawaii longline fishery management alternatives analyzed in detail for consideration by the Council

Committee Alternative	Tuna Fishery?	Model Swordfish Fishery - with circle hooks and mackerel bait?	Dehooker, (and line cutter, dip net and bolt cutters) required?	Conservation measures?
1	Yes, with no time/area closure	Yes, 1,060 sets annually	Yes	Yes
2	Yes, with no time/area closure	Yes, 1,560 sets	Yes	Yes
3	Yes, with recent time/area closure except for EEZ waters around Palmyra	Yes, 2,120 sets annually	Yes	Yes
4 Preferred Alternative	Yes, with no time/area closure	Yes, 2,120 sets annually	Yes	Yes
5	Yes, with no time/area closure	Yes, 3,179 sets annually	Yes	Yes
6 Current Fishery	Yes, with recent time/area closure	No	Yes, except for dehooker	Yes
7 No Action	Yes, with no time/area closure	Yes, no specific limits	Yes, except for dehooker	No

tuna fishery with no time/area closures, the mandated use of dehookers, and the continuation of a suite of conservation measures (Alternative 4). These conservation measures include protection of potentially affected turtles and eggs at nesting beaches and in coastal foraging waters in various areas throughout the Pacific. Based on information from NMFS' Pacific Islands Fishery Science Center and NMFS' Office of Protected Resources, as well as consideration of the conservation measures that are part of Alternative 4, the Council believes this alternative will best meet this action's objective of achieving optimum yields from the fisheries without jeopardizing sea turtles or other listed species.

All alternatives, apart from Alternative 6, would permit shallow-set swordfish style fishing by vessels with a Western Pacific general longline permit. American Samoa longline vessels currently fish under a general permit, but a limited entry program for this fishery is currently nearing completion. American Samoa vessels could conceivably fish north of the equator and make shallow sets for swordfish but have no history of doing so. Moreover, the American Samoa fleet targets primarily albacore for the two fish canneries in Pago Pago, and there is little to no market for fresh swordfish in American Samoa. More importantly, there is no easy access to markets elsewhere on the U.S. mainland, unlike Hawaii, where most of the swordfish catch was sent. Two general longline permits have been issued in the Mariana Islands, one in Guam and the other in Commonwealth of the Northern Mariana Islands (CNMI). Neither permit is being used to conduct longline fishing from these locations. Based on historical data from other fleets, any longline fishing conducted around the Marianas would target tunas and not swordfish. Vessels with a Western Pacific general permit may not land longline caught fish in Hawaii.

On December 3, 2003 (68 FR 67640), the Council and NMFS published a Supplemental Notice of Intent to prepare the SEIS for this action, along with public notice of a compressed schedule under alternative procedures approved by the Council on Environmental Quality (CEQ). This notice furnished additional information on the need for expedited management action on proposed management measures for the Hawaii-based longline fishery and it's potential impact on protected sea turtle populations. The accelerated management action schedule avoids a lapse in appropriate management measures after April 1, 2004. It further announced the Council and NMFS' intent to apply alternative procedures approved by the CEQ to facilitate completion of the SEIS on the proposed management measures for the Hawaii-based longline fishery for implementation of rules effective by April 1, 2004.

Since the completion of the Draft SEIS for this action, NMFS' Office of Protected Resources completed its section 7 consultation and issued a Biological Opinion on the preferred alternative presented here. That Opinion (attached as Appendix V) concluded that the preferred alternative, in conjunction with three measures which are expected to be implemented through future rule-making within the next year, is not likely to jeopardize the continued existence of sea turtles or other species listed as threatened or endangered under the Endangered Species Act. This process is described in detail in Section 14.0.

3.0 Table of Contents

3.1 List of tables

3.2 List of figures

3.3 List of acronyms and abbreviations

AMSY	Average Maximum Sustainable Yield
BiOp	Biological Opinion
CNMI	Commonwealth of the Northern Mariana Islands
CRE	Coral Reef Ecosystems
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
FADs	Fish Aggregation Devices
FEIS	Final Environmental Impact Statement
FMP	Fishery Management Plan
FWS	Fish and Wildlife Service
GAM	generalized additive model
HAPC	Habitat Areas of Particular Concern
HBF	Hooks Between Floats
MHI	Main Hawaiian Islands
MSST	Minimum Sustainable Stock Threshold
MSY	Maximum Sustainable Yield
MUS	Management Unit Species
nm	nautical mile
NEPA	National Environment Policy Act
NMFS	National Marine Fisheries Service
NWHI	Northwestern Hawaiian Islands
OY	Optimum Yield
PIFSC	Pacific Islands Fisheries Science Center
PIRO	Pacific Islands Regional Office
PMUS	Pelagic Management Unit Species
PRIA	Pacific Remote Island Areas (i.e., Howland, Baker, Jarvis and Wake Islands; Johnston, Midway and Palmyra Atolls; and Kingman Reef)
RFA	Regulatory Flexibility Act
RIR	Regulatory Impact Review
SPR	Spawning Potential Ratio
SWFSC	Southwest Fisheries Science Center
VMS	Vessel Monitoring System
WCPO	Western Central Pacific Ocean
WPRFMC	Western Pacific Regional Fishery Management Council

4.0 Introduction

4.1 Responsible agencies

The Western Pacific Regional Fishery Management Council (Council or WPRFMC) was established by the Magnuson Fishery Conservation and Management Act of 1976 (Public Law 94-265; 16 U.C.S. 1801 *et. seq*.) to develop fishery management plans (FMPs) for fisheries operating in the U.S. Exclusive Economic Zone (EEZ) around American Samoa, Guam, Hawaii, the Commonwealth of the Northern Mariana Islands (CNMI) and the remote U.S. Pacific Island possessions.[1] Once an FMP is approved by the Secretary of Commerce (Secretary), it is implemented by Federal regulations, which are enforced by the National Marine Fisheries Service (NMFS) and the U.S. Coast Guard in cooperation with state agencies.

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4.2 Public review process and schedule

On March 29, 2001, the National Marine Fisheries Service (NMFS) issued a Biological Opinion under section 7 of the Endangered Species Act for the authorization of fisheries under the Pelagics Fishery Management Plan (FMP) of the Western Pacific Region. The Biological Opinion (BiOp) contained a series of non-discretionary actions (Reasonable and Prudent Alternative) to mitigate interactions between the Hawaii-based longline fishery and sea turtles. At the 110th Council Meeting held June 18-21, 2001, staff of the Western Pacific Regional Fishery Management Council (WPRFMC) were directed to prepare a regulatory amendment recommending implementation of the Reasonable and Prudent Alternative (RPA) as required under the Endangered Species Act (ESA). This recommendation was prepared, and it was implemented by NMFS on June 12, 2002. New measures included a ban on the use of shallow-set swordfish longline fishing north of the equator and a seasonal area closure from 15° N. lat. to the equator and from 145° W. long. to 180° long. during April and May for any longline vessel fishing under the authority of the FMP.

On December 12, 2001, NMFS reinitiated section 7 consultation on the Western Pacific Region’s pelagic fishery. This reinitiation was based on the availability of new information that

[1] Howland Island, Baker Island, Jarvis Island, Johnston Atoll, Midway Atoll, Kingman Reef, Palmyra Atoll and Wake Island.

could improve the agency's ability to quantify and evaluate the effects of the fishery on listed sea turtle populations, as well the economic impacts of the implementation of the March 2001 RPA. At the conclusion of this reconsultation, NMFS issued a new BiOp (November 15, 2002), which maintained the June 12, 2002 regulations including the ban on shallow-setting north of the equator and the April-May southern area closure. Meanwhile, on September 24, 2002, the D.C. District Court vacated the 2001 BiOp and RPA, effective November 15, 2002.

At its 118th meeting in June 2003 (68 FR 27969), the Council reviewed a number of potential modifications to the southern area closure to determine whether modifications could be made to support the economic viability of the fleet without jeopardizing sea turtles. The Council subsequently directed its staff to continue its preparation of a regulatory amendment to the Pelagics FMP containing a further range of alternatives and the impacts of those alternatives on sea turtles, fisheries, and the environment. Staff were also directed to include analyses of the impacts of those alternatives on sea turtles, fisheries and the environment. The Council directed staff to work with the NMFS Pacific Islands Regional Office (PIRO) and Pacific Islands Fisheries Science Center (PIFSC) to complete the package so the Council could consider it for final action at its 119th meeting, scheduled for mid-September 2003, with the intention of implementing this change prior to the 2004 seasonal area closure. A summary document that illustrated these alternatives and their impacts (*Draft Regulatory Amendment 4 to the Pelagics Fishery Management Plan of th Western Pacific Region, August 8, 2003*), as well as a 119th meeting agenda, was mailed to interested parties including all Hawaii longline permit holders and all holders of Hawaii Commercial Marine Licenses. These documents were also available on the Council's website.

However, on August 31, 2003, the Federal Court invalidated the 2002 BiOp and the regulations put in place in June 2002. Consequently, in preparation for the 119th Council meeting, a supplement for the existing document (which was then focused on changes to the southern area closure) was drafted which included a range of new alternatives for the long-term management of the fishery. Due to the rapidly changing environment, this supplement (*Draft Supplement to Regulatory Amendment 4 to the Pelagics Fishery Management Plan of th Western Pacific Region, September 18, 2003*) was not mailed out , but was instead distributed to the public at the 119th meeting and made available on the Council's website.

At its 119th (emergency) meeting on September 23, 2003 (9/21/03 Honolulu Advertiser), the Council voted to recommend an emergency action which would allow a model swordfish longline fishery north of the equator at approximately 75% of historic (1994-1998 average annual) swordfish levels of effort (sets) in conjunction with fishing experiments that stay within the anticipated takes in the model fishery. The fishery would only be allowed to operate with circle hooks instead of J-hooks and mackerel bait instead of squid, measures proven successful in minimizing leatherback and loggerhead interactions in the Atlantic Ocean. The emergency action would also require mandatory night setting for vessels shallow-setting fishing north of 23° N, implement a "hard limit" for turtle interactions, and would not implement any time/area closures. Under this approach, the swordfish fishery would be closed annually upon exceeding its incidental take statement (rather than just reinitiating consultation) or when it reaches its effort limit (75% of historic effort or 3,200 sets). In addition, the Hawaii-based tuna and swordfish fisheries would have separate incidental take statements, the hard limit detailed above would apply only to the swordfish fishery. All longline vessels (tuna and sword) would be obliged to carry and use effective dehooking devices. Finally, a series of conservation measures designed to protect sea turtles on nesting beaches and in coastal waters would be pursued. Looking ahead, the Council also created a special advisory committee to include scientists, managers, industry and conservation groups who would work together to develop and recommend to the Council measures for the long-term management of this fishery. This recommendation was included in an emergency rule package that included an Environmental Assessment as well as a Biological Assessment and which was transmitted to NMFS for review and implementation on October 10, 2003. At the 119th meeting, Council staff were also directed to continue development of a supporting document for the long-term management of the fishery in anticipation of future action by the Council.

On October 6, 2003, the Federal Court stayed the execution of the August 31, 2003 order until April 1, 2004 to allow NMFS to develop a new BiOp and hopefully render a more permanent solution than interim or emergency measures. The purpose of this amendment is thus to provide recommended measures for the long-term management of the Hawaii-based longline fishery.

The Court's decision coincided with Council and NMFS' preparation of an announcement of intent to prepare a Supplemental Environmental Impact Statement (SEIS) in accordance with the National Environmental Policy Act (NEPA), on pelagic fishery issues and potential management options. The announcement was expanded to include information on the court decisions and possible implications, including priorities to apply in addressing management issues. In order to initiate and facilitate the SEIS process, on October 17, 2003, the Council and NMFS (also known as NOAA Fisheries) announced their intent to prepare an SEIS, provided notice of scoping meetings, and requested comments (68 FR 59771). In addition to identifying and soliciting input on a number of management concerns, the notice advised that because the court actions could result in leaving the Pelagics FMP in place without measures to eliminate the likelihood that fishing pursuant to the Pelagics FMP would jeopardize the continued existence of species of listed sea turtles, NMFS and the Council were considering management measures to comply with requirements under the Endangered Species Act for sea turtle protection. Additionally, as recent research identified practical measures to reduce interactions, re-examination in the SEIS of the management measures previously imposed to minimize interactions between the Hawaii-based longline fishery and protected species was warranted. Public meetings were scheduled and held on October 21, 2003, at 6:00 p.m. at Fisherman's Wharf Restaurant, 1009 Ala Moana Blvd. Honolulu, HI; October 27, 2003, at 7 p.m. at the Chiefess Kamakahelei Middle School, 4431 Nuhou St., Lihue, Kauai, HI; October 28, 2003, at 7 p.m. at the Maui Beach Hotel, 170 Kaahumanu Ave., Kahului, Maui, HI; October 30, 2003, at 7 p.m. at the King Kamehameha Hotel, 75-5660 Palani Rd., Kailua-Kona, HI; November 6, 2003, at 7 p.m. at the Department of Marine Resources and Wildlife Conference Room, Dockside, Pago Pago Harbor, American Samoa; December 3, 2003, 7 p.m. at the Pedro P. Tenorio Multipurpose Bldg., Susupe, Saipan, CNMI; December 4, 2003, 7 p.m. at the Guam Fisherman's Cooperative, Lot 12 section 4, Greg D. Perez Marina, Hagatña, Guam; and February 18, 2004 in Honolulu.

On December 3, 2003 (68 FR 67640), the Council and NMFS published a Supplemental Notice of Intent to prepare the SEIS, along with public notice of a compressed schedule under alternative procedures approved by the Council on Environmental Quality (CEQ). This notice furnished additional information on the need for expedited management action on proposed management measures for the Hawaii-based longline fishery and it's potential impact on protected sea turtle populations. The accelerated management action schedule avoids a lapse in appropriate management measures after April 1, 2004. The Supplemental Notice of Intent further announced the Council and NMFS' intent to apply alternative procedures approved by the CEQ to facilitate completion of the SEIS on the proposed management measures for the Hawaii-based longline fishery for implementation of rules effective by April 1, 2004, with a subsequent phase of a Pelagics SEIS to be prepared to address other management issues identified in the October 17, 2003 notice of intent. The supplemental notice of intent confirmed the scoping meeting schedule and effectiveness of the public input opportunity through December 15, 2003.

The Council and NMFS also solicited, recorded, and considered input on issues and possible action options and alternatives received during public Council meetings and public meetings of the Council's Sea Turtle Conservation Special Advisory Committee that was formed in September 2003.

At its 120th meeting on October 20, 2003 (68 FR 56816), the Council reviewed an October 9, 2003 document *(Emergency Rule Package for the Management of Pelagic Fisheries under the Pelagics Fishery Management Plan of the Western Pacific Region)* that combined the draft document distributed prior to the 119th meeting with the supplement circulated at the 119th meeting and further discussed long-term measures for the fishery. Again due to the rapidly changing environment, this combined document was not mailed out, but was instead distributed to the public at the 120th meeting and made available on the Council's website. At this meeting, the Council rejected a request from NMFS that it withdraw its recommendation for emergency measures on the basis that the stay through April 1, 2004 eliminated the need for emergency action. NMFS also requested that the Council work to develop and transmit a complete long-term rule package to NMFS by December 1, 2003 so that it could be processed and implemented by April 1, 2004. In response, the Council directed its staff to continue development of this long-term rule package through a series of meetings of the special advisory committee, workshops and seminars, and preparation of an appropriate NEPA document, with the goal of meeting the December 1 deadline. However, given the abbreviated time available, the Council declined to withdraw the emergency rule package, instead recommending that, if the long-term rule package is not completed according to NMFS' schedule, NMFS should process the Council's emergency rule for implementation by April 1, 2004.

On October 28-29, 2003, the first meeting of the Council's Sea Turtle Conservation Special Advisory Committee was held at the Council's office in Honolulu. This meeting was advertised in the local media, open to the public and included daily comment periods. Committee membership included representation from fishery managers, scientists, industry, and environmental organizations. A call-in number was provided for those not able to attend in person. Committee members reviewed and discussed a range of issues related to sea turtle conservation and developed four scenarios to receive preliminary analysis by NMFS prior to the committee providing final recommendations to the Council. Three of these scenarios were already included in the Council's range of long-term alternatives, the fourth was added.

On November 12, 2003, the committee met a second time. This meeting was held in Washington, D.C. and was again open to the public with comments taken and a call-in number provided. At this meeting committee members were updated on progress by NMFS. Following this meeting, two more alternatives of interest (Committee Alternatives 5-6) were submitted to NMFS for analysis and added to this document. Committee Alternative7 was subsequently added by NMFS' committee representative for analytical purposes.

On November 24, 2003, the committee had its third meeting in Honolulu (this meeting was advertised in the local media, open to the public, included a comment period, and a call-in number was provided). Committee members discussed NMFS' findings and reviewed NMFS' preliminary rankings of the alternatives in terms of the potential for adverse impacts on sea turtles. The Committee did not reach consensus on a single recommendation, but instead forwarded all seven alternatives to the Council for their consideration.

On November 25, 2003 (11/23/03 Honolulu Advertiser), the Council held its 121st (emergency) Council meeting via teleconference at the Council's Honolulu office. This was an emergency meeting and the measures discussed here were its sole focus. The Council's November 18, 2003 document *An Amendment to the Pelagics Fishery Management Plan of the Western Pacific Region, Long-Term Management Measures of the Western Pacific Pelagic Fisheries (Including a Draft Preliminary Draft Supplemental Environmental Impact Statement)* was distributed at this meeting as well as made available on the Council's website. The Council also reviewed the Committee's alternatives and estimates of their relative impacts. The Council's final action on this measure was to recommend that NMFS now allow 2,120 swordfish sets to be made annually to model the use of circle hooks with mackerel-type bait, dehookers and other new technologies shown to reduce and mitigate interactions with sea turtles, in addition to a continued tuna fishery with no time/area closure, the mandated use of dehookers, and the pursuit of a suite of conservation measures.

On January 23, 2004, the Environmental Protection Agency published a Federal Register notice announcing the availability of the DSEIS. In addition to responding to resultant requests for copies of the DSEIS, copies were also sent to the previously established list of interested parties (see Appendix W). The comment period for the DSEIS ended February 23 and a total of 27 unique responses were received (212 copies of an identical or nearly identical form letter were also received). One additional responses were received at a public hearing on the DSEIS held February 18, 2004 in Honolulu. Comments received and responses to those comments are attached as Appendix X.

4.3 List of preparers

This document was prepared by (in alphabetical order):

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5.0 Purpose and Need for Action

The purpose of this action is to establish a limited model swordfish fishery that will permit environmentally responsible shallow- set swordfish longlining, while minimizing impacts on, and conserving protected species of sea turtles in the Pacific Ocean. Measures implemented by the Council's January 2002 regulatory amendment to its Pelagics FMP (that were based on the June 2001 BiOp and published in the Federal Register on June 12, 2002) greatly reduced interactions between turtles and Hawaii-based longline fishing vessels. However, this was achieved at the expense of the Hawaii-based longline fishery, chiefly by eliminating swordfish longline fishing, which resulted in a 20% decline in landings and a 40% decline in ex-vessel revenue in the first year following its implementation (WPRFMC 2002). Subsequently, there was a substantial increase in Taiwanese swordfish directed longline effort in the area vacated by the Hawaii-based fleet, presumably to fill the market demand now unmet by domestic fisheries. Recent research in the Atlantic has shown that shallow-set longline fishing with circle hooks and mackerel bait can markedly reduce interactions with loggerhead and leatherback turtles, while maintaining viable swordfish catch rates. Consequently, this amendment considers allowing the swordfish segment of the Hawaii longline fishery to operate as a model fishery employing the circle hook/mackerel bait method, along with other measures to mitigate sea turtle interactions. Thus, under the preferred alternative the Hawaii-based longline fishery would serve as a model, both domestically and internationally, of newly discovered technologies to reduce and mitigate sea turtle interactions, as well as of the US commitment to worldwide sea turtle conservation.

In addition, although tuna-targeting longline fishing has continued, it is constrained by the annual seasonal (April-May) longline closure of about one million square nautical miles (nm) of ocean bounded by 15˚ N. lat. to the equator and from 145˚ W. long. to 180˚ long. This closure denies the fleet access to yellowfin and bigeye catches at a time when these stocks are known to be especially productive in equatorial regions, particularly in the U.S. EEZ around Palmyra Atoll and Kingman Reef. For this reason, this document also considers several time/area closures in addition to a model swordfish fishery.

Finally, this document considers the need for continuing conservation measures that are intended to improve sea turtle recruitment and thus offset any potential harm the Hawaii longline fishery could still pose to sea turtles. These measures are essential to provide enhanced protection to potentially affected sea turtles and include protection of potentially affected turtles and eggs at nesting beaches and in coastal foraging waters in various areas throughout the Pacific.

5.1 Objectives of the FMP

The objectives of the 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.

5.2 Objectives of this action

In accordance with FMP Objectives 1, 2 and 7, the objective of this action is 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.

6.0 Initial Actions

The Pelagics FMP of the Western Pacific Region was published in 1987. The FMP did not include specific measures to conserve Pacific sea turtles; however, Amendment 2 (implemented in May 1991) required the operators of Hawaii-based longline vessels to contact NMFS for potential observer placement before fishing in a 50 nm protected species zone around the Northwestern Hawaiian Islands (NWHI). Amendment 3 (implemented in October 1991) extended this requirement to require that NMFS observers be accommodated aboard all Hawaii-based longline vessels to collect information on interactions with sea turtles and other protected species. Amendment 3 also established a 50 nm area closure around the NWHI, which together with a 25-75 nm longline closure around the Main Hawaiian Islands implemented through Amendment 5, afforded protection to adult green turtles foraging in nearshore coastal waters. Amendments 4 and 7 (October 1991 and June 1994, respectively) implemented a limited entry program for the Hawaii-based longline fishery with a limit of 164 permits and a maximum vessel length of 101 feet, thus controlling fleet effort.

On March 28, 2000, NMFS published a final rule that requires operators of Hawaii-based longline vessels to carry and use dip nets and line-clippers to disengage sea turtles hooked or entangled by longline fishing gear. This rule also includes requirements concerning the handling, resuscitation and release of sea turtles. This rule was initiated and implemented by NMFS and has no expiration date. Following the Council's recommendation, on June 12, 2002, NMFS additionally published a final rule that implemented the "non-discretionary" Reasonable and Prudent Alternative contained in its March 2001 BiOp including the northern prohibition on shallow setting and a southern seasonal longline area closure.

At its 118th meeting in June 2003, the Council reviewed a number of potential modifications to the southern area closure to determine whether modifications could be made to support the economic viability of the fleet without jeopardizing sea turtles. The Council subsequently directed its staff to continue its preparation of a regulatory amendment to the Pelagics FMP containing a further range of alternatives and the impacts of those alternatives on sea turtles, fisheries, and the environment. The Council anticipated selecting a final preferred alternative at its 119th Council meeting, which would then be transmitted to NMFS for review and approval with the intention of implementing this change prior to the 2004 seasonal longline area closure.

However, on August 31, 2003, the Federal Court invalidated the 2002 BiOp and the regulations put in place in June 2002. Consequently at its 119th meeting on September 23, 2003, the Council voted to recommend an emergency action which would allow a model swordfish longline fishery north of the equator at 75% of historic (1994-1998 average annual) swordfish levels of effort (sets) in conjunction with fishing experiments that stay within the anticipated takes in the model fishery. The fishery would only be allowed to operate with circle hooks instead of J-hooks and mackerel bait instead of squid, measures proven successful in minimizing leatherback and loggerhead interactions in the Atlantic Ocean. The emergency action would also require mandatory night setting for vessels shallow-setting fishing north of 23° N, implement a "hard limit" for turtle interactions, and would not implement any time/area closure. Under this approach, the swordfish fishery would be closed annually upon exceeding its incidental take statement (rather than just reinitiating consultation) or when it reaches its effort limit (75% of historic effort or 3,200 sets). In addition, the Hawaii-based tuna and swordfish fisheries would have separate incidental take statements, the hard limit detailed above would apply only to the swordfish fishery. All longline vessels (tuna and sword) would be obliged to carry to carry and use effective dehooking devices. Finally, a series of continuing conservation measures designed to protect sea turtles on nesting beaches and in coastal waters would be pursued. Looking ahead, the Council also created a special advisory committee to include scientists, managers, industry and conservation groups who would work together to develop and recommend to the Council measures for the long-term management of this fishery.

On October 6, 2003, the Federal Court stayed the execution of the August 31, 2003 order until April 1, 2004 to allow NMFS to develop a new BiOp and hopefully render a more permanent solution than interim or emergency measures. The purpose of this amendment is thus to provide recommended measures for the long-term management of the Hawaii-based longline fishery.

At its 120th meeting (October 20, 2003), the Council rejected a request from NMFS that it withdraw its recommendation for emergency measures (transmitted to NMFS for implementation on October 10, 2003) on the basis that the stay through April 1, 2004 eliminated the need for emergency action. NMFS also requested that the Council work to develop and transmit a complete long-term rule package to NMFS by December 1, 2003 so that it could be processed and implemented by April 1, 2004. In response, the Council directed its staff to continue development of this long-term rule package through a series of meetings of the special advisory committee, workshops and seminars, and preparation of an appropriate NEPA document, with the goal of meeting the December 1 deadline. However, given the abbreviated time available, the Council declined to withdraw the emergency rule package, instead recommending that if the long-term rule package is not ready according to NMFS' schedule, NMFS should process the Council's emergency rule for implementation by April 1, 2004.

At its 121st meeting (November 25, 2003), the Council discussed a range of alternatives and estimates of their relative impacts. The Council then took final action to recommend that NMFS allow 2,120 swordfish sets to be made annually to model the use of circle hooks with mackerel-type bait, dehookers and other new technologies shown to reduce and mitigate interactions with sea turtles, in addition to a continued tuna fishery with no time/area closure, the mandated use of dehookers, and the pursuit of a suite of conservation measures.

7.0 New Information on Technologies and Techniques to Reduce and Mitigate Fishery Interactions

The use of modified hooks to reduce and mitigate sea turtle interactions has been a focus of research for several years. NMFS' Pascagoula Laboratory, in conjunction with the Blue Water Fishermen's Association conducted research between 2001 and 2003 to evaluate fishing gear modifications and strategies to reduce and mitigate interactions between endangered and threatened sea turtle species and longline fishing gear. Results of this research conducted during 2001 and 2002 have been presented by Watson et al., (2002, 2003) from which the following has been summarized. The area of operations was the Northeast Distant Waters (NED) statistical reporting zone in the Western Atlantic Ocean.. This area is closed to pelagic longline fishing by U.S. flagged vessels with the exception of the experimental fishery. Between 2001 and 2002, almost 700 swordfish target shallow-sets were made to test potential sea turtle mitigation techniques.

In 2001 the research experiment was designed was to test the effect of moving the hooks that are normally deployed very near floats to a position 20 fathoms away from the floats, as historical data indicate a higher turtle take rate on the hooks near floats. The design also tested the effect of using blue dyed squid rather than the standard squid as bait. Analysis of the data collected in 2001 indicated that there was no significant effect of blue dyed squid on turtle interactions; however, there were more interactions with leatherback turtles on hooks placed 20 fathoms from floats than on hooks closer to floats. A general linear model indicated that there was no effect of daylight soak time for leatherback turtle interactions, but that this factor was the only variable which affected loggerhead turtle interaction rates, which increased slightly with increased daylight soak time, indicating that loggerhead interactions with longline gear in the NED are a daytime interaction.

In 2002, the experimental design evaluated the effect of reducing the daylight hook soak time, the use of 18/0 circle hooks (both offset and non-offset) with squid bait, and the use of mackerel bait on both J-hooks (control) and 18/0 circle hooks, in reducing sea turtle interactions with pelagic longline gear. Each vessel participating in the experiment alternated three set configurations (A, B, C). Set A alternated control J-hooks with squid 18/0 non-offset circle hooks with squid bait in a non repeating pattern with three hooks between floats. Set B alternated control J-hooks with squid bait and 18/0 circle hooks with squid bait. Set C alternated J-hooks with mackerel bait with 18/0 offset circle hook with mackerel bait. All other gear specifications were standardized within and between vessels. All vessels were given a target window to have all gear hauled in order to evaluate the effect of reduced daylight hook soak time.

Both loggerhead and leatherback turtle interactions rates were significantly reduced for the 18/0 offset circle hook with squid bait compared to the J-hook with squid bait. The mean reduction in interaction rates for leatherback turtle was 64% and loggerhead interactions were reduced by 88%. There was an average reduction of swordfish catch (by weight) of 33%, with a nominal 25% increase in bigeye tuna catch, although this was not statistically significant.

Leatherback and loggerhead turtle interaction rates were also significantly reduced with the18/0 10° offset circle hook with squid bait compared to the J-hook with squid bait. The mean reduction rate was 50% for leatherbacks and 85% for loggerheads. Swordfish catches were reduced by 29% and a nominal increase was seen in bigeye tuna catches which were determined to be not statistically significant.

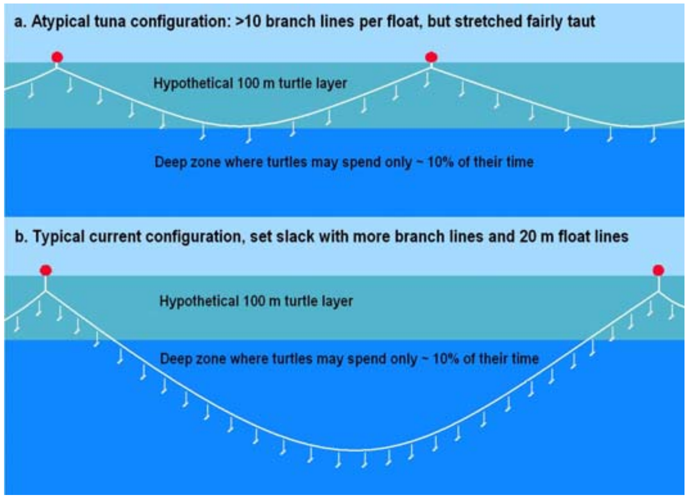
Leatherback and loggerhead interaction rates were also significantly reduced by using mackerel as bait rather than squid on J-hooks. There was a mean leatherback reduction rate of 67% using mackerel bait and a loggerhead reduction of 75%. There was a 63% increase in swordfish catches using mackerel, while bigeye tuna catch was reduced by 90%.

The greatest reduction in loggerhead interactions was achieved using a combination of mackerel bait with an 18/0 circle hook with a 10° offset. The mean reduction rate for loggerhead turtles was 92%, with an accompanying 67% reduction of leatherback interactions. Swordfish catches increased by 30%, with a mean loss of 81% in bigeye tuna catches.

The threading of mackerel bait on hooks appeared to have some influence on turtle interactions. About one third of the vessels used a "single hooking" technique, which involved passing the hook point a single time through the bait's eye, back or tail. The remaining vessels employed a threading technique which involved passing the entire hook through the bait multiple times starting through the eyes, back or tail. This technique was used to better secure the bait to the hook and minimize bait loss. Interactions with loggerhead turtles were 74 % greater with this threading technique as compared to the single hooked mackerel. This may be due to the ease with which single hooked baits are torn away from the hooks during the feeding process. The single hooked baits also had the highest catch rates of swordfish. However, the single hooked baits had a 107% higher leatherback interaction rate than the threaded bait. This is likely due to the shielding effect offered by the threading of the bait, as leatherback turtles are known to be frequently flipper hooked, presumably because they tend to run into the longline gear accidentally rather than biting it.

In addition effective dehooking devices, such as those developed by Aquatic Release Conservation (ARC) in conjunction with NMFS' Mississippi Marine Lab are in use on an experimental basis by NMFS observers to release turtles and other bycatch in the Atlantic commercial longline fishery. These devices are reported to be "well liked" by observers (Watson, 2003) and NMFS is now designing specific guidelines for their use in that fishery. These dehookers are made of 316 grade stainless steel and lightweight aircraft aluminum for strength and durability. They are designed to remove internal and external hooks without touching or removing the bycatch from the water. In essence they consist of a long-handled pole ending in a clip or curved piece of metal with a covered or rounded face. The clip is used to seize and surround the hook so that it may be removed without further injury. Similar dehooking devices have been used by both commercial and recreational fishermen to mitigate the effects of catching and releasing fish for many years.

New research information has also revealed some evidence to suggest that deeper setting by the Hawaii-based longline fishing fleet targeting tuna has in itself reduced the take of leatherback turtles more than anticipated. Recent observations on the diving behavior of leatherback turtles in the Pacific by the NMFS Pacific Islands Science Center (Jeffery Polovina, NMFS PIFSC,



pers. comm.) suggest that their diving behavior and dive profiles are comparable to those of olive ridley turtles, which spend more than 90% of their time at depths of less than 100 m. Although published information on leatherback turtles in the Atlantic indicates that they are capable of making dives to depths greater than a 1000 m (Eckert et al, 1986), this species more routinely dives to depths between 50-84 m (Eckert et al, 1986). Swimming at these depths in the Pacific places leatherbacks primarily in the zone where shallow-set swordfish targeting longline gear, or the shallowest of hooks on deeper tuna targeting gear would be deployed by the Hawaii longline fleet.

Since mid-2001 regulations have required Hawaii-based longline fishermen to use floatlines with a minimum length of 20 meters, prior to that there were no specific regulations regarding fishing depth. The comparison of observations on fishery interactions with leatherback turtles from these two regulatory regimes has prompted the hypothesis that some of the past observed sets with leatherback interactions that were categorized as deep-sets, may have actually been set shallower than current regulations allow. Prior to the regulatory requirements regarding deep-sets, all sets with more than 10 branch lines between floats were defined as deep-sets, but this configuration does not necessarily result in a deep-set under current definitions, especially if no slack is set in the line. In the past fishermen may have been motivated to set the line taut and relatively shallow to catch some swordfish even though their gear was categorized as deep-set (Figure 1). The simulation model used to generate interaction estimates employs a baseline average of the catch and effort in set types (shallow vs. deep) for the fishery from 1994-1999. Turtle interaction data from the observer program is used in conjunction with this baseline data to generate the fleet-wide estimates of turtle take by deep and shallow sets. Categorizing those historical taut sets as deep-sets, as well as including sets with relatively short float lines may have led to upwardly biased estimates for interaction rates with leatherbacks and olive ridleys under the current requirements for deep-set tuna style longline fishing. Thus it is likely that the current deep-set line configuration may well be catching fewer leatherback turtles than has been anticipated, because less gear is placed where they spend the majority of their time (Table 2).

Figure 1. Atypical and typical tuna configurations for the Hawaii-based longline fishery.

Table 2. Anticipated and actual takes of leatherback and olive ridley turtles in the Hawaii longline fishery during 2002 Source: NMFS PIFSFC, McCracken 2003

Species	2001 anticipated take	2002 actual take
Leatherback	29	8
Olive ridley	98	26

8.0 Management Alternatives

This document examines a range of alternatives for the management of longline fisheries managed under the Pelagics FMP for the Western Pacific Region. Because the impetus for this action is concern for fishery interactions with sea turtles, and because the FMP's Hawaii-based longline fishery is the only one thought to interact significantly with sea turtles (see Section 9.1.4.9 to Section 9.1.4.11), these alternatives largely focus on that fishery.

The alternatives described here supplement those described in NMFS' 2001 Final Environment Impact Statement (FEIS) for the Pelagic Fisheries of the Western Pacific Region through the examination of an additional range of levels of swordfish fishing, in conjunction with circle hooks and mackerel-type bait. Please see the FEIS for details on six additional action alternatives (FEIS Alternatives 3-7 and 8) previously considered by the Council, but now rejected as they do not consider the additional use of circle hooks with mackerel-type bait to reduce sea turtle interactions on shallow-sets (this gear type is briefly discussed on FEIS p. 2-60 , but at that time its impacts and efficacy were uncertain), or the range of swordfish effort levels examined here. These technologies have been found to reduce leatherback and loggerhead interaction rates by 67% and 92% respectively (Watson, 2003). As described above, new information and extended studies of this technology have now provided fishery managers with an enough positive information to reject alternatives which would allow shallow-set swordfishing without requiring their use as unnecessarily hazardous to sea turtles. Also not presented in this document are FEIS

Alternatives 1 ("No Action FMP Baseline") and 9 ("Regional Longline Closure"). The first was rejected on the basis that several regulatory changes unrelated to turtles have occurred since the FEIS was prepared and thus today's "no action" is not the same as that which existed in 2001 and in fact the 2001 regulatory regime would be quite different from that which would exist under this document's no action alternative (see below). FEIS Alternative 9 was rejected on the basis that available information does not support a fishery closure to protect sea turtles, (and in fact such a closure has never been advocated or proposed by fishery scientists or managers) and that this action would thus fail to meet the objective of achieving OY from the Pelagics FMP fisheries. Historical data indicate that the tuna fishery has very low interaction rates, and given new technologies the model swordfish fishery is anticipated to also have low numbers of interactions (due to the combination of reduced interaction rates and limits on total annual effort). Thus complete closure of these fisheries is not necessary to protect sea turtles.

Alternatives retained from the FEIS in this document include FEIS Alternative 2 ("Pending Council Actions") which is here represented by the no action alternative (Alternative 7) as these actions have now been implemented and they represent the anticipated configuration of the fishery if no management action is taken prior to April 1, 2004 (when the stay of the order vacating the regulations resulting from the 2001 BiOp will end). Also retained in this document is FEIS Alternative 10 ("Preferred Alternative") which is here represented by the current fishery alternative (Committee Alternative 6) as this combines all measures implemented by the Council to date, including those regulations stemming from the 2001 BiOp. Finally, where possible the impacts of the retained alternatives are presented in relationship to FEIS Alternative 1 ("FMP Baseline") which represents the historical (1994-1999) operations of the fishery during a time period of relatively consistent regulations which allowed both swordfish and tuna fishing with no special constraints beyond the existing limited entry system and maximum vessel size limits.

A number of additional alternatives considered by the Council following publication of the FEIS are also briefly described in this document, but not presented in detail as the Council's focus for final action (at its 121st meeting) was those alternatives recently recommended by its Turtle Conservation Special Advisory Committee. Please see the Council's October 9, 2003 document *Emergency Rule Package of the Management of Pelagic Fisheries under the Pelagic Fisheries Management Plan of the Western Pacific Region* for a detailed description and analysis of these 18 action alternatives recently considered by the Council.

A total of six alternatives were recommended for detailed analysis by Committee members (herein designated Committee Alternatives) and a seventh, a 'no action' alternative, was added at the request of the NOAA Fisheries acting Regional Administrator for the Pacific Islands Region. These seven alternatives are the subject of this document. These alternatives range from a closed swordfish fishery (Committee Alternative 6, tuna fishing only), to one in which there are no constraints on swordfish fishing beyond the existing limited entry program and maximum vessel size limits (Alternative 7, the no action alternative).

The changes considered here include several time/area closures, as well as alternatives that combine these closures with varying levels of "model" shallow-set swordfishing by the Hawaii-based fleet. This model fishery would utilize 18/0 10° offset circle hooks with mackerel-type bait, which in combination have been found to radically reduce the level of interactions with leatherback and loggerhead turtles, while maintaining commercially viable swordfish catch rates as described above. In addition, the document considers the pursuit of non-regulatory nesting beach and coastal water conservation measures to improve sea turtle recruitment, and thus offset any potential harm the fishery could still pose to sea turtles.

All alternatives that would allow shallow-setting north of 23° N. also include the continuation of current seabird mitigation measures, as well as the implementation of an additional measure that was articulated in a Biological Opinion issued by the Fish and Wildlife Service (FWS) on November 28, 2000 and amended on November 18, 2002. This BiOp examined the Hawaii-based longline fishery as it operated in 1999 (prior to the prohibition on shallow-setting) and included measures to mitigate interactions between shallow-setting vessels and seabirds. However, between the time the FWS BiOp was issued and implemented, shallow-setting was prohibited by NMFS. In acknowledgment of the outstanding requirement, NMFS include the following statement in their final rule implementing the FWS BiOp (67 FR 34408):

> "Although shallow "swordfish-style" setting is currently prohibited by an emergency rule to protect sea turtles...the FWS BiOP requires that vessel operators making shallow sets north of 23° N. lat. 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. This requirement is not included in this final rule because the prohibition on "swordfish style" shallow set fishing is being undertaken under separate rulemaking to make this measures permanent in compliance with a March 29, 2001 biological opinion issued by NMFS regarding sea turtles."

Any regulatory changes which allows shallow-setting north of 23° N. lat. necessitate the implementation of the above requirement.

General longline permit holders would also continue be prohibited from participating in the Hawaii-based longline fishery (meaning to fish in Hawaii's EEZ or to land fish in Hawaii) without obtaining a longline limited access permit. All alternatives, except Alternative 6-the current fishery, would permit shallow set swordfish style fishing by vessels with a Western Pacific general longline permit. American Samoa longline vessels currently fish under a general permit, but a limited entry program for this fishery is currently nearing completion. American Samoa vessels could fish north of the equator and make shallow sets for swordfish but have no history of doing so. Moreover, the American Samoa fleet targets primarily albacore for the two fish canneries in Pago Pago, and there is little to no market for fresh swordfish in American Samoa. More importantly, there is no easy access to markets elsewhere on the U.S. mainland, unlike Hawaii, where most of the swordfish catch was sent. Two general longline permits have been issued in the Mariana Islands, one in Guam and the other in Commonwealth of the Northern Mariana Islands (CNMI). Neither permit is being used to conduct longline fishing from these locations. Based on historical data from other fleets, any longline fishing conducted around the Mariana Islands would target tunas and not swordfish. Vessels with a Western Pacific general permit may not land longline caught fish in Hawaii. Conceivably, longline vessels with a general permit could catch swordfish with shallow sets beyond the 200 mile EEZ around Hawaii and tranship to a Hawaii-based vessel with a receiving permit. However there is no records of such an operation over the entire history of the Hawaii-based longline fishery.

8.1 Alternatives considered in detail

As discussed in Sections 4.2, the Council's Sea Turtle Conservation Special Advisory Committee held a series of meetings in late 2003 to craft recommendations for further analysis and possible Council action. Four of the seven alternatives discussed were very similar to those previously considered by the Council. Committee Alternative 2 is completely new and is predicated on allowing the minimum amount of model swordfishing necessary to determine the efficacy of circle hooks with mackerel-type bait in reducing sea turtle interactions, while allowing commercially viable swordfish catch rates in the Hawaii-based longline fishery. This alternative would presumably have a limited duration as it is based on the on an estimated minimum number of sets to make statistically significant comparisons between turtles takes using the circle hook/mackerel bait combination for shallow swordfish sets , and turtle takes in swordfish sets prior to 1999. It is expected that the Council would take further action following an analysis of the results. Committee Alternatives 6 and Alternative 7 are also new and respectively represent a continuation of the current fishery, and a return to the previous management regime in which there were no special constraints on shallow-setting.

As stated above, all Committee Alternatives would require night-setting by vessels shallow-setting north of 23° N. and Committee Alternatives 1-5 would require the use of dehookers as directed by NMFS. All action alternatives also include the pursuit of a suite of conservation measures and potential fishing trials as described below.

Committee Alternative 1.	Allow 1,060 model* swordfish sets annually, in conjunction with tuna fishing with no time/area closure.
Committee Alternative 2.	Allow 1,560 model swordfish sets in conjunction with tuna fishing with no time/area closure.
Committee Alternative 3.	Allow 2,120 model swordfish sets annually, in conjunction with tuna fishing under the reimplementation of the recent time/area closure modified by opening EEZ waters around Palmyra Atoll.
Committee Alternative 4. (preferred)	Allow 2,120 model swordfish sets annually, in conjunction with tuna fishing with no time/area closure.
Committee Alternative 5.	Allow 3,179 model swordfish sets annually, in conjunction with tuna fishing with no time/area closure.
Committee Alternative 6.	Do not allow any swordfish sets, allow tuna fishing with recent

(current fishery)	time/area closure.
Alternative 7. (no action)	No management action is taken by April 1, 2004, June 12, 2002 rules are vacated, fishery returns to previous FMP management regime.

*Note: model swordfish sets are shallow-sets that use 18/0 or larger 10° offset hooks with mackerel-type bait.

IMPLEMENTING DETAILS There are several available options in implementing a system that distributes and monitors and controls a restricted amount of fishing effort allowable for the model swordfish fishery. Assuming all options achieve their objective of successfully distributing, monitoring and controlling allowable effort, the details of how this effort is managed are not likely to significantly impact the number of sea turtle interactions or mortalities. The outstanding exception is the degree which re-established Hawaii-based allowable swordfish effort is exerted by vessels now based in California and not subject the requirements proposed here to reduce and mitigate sea turtle interactions. Relocation of this effort would reduce overall turtle interactions with vessels belonging to holders of Hawaii longline limited access permits. In all cases, these implementing details may significantly affect the operations and success of fishery participants and thus are relevant to this action's objective of achieving OY. Due to ease and familiarity in implementation, these options assume that allowable fishing effort would be identified and monitored in number of sets, though limits on the number of trips, vessels, or other systems could also be appropriate. A series of Participation Options examine ways in which allowable effort is distributed, while three Closure Options examine ways in which the model swordfishery could be closed when allowable limits are reached. Under all options, allowable effort would not be temporally restricted, meaning that participants would be able to fish at any time during the year.

Participation Options 1-4 were discussed at the 120th Council meeting. The Council indicated that it preliminarily preferred Option 4, but in recognition of some outstanding issues, an advisory group consisting of industry members, scientists, and managers was formed to make recommendations to NMFS concerning its technical and operational details. Option 5 (preferred) which would divide allowable effort equally among interested permit holders is the result of that group's work (WPRFMC 2003a).

Participation Option 1. Open to all: under this option all holders of Hawaii limited access longline permits legally registered to vessels would be allowed to fish until allowable limits were reached and they were notified or otherwise instructed to stop fishing.

Participation Option 2. Individual historical participation: under this option allowable fishing effort would be distributed to individual permit holders based proportionally on records of their historical participation in the swordfish fishery, with higher recorded historical rates associated with higher allowable effort levels.

Participation Option 3. Divide allowable effort equally among all permit holders: under this option all Hawaii limited entry permit holders would be entitled to fish an equal fraction of allowable swordfish-style effort.

Participation Option 4. Lottery: under this option, available effort would be distributed based on a random draw from all permit holders with swordfishing experience. Participants would be free to fish their limit at any time during the season or year.

Participation Option 5. Divide allowable effort equally among interested permit holders (preferred): under this option, all Hawaii longline limited access permit holders would be contacted prior to the beginning of the season (January 1, except for the 2004 season which would begin April 1, 2004) to see if they are interested in receiving shares of the allowable shallow-set effort. Allowable effort (sets) would then be divided equally among all permitted vessels registered to interested permit holders. Permit holders could either fish their shares themselves, or trade, sell, or give them to other Hawaii longline limited access permit holders to use during that fishing year. Each set would be represented by a physical certificate with a unique number. Fishery participants would be required to carry onboard and submit to NMFS sufficient certificates for each fishing day of each swordfish (shallow-set) trip taken. If a set is made consisting of one mile or more of mainline, it will be counted as a full set. Deep-sets would be defined as those in which the deepest point of the main longline between any two floats is at a depth of at least 100 meters, every float line is at least 20 meters in length, at least 15 branch lines are used between any two floats (except for basket-style longline gear which must have at least 10 branch lines between floats), and no lightsticks or squid bait are used. Any set not meeting these criteria would be defined as a shallow-set.

Several options for the monitoring and control of model swordfishing effort and turtle interactions have been discussed. Fishery data would continue to be collected based on logbooks and other fishery monitoring systems, with fishing ceasing each year when all allowable effort certificates were used. Interaction data would continue to be collected by NMFS through its observer program. NMFS has reported that the recent recalibration of its observer placement design to achieve random sampling should allow relatively simple and timely extrapolations of observed interactions into fleet wide estimates.

The following options consider the action to be taken when these extrapolations indicate that the model swordfishery has reached its anticipated takes. Closure Options 1 and 2 were discussed at the 120th Council meeting. The Council indicated that it preliminarily preferred Option 1, but in recognition of some outstanding issues, an advisory group consisting of industry members, scientists, and managers was formed to make recommendations to NMFS concerning its technical and operational details. Option 3 (preferred) which would apply a "hard limit" for the swordfish fishery for leatherbacks and loggerheads is the result of that group's work (WPRFMC 2003a).

Closure Option 1. "Hard limit" for the swordfish fishery: under this option, the model swordfishery would be closed each year when the average (point estimate) of the swordfish fishery’s anticipated takes for any species under the ESA is reached. Barring other new information, the fishery would automatically reopen on January 1 of the next year. This option could also include the specification of a “yellow light” for sea turtle interactions which would be set below the anticipated take and would lead to examination of the fishery, and potential increases in monitoring or other activity as deemed necessary.

Closure Option 2. No hard limit for the swordfish fishery: under this option, the model swordfishery would not necessarily close when anticipated interactions were reached, but would instead continue to operate under the current provisions of the Endangered Species Act which in general require reinitiation of consultation when anticipated takes are exceeded, but do not always require that fisheries be closed during the consultation period.

Closure Option 3. “Hard limit” for the swordfish fishery for leatherbacks and loggerheads (preferred): under this option, the model swordfishery would be closed each calendar year when the swordfish fishery’s prevailing incidental take statement (concerning total interactions) for leatherback or loggerhead sea turtles is reached. Due to statistical limitations surrounding the rarity of interactions, these limits would be based on total interactions as anticipated in the fishery’s new incidental take statement, rather than on the smaller subset of lethal interactions (mortalities). Updated information on year-to-date interactions will be available from fishery managers to inform participants as to the fishery’s status regarding the established hard limits. This will allow vessel operators to avoid embarking on trips that are likely to be ended prematurely, as well implicitly providing notice of upcoming closures. Fishery participants would receive formal notice from NMFS at least one week in advance of any closure. Barring other new information considered significant by NMFS, the fishery would automatically reopen on January 1 of the next year.

Take statements for olive ridley and green sea turtles would be combined with those for the tuna fishery and hard limits would not be used for these species (normal ESA procedures would apply, as they would also apply to leatherbacks and loggerheads taken by the swordfish fishery). Providing separate incidental take statements would allow early closure of fisheries that are having high rates of interactions with the species of highest concern, but allow fishing to continue by lower impact gear types. Data on anticipated interactions has historically been grouped into deep vs. shallow-set gears so this will not pose a new estimation problem. However, due to sampling procedures and the desire to maintain consistent rates of observer coverage, participants would have to declare their trip type (deep or shallow set) when they contacted NMFS as to whether they would need to carry an observer. Once the trip commenced, participants would be prohibited from switching gear types for the remainder of that trip.

In addition to the measures described above, the advisory group has suggested that NMFS hold dockside or other sessions to educate participants in the model swordfish fishery on the proper use of circle hooks with mackerel-type bait, and to educate all fishery participants on the appropriate use of dehookers. This group also suggested that NMFS consider providing 100% observer coverage for the model swordfish fishery for at least the first year, as this would provide complete information on the frequency and nature of fishery interactions with sea turtles as well as detailed information on the fishing practices of all vessels. Regardless of observer coverage, the group recommended that if realtime estimates are necessary and practicable, NMFS provide observers with a reliable means of shoreside communications for them to call-in immediately if interactions are observed.

Fishing trials

Committee Alternative 4 (preferred) would also include the potential for fishing trials within the model swordfish fishery, if recommended by NMFS' scientists. These trials would take place on commercial fishing boats and use the circle hooks and mackerel-type bait described here as a control, meaning that new technologies would be used in conjunction addition to circle hooks with mackerel-type bait. All fishing effort expended, and turtle interactions recorded during any such trials, would count against the swordfish fisheries effort and turtle limits. Examples of technologies that might be tried include turtle repellent bait, the use of lights that turtles perceive as flashing and unattractive, but which appear steady and attractive to fish, and other techniques that could be used in conjunction with circle hooks and mackerel-type bait to further reduce and mitigate interactions with sea turtles.

Analytical methods

The action alternatives (Committee Alternatives 1-5) were analyzed by the NMFS PIFSC using the Kobayashi/Polovina model (see Appendix H for a detailed description of the model). This model generates estimates of anticipated average annual sea turtle interactions for the Hawaii longline fishery. Kobayashi and Polovina first modeled interactions between sea turtles and the fishery based on a suite of variables from observer data. The second Kobayashi and Polovina model integrated the first model with data from fishery logbooks. This integrated model was used to estimate historical interactions as well as to predict the likely number of interactions that were likely to result from restrictions on gear types, as well under a range of fishery time and area closures. The underlying predictive models are based on 1994 to 1999 data when the swordfish fishery was operating normally. The model is able to predict effects of time/area closures and varying effort by different fishing types. In 2003 this model was further revised by applying the interaction reduction rates associated with circle hooks and mackerel bait as discussed in Section 7.0 (See Appendix I)

8.2 Description of conservation projects included in all action alternatives

Five conservation projects are included as a part of all action alternatives. These measures are designed to conserve sea turtles in their nesting and near-shore habitats and in doing so to mitigate fishery impacts on affected populations. Of the four sea turtle species of concern, the population of Hawaii green sea turtles is increasing and olive ridley turtle nesting aggregations in the western Pacific appear to be somewhat stable or increasing slightly. On the other hand, leatherback and loggerhead turtles are the species most often captured by the Hawaii-based longline fishery and their Pacific populations are in general decline. Moreover, at its July 2003 meeting, the Council's Turtle Advisory Committee recommended that the Council's sea turtle conservation program focus on long term projects to obtain demographic and population abundance data on key populations of Southwest Pacific leatherbacks and North Pacific loggerheads (i.e. those species which interact with the fishery) (WPRFMC 2003b). For these reasons, these species are the focus of these conservation projects.

For leatherback sea turtles, the emphasis of these measures is placed on the western Pacific leatherback stock because the majority of interactions with the Hawaii-based longline fishery have been with this stock (16 out of 17 sampled turtles have been from the western Pacific stock). Although geneticists have been unable to trace these fishery interactions to specific nesting beaches, beaches in Papua (also known as Irian Jaya) and Papua New Guinea are believed to comprise the majority of western Pacific nesting populations and are thus most likely to contain populations affected by the fishery. Satellite telemetry data from the electronic tagging of turtles from the northern coast of Irian Jaya has also shown that these turtles are the likely source of the majority of leatherback turtles that migrate through the areas of ocean fished by the Hawaii longline fleet. In addition to the egg protection which is a necessary component of a conservation and recovery program, leatherback measures emphasize protection of adults as the fishery is known to interact with adults and sub-adults. Loggerhead measures focus on the North Pacific (Japanese) stock because all fishery interactions have been with this population. Loggerhead measures have a particular emphasis on juveniles as that is the life stage with which the fishery interacts.

Under the action alternatives, the Council would continue to collaborate with NMFS' to develop and fund contracts with experienced non-governmental organizations (NGOs) such as World Wildlife Fund - Indonesia (WWF-Indo), Kamiali Integrated Conservation Development Group (KICDG) of Papua New Guinea, the Sea Turtle Association of Japan, and Wildcoast in Baja, Mexico. The Council has worked with NMFS for over a year to successfully lay the groundwork for activities such as these (Appendix F). The conservation measures in this document have come directly from these NGOs currently working at relevant sites conducting research and population monitoring activities and were reviewed and endorsed by the Council's Sea Turtle Advisory Committee at their July 2003 meeting (see Appendix F). This committee was established by the Council to direct and advise the Council in its activities related to sea turtle conservation and sea turtle related fishery management initiatives. Committee members include world renowned experts in sea turtle biology, conservation and recovery, including several scientists from NMFS' Science Centers (see Appendix G). The committee concluded that the projects described here are viable, valuable, hold scientific merit, and should be incorporated into the management measures considered by the Council. The conservation measures described below are new projects, but cost estimates are dependent on preexisting programs. In other words, these projects are designed to augment programs already in existence to support additional conservation objectives and projects. As noted below, establishment of some of these projects has commenced in order to protect turtles during the 2003 nesting season.

Papua (formerly Irian Jaya), War-mon Beach:
The Council has contracted with the World Wildlife Fund-Indonesia (WWF-Indo), to hire villagers to protect the War-mon nesting beach at Jamursba-Medi, Bird's Head Peninsula in Papua (formerly Irian Jaya). This project builds on existing programs already established by WWF-Indo and supported by the Indonesian Government at Jamursba-Medi, the largest known

leatherback nesting site in Indonesia. WWF-Indo has achieved great success in eliciting the enthusiastic support and involvement of local people for nesting beach protection and management in this area.

This effort will monitor and protect 1/3 of the known leatherback nesting beach habitat along the north coast of Papua and protect between 90% and 100% of the currently unprotected War-mon beach at Jamursba-Medi. This effort has been estimated to result in the protection of approximately 1,000 leatherback nests per year (TAC 2003, P. Dutton, NMFS SWFSC) from predation by feral pigs, beach erosion and egg collectors. Protection may be achieved through the use of an electric fence to keep pigs off beaches, by relocating eggs to more secure areas, and deter poachers through monitoring presence. In addition, through monitoring presence, measures are expected to conserve an additional 10 adult nesting females per year from poachers. The estimated cost of this activity is $30,000 per year.

Western Papua coastal foraging grounds:
The Council has contracted with WWF-Indo to work with villagers in western Papua's Kei Kecil Islands to reduce and /or eliminate the harpooning of about 100 adult leatherback turtles per year in the coastal foraging grounds (TAC 2003, P. Dutton, NMFS SWFSC). In addition, effort will be made to explore and identify alternative food resources. The estimated cost of this activity is $75,000 per year and the first year's contract's performance period is November 1, 2003-October 31, 2004.

Papua New Guinea nesting beaches:
The Council has contracted with the Kamiali Integrated Conservation Development Group (KICDG), commencing November 1, 2003 to work with up to three villages of the Kamiali community in Papua New Guinea to eliminate egg harvesting and nest predation of leatherback eggs, and move those eggs laid in areas likely to be lost to beach erosion. Current practices have a two km section of beach marked off as a "no take" area. This effort will provide additional protection of approximately 90% of the nesting beach, and is estimated to save about 1,000 to 1,500 nests per year (TAC 2003, P. Dutton, NMFS SWFSC). The estimated cost of this activity is $48,000 per year and the first year's contract performance period is November 1, 2003 through May 31, 2004.

In addition to establishing nesting beach management measures in Papua New Guinea, the Council, NMFS PIRO/PIFSC and NMFS Southwest Fisheries Science Center (SWFSC) will conduct aerial surveys of the coastal areas of northern Papua New Guinea, Solomon Islands and Vanuatu to establish a comprehensive inventory of leatherback nesting beaches for which further conservation projects might be established. An initial feasibility study to conduct the initial surveys has been funded for late 2003 (WPRFMC in prep.), and funding has been identified for a more complete survey of northern Papua New Guinea in 2004.

Baja, Mexico halibut gillnet fishery:
The Council has contracted with Wildcoast to conduct mortality reduction workshops with fishermen and place observers on local boats to insure that all the live loggerheads that comprise

the estimated 3,000 loggerhead juveniles per year caught in the halibut gillnets are returned to the ocean (TAC 2003, P. Dutton, NMFS SWFSC). Without observers, these loggerheads become part of the catch. The estimated cost of this activity is $50,000 per year.

Japan nesting beaches:

The Sea Turtle Association of Japan (STAJ) has proposed moving loggerhead eggs from locations prone to washing out and provide shading to nests that experience extreme temperatures at two nesting beaches. A contract has been developed with STAJ for this work to begin during the May 2004 nesting season. This activity is estimated to result in saving 53 loggerhead nests (TAC 2003, G. Balazs, NMFS PIFSC), and would provide valuable benefits toward establishing cooperative working relationships. The estimated cost of this activity is about $10,000 per year and the first year's contract performance period is May 1, 2004 through October 31, 2004.

The Council will also continue to augment and expand its role in developing educational materials to support the establishment of a nesting beach management program at War-mon Beach and for the establishment of similar programs elsewhere in Melanesia.

In addition, a contract has been developed with the Ostional National Wildlife Refuge in Costa Rica to assist managers to convene workshops to reduce sea turtle mortalities in longline fisheries based in Costa Rica.

Protection of nesting beaches and coastal habitats has been proven successful in supporting the recovery of populations in a variety of locations. Please see Section 8.2.1 for a description of successful projects to date.

Finally, the expected beneficial impacts of these measures (Section 10.5) are based on the best available scientific data coupled with precautionary assumptions concerning the survival rate of eggs to adults.

These conservation projects represent a collaboration between the Council, the Pacific Islands Regional Office and NMFS' Southwest Fisheries Science Center (SWFSC), regional and local governments around the Pacific rim, conservation and wildlife groups internationally, and the fishing industry both nationally and internationally.

Roles in these conservation projects are evolving as the new Pacific Islands Region becomes established and the Council's efforts are developed. The SWFSC – which has a strong history of collaboration with the international sea turtle conservation community -- has been the technical monitor for the projects that were implemented in 2003 and is expected to continue to do so with assistance from the PIFSC and PIRO, which also serves as grants monitor. Funding for the projects comes from a variety of sources, some from NMFS base funds and some as part of cooperative agreements between NMFS and the Council based on Congressional appropriations for sea turtle research in the Pacific. PIRO focuses on the US flag states in the Pacific while the SWFSC and the Council are focusing on international projects. The roles of NGOs and the fishing industry will also develop as these projects progress into a fully formed program of sea turtle conservation in critical areas throughout the Pacific. The continuation of these projects as well as the initiation of the new projects proposed by the Council is subject to the availability of funds. Nonetheless the Council is committed to this approach as part of a broad sea turtle conservation effort.

In addition to the measures described above, a Council advisory group formed to provide technical advice on the implementation of the proposed action has suggested that NMFS hold dockside or other sessions to educate participants in the model swordfish fishery on the proper use of circle hooks with mackerel-type bait, and to educate all fishery participants on the appropriate use of dehookers. This group also suggested that NMFS consider providing 100% observer coverage for the model swordfish fishery for at least the first year, as this would provide complete information on the frequency and nature of fishery interactions with sea turtles as well as detailed information on the fishing practices of all vessels. Regardless of observer coverage, the group recommended that if realtime estimates are necessary and practicable, NMFS provide observers with a reliable means of shoreside communications for them to call-in immediately if interactions are observed.

8.2.1 Sea turtle programs with published recovering population trends

When considering the proposed conservation measures, it is important to keep in mind the conservation strategies employed by sea turtle programs throughout the world, many of which have gained measurable success in the recovery of once depleted nesting stocks. The first sea turtle monitoring and research program began in 1955 at Tortuguero, Costa Rica by Archie Carr (Carr et al. 1978). To date, this 22-mile (35 km) beach hosts the largest green sea turtle rookery in the Western Hemisphere (Bjorndal 1999). Since the inception of this program, sea turtle research, conservation and monitoring programs have been established globally by national and international government, academic, and non-governmental organizations (NGOs). Programs vary extensively in their monitoring, conservation and management strategies to address threats occurring at each individual location. Although many programs struggle with funding support, resource availability, political will and public involvement, a number of programs have achieved measurable success in the recovery of once depleted nesting stocks. In addition, a few programs appear to have survived the intense harvest pressures of the 20th century and can boast of stable population trends over the past 30 years. These stable nesting populations include the green sea turtle stock at Terengganu, Malaysia (Liew 2002); Western Australia (Limpus 2002); and the Galapagos Islands, Oman and Saudi Arabia (Seminoff 2002; although these last three sites have been monitored for less than 20 years).

The evaluation of sea turtle nesting trends requires many years of data because of the large degree of annual variation in nesting numbers. Between 20 and 30 years of program viability may be necessary to identify recovering population trends. Therefore, a long-term commitment is essential to ensuring the visible result of the conservation values assessed for each of the conservation measures. It is also important to note that nesting beach monitoring assesses trends in only one segment of the population (mature females), and this may or may not represent the trend of the entire population.

The following 23 programs are those with published recovering trends (Table 3). These populations should not be considered recovered, but recovering. In other words, conservation efforts must be viewed as a permanent, lifetime commitment. In these recovering projects, *nesting beach management* refers to any combination of strategies that may have been employed, including: education and awareness campaigns; community and/or fishermen integration; development of economic alternatives; egg/nest protection; and/or physical manipulation of nesting beaches to promote nesting success including the implementation of hatcheries (in-situ or otherwise), removal of beach debris or light reduction. *Egg protection* refers to management where emphasis is placed on eggs and/or nests. In this strategy, eggs/nests are relocated to prevent egg loss through beach erosion, predation or poaching. Eggs may or may not be relocated to hatcheries, but the emphasis is in egg/nest protection by whatever means necessary (including shading of nests to prevent overheating of eggs during extreme temperatures). Management efforts geared to *eliminate/reduce direct harvest* (of adults, juveniles or eggs) are achieved through education, laws and/or monitoring presence. In many instances, the elimination or reduction of harvest was achieved by the closure of once active sea turtle fisheries (e.g., olive ridleys in Oaxaca, Mexico, and shell harvest of hawksbills of the Yucatan Peninsula, Mexico). Additional management efforts also include head starting (i.e. Kemps ridleys), and fishery management technology (e.g., use of Turtle Excluder Devices (TEDs)). Please see Appendix E for an update on the Council’s ongoing turtle conservation program.

Table 3. Nesting stocks with conservation and mitigation programs and published recovering population trends.

Location (Year Established)	Species	Conservation Method Used	Primary Citation
CARIBBEAN/ATLANTIC			
Costa Rica, Tortuguero (1971)	GR	Nesting beach management Egg protection Eliminate/reduce direct harvest	Bjorndal 1999
Guyana, South America (1988)	GR; HB; LB; OR	Eliminate/reduce direct harvest Egg protection Nesting beach management	Tambiah 1995
Surinam, South America (1968-1985)	LB	Nesting beach management Egg protection	Reichart & Fretey 1993
French Guiana, ***** South America (1978)	LB	Nesting beach management Egg protection	Girondot 1996 *
Antilles, Bonaire, West Indies (1991)	HB, LH	Eliminate/reduce direct harvest Nesting beach management Education	van Eijck & Valkering 2000
Florida (1967)	GR, LH	Nesting beach management Egg protection	Pritchard 1982; Meylan et al. 1994
Sandy Point, St. Croix (1981)	LB	Egg protection Nesting beach management	Dutton et al. 1996
Buck Island, St. Croix (1980)	HB	Eliminate/reduce direct harvest Egg protection Nesting beach management	Hillis-Starr 2000
Ascension, Island (1977)	GR	Egg protection Nesting beach management	Godley 2001
Mexico, Rancho Nuevo [Padre Island, Texas] (1963)	Kemps Ridley	Head starting Fishery = TEDs Nesting beach management	Marquez. et al.1999
Tamaulipa, Mexico (1966)	Kemps Ridley	Eliminate/reduce direct harvest Fishery = TEDs Nesting beach management	Sarti et al. 2000
Mexico, Yucatan Peninsula (1977)	HB, GR	Eliminate/reduce direct harvest Egg protection Nesting beach management	Guzman. et al. 1999
Brazil, projeto TAMAR (1980)	HB, GR	Eliminate/reduce direct harvest Egg protection Nesting beach management	Marcovaldi et al. 1999
EAST PACIFIC			
Mexico, Oaxaca Mexico, La Escobilla (1973)	OR	Eliminate/reduce direct harvest Egg protection Nesting beach management	Marquez 2000

Ostional, Costa Rica (1988)	OR	Eliminate/reduce direct harvest Egg protection Nesting beach management	Ballestero 2000
AFRICA			
Seychelles (1971)	GR, HB	Nesting beach management Egg protection	Mortimer 2000; Mortimer 1999
South Africa, Tongaland (1963)	LH, LB	Egg protection	Hughes 1996
Comoros Islands, West Indian Ocean (1972)	GR	Eliminate/reduce direct harvest Egg protection	Woodworth 1992; Seminoff 2002
South Africa, Europa & Tromelin (1973)	GR	Egg protection	Hughes 1982
WEST PACIFIC/SE ASIA			
PNG, Mussau Island, Bismarck Sea (1930)	GR	Eliminate/reduce direct harvest Egg protection Religion (7^{th} Day Adventists)	Pritchard 1982
Great Barrier Reef, Australia (1985-92)	GR	Eliminate/reduce direct harvest Nesting beach management	Chaloupka & Limpus 2001
Sabah Turtle Islands Malaysia/Philippines (1965)	GR, HB	Eliminate/reduce direct harvest Egg protection Nesting beach management International cooperation	Liew 2002 Basintal 2002
CENTRAL PACIFIC			
Hawaii (1973)	GR	Eliminate/reduce direct harvest Nesting beach management	Balazs 2003

* A general increase has been observed, but actual trend is unclear

9.0 Relationship to Other Applicable Laws and Provisions of the Magnuson-Stevens Act

9.1 National Environmental Policy Act

This section has been prepared in accordance with the requirements of the National Environment Policy Act of 1969, to assess the impacts on the human environment that may result from the preferred alternative. In March 2001, NMFS published an FEIS concerning the ongoing operations of the pelagic fisheries managed under the Pelagics FMP of the Western Pacific Region (NMFS, 2001). That comprehensive analysis examined a range of issues facing pelagic fisheries including their association with endangered and threatened sea turtles, and provided an extensive discussion of these species and the pelagic environment. For further details, please see the complete FEIS, which is available from the NMFS' Pacific Islands Regional Office (PIRO, 1601 Kapiolani Blvd. Suite 1110, Honolulu, HI 96814). The following Supplemental Environmental Impact Statement (SEIS) to the 2001 FEIS provides background and new information and specifically examines the impact of the use of circle hooks with mackerel-type bait to reduce interactions with sea turtles.

The following SEIS includes information from the 2001 FEIS, as well as from the Council's 1999 and 2000 Annual Reports on the Pelagic Fisheries of the Western Pacific Region (available from the WPRFMC, 1164 Bishop St. Suite 1400, Honolulu, HI 96813), and recent fishery information from NMFS' PIFSC and other sources.

The following SEIS (Sections 9.0 through 14.0) incorporates by reference the cover sheet, table of contents, list of preparers, list of agencies, public review process and schedule, list of references, responses to comments, and index, as well as the discussion the purpose and need for action, and the description of its alternatives from other sections of this document as indicated. It also incorporates by reference pp. 3-5 to 3-450 of Chapter 3 of NMFS' 2001 FEIS.

9.1.1 Purpose and need for action

The purpose and need for action are described in Section 5.0 of this document.

9.1.2 Objective of this SEIS

The objective of this SEIS is to supplement the analyses provided in the 2001 FEIS. Those analyses provided a comprehensive look at a wide range of issues and alternatives designed to achieve the objectives of the Pelagics FMP. This SEIS focuses on the issue of fishery interactions with sea turtles and supplements earlier information with new data on the use of circle hooks and other technologies to reduce and mitigate these interactions, as well as updated information on fisheries managed under the Pelagics FMP. Given the focus on management issues involving listed sea turtle interactions with the Hawaii-based longline fishery since the March 2001 FEIS, as well as related litigation work, court determinations, and public input generated in the context of ongoing Council and NMFS deliberations described earlier in this document comments received during the SEIS scoping comment period were considered in the context of the considerable body of existing information (A description of the public and scoping meetings held to date is provided in Section 4.2). In particular, comments focused on types of gear used and frequency of interactions with listed sea turtles, effects of court ordered fishery management actions, effects of management actions to date on Hawaii-based longline fishing and listed sea turtle populations, the significance of other fisheries (US and non-US) on listed sea turtle populations, the nature of the management approach to be taken, recent data on Pacific sea turtle populations, evolving data on gear types such as circle hooks and mackerel-type bait, combinations of management tools including closed areas and conservation measures and cumulative effects. New input and information was used to refine and define more specifically the scope and significant issues to be analyzed in detail in this SEIS.

9.1.3 Description of the alternatives

A description of the alternatives considered is provided in Section 8.0 of this document.

9.1.4 Description of the affected environment given cumulative impacts to date

This section provides information on the environment in which the Pelagics FMP fisheries exist and includes background and historical information, as well as new information where available.

9.1.4.1 Regulatory environment

This section details the regulations in place for the pelagic fisheries as of November 25, 2003. Those believed to have been remanded by the Judge's August 31, 2003 order (and reinstated through April 1, 2004 by the subsequent October 6, 2003 Court order) are indicated by strike outs and explanatory annotations are provided. All discussion of potential regulatory measures is predicated on the understanding that the following presentation is accurate.

1 Fishing for PMUS in EEZ waters of the Western Pacific Region with drift gillnets is prohibited (52 FR 5987, March 23, 1987).

2 Vessels using longline gear to fish for PMUS in EEZ waters of the Western Pacific Region and vessels transporting or landing longline-harvested PMUS shoreward of the outer boundary of these same EEZ waters must be registered for use with a general longline permit and must keep daily logbooks detailing species harvested, area of harvest, time of sets and other information. Also, longline gear used in EEZ waters of the Western Pacific Region must be marked with the official number of the permitted vessel that deploys the gear (56 FR 24731, May 1991).

3 Hawaii-based longline vessels must carry a NMFS observer if requested to do so (55 FR 49285, November 1990; 58 FR 67699, December 1993).

4 Each vessel that uses longline gear to fish for PMUS in EEZ waters around Hawaii, or is used to transport or land longline-harvested PMUS shoreward of the outer boundary of the EEZ around Hawaii, must be less than 101 feet in length and registered for use with one of 164 Hawaii-based longline limited entry permits (59 FR 26979, June 1994).

5 As requested by NMFS, all vessels registered for use with a Hawaii-based longline limited access permit must carry and use a NMFS-owned VMS transmitter (59 FR 58789, November 1994). Longline fishing for PMUS is prohibited in circular areas (known as "protected species zones") 50 nm around the center points of each of the NWHI islands and atolls, plus a 100 nm wide corridor connecting those circular closed areas that are non-contiguous (56 FR 52214, October 1991). To avoid gear conflicts with troll and handline fisheries near the MHI, longline fishing is prohibited in areas approximately 75 nm around the islands of Kauai, Niihau, Kaula, and Oahu, and approximately 50 nm off the islands of Hawaii, Maui, Kahoolawe, Lanai and Molokai. This prohibition is lessened from October 1 through January 30, when the longline closed areas decrease on the windward sides to approximately 25 nm off Hawaii, Maui, Kahoolawe, Lanai, Molokai, Kauai, Niihau and Kaula and

approximately 50 nm off Oahu (56 FR 28116, June 1991)[2]. Longline fishing is also prohibited in an area approximately 50 nm around Guam (57 FR 7661, March 1992).

6 Domestic vessels greater than 50 feet, except as exempted, are prohibited from fishing for PMUS within approximately 50 nm around the islands of American Samoa, including Tutuila, Manua and Swains Islands and Rose Atoll (67 FR 4369, January 30, 2002).

7 Federal regulations implementing the Shark Finning Prohibition Act prohibit any person under U.S. jurisdiction from engaging in shark finning, possessing shark fins harvested on board a U.S. fishing vessel without corresponding shark carcasses or landing shark fins harvested without corresponding carcasses (67 FR 6194 February 11, 2002).

8 Any domestic fishing vessel that employs troll or handline gear to target PMUS in EEZ waters around the U.S. PRIA must be registered for use with a permit issued by NMFS and must maintain and submit daily logbooks detailing species harvested, area of harvest, fishing effort and other information, including interactions with protected species (67 FR 30346, May 6, 2002).

9 Vessels registered to Hawaii limited-access longline permits operating north of 23° N lat. must use line setting machines with a weight of at least 45 g attached to each branch line within one m of each hook or employ traditional basket-style longline gear when setting longline gear to fish for PMUS; use thawed blue-dyed bait; and discharge offal strategically (67 FR 34408, May 14, 2002). The operator and crew of all vessels registered to Hawaii limited access permits who accidentally hook or entangle an endangered short-tailed albatross must also employ specific handling procedures (67 FR 34408, May 14, 2002). *History: on 5/14/02 a final rule implementing the 2000 FWS BiOp was published. This rule noted in its preamble that although "shallow swordfish-style setting is currently prohibited by an emergency rule implemented to protect sea turtles, the USFWS BiOp requires that vessel operators making shallow sets north of 23 N. latitude 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."*

10 All vessels registered for use with Hawaii limited access ~~or longline general permits, as well as domestic pelagic troll and handline vessels fishing for PMUS in EEZ waters of the Western Pacific Region~~, are required to employ sea turtle handling measures. Specifically, vessels that have a freeboard of three feet or more must carry aboard their vessels line clippers meeting the NMFS minimum design standards, including a 6-foot handle, as well as wire or bolt cutters capable of cutting through the vessel's hooks. These items must be used to disengage any hooked or entangled sea turtles with the least harm possible in accordance with the handling, resuscitation and release requirements. Vessels that have a freeboard of three feet or less must carry aboard their vessels line clippers capable of cutting the vessel's fishing line or leader within approximately one foot of the eye of an embedded hook as well as wire or bolt cutters capable of cutting through the vessel's hooks. These items must be used to disengage any hooked or entangled sea turtles with the least harm possible in

2A few longline vessel owners qualify for exemptions to fish in portions of longline closed areas around the MHI where they can document historical longline fishing activity prior to 1970.

accordance with the handling, resuscitation, and release requirements. In addition, all incidentally taken sea turtles brought aboard these vessels for dehooking and/or disentanglement must be handled in a manner to minimize injury and promote post-hooking survival. When practicable, comatose sea turtles must be brought on board immediately, with a minimum of injury. If a sea turtle is too large or hooked in such a manner as to preclude safe boarding without causing further damage/injury to the turtle, line clippers meeting the NMFS standards must be used to clip the line and remove as much line as possible prior to releasing the turtle. If a sea turtle brought aboard appears dead or comatose, the sea turtle must be placed on its bottom shell or plastron, so that the turtle is right side up and its hindquarters elevated at least six inches for a period of no less than four hours and no more than 24 hours. The turtle must be shaded and kept damp or moist, but under no circumstances placed in a container holding water. The turtle should be periodically rocked gently left to right and right to left by holding the outer edge of the shell (carapace) and lifting one side about three inches and then alternate to the other side. A reflex test must be performed at least every three hours to see if the turtle is responsive. Turtles that revive and become active must be gently returned to the sea; those that fail to revive in 24 hours must also be returned to the sea. (65 FR 16346, March 28, 2000; 66 FR 67495 December 31, 2001; 67 FR 40232, June 12, 2002). Note: Bringing sea turtles aboard vessels is only required "when practicable"; this action is not likely to be practicable on many non-longline vessels. *History: a proposed rule was published on 2/17/00 that cited NMFS' 1998 BiOp's ITS, as well as a 9/26/99 court order directing NMFS to require "every vessel with a Hawaii longline permit to carry and use line clippers and dip nets to disengage hooked or entangled sea turtles." In addition, the rule imposed handling requirements. This rule was finalized on 3/28/00. On 12/31/01 the handling requirements were slightly revised due to findings by NMFS that pumping a turtle's plastron may be detrimental. On 6/12/02, in a final rule that "implements the reasonable and prudent alternative of the March 29, 2001 BiOp," the mitigation gear and handling requirements were enlarged to include American Samoa longline, and non-longline vessels, as well as slightly relaxed for vessels with less than 3' in freeboard (based on a request from the Council and PIRO).*

11 Operators and owners of vessels registered to Hawaii limited access permits ~~or longline general permits (after August 31, 2002)~~ must annually attend protected species workshops conducted by NMFS that discuss sea turtle and seabird biology, conservation and mitigation techniques (67 FR 34408, May 14, 2002; 67 FR 40232, June 12, 2002). *History: on 5/14/02 a final rule implementing the 2000 FWS BiOp was published. This rule appears to require both the owner and operator of Hawaii registered longline vessels to annually attend protected species workshops sponsored by NMFS. The 6/12/02 final rule extended the requirement to include operators of vessels registered to longline general permits.*

12 ~~A Hawaii longline limited access permit may be re-registered to a vessel only during the month of October, if its owner had previously de-registered that from its permit vessel after March 31, 2001 (67 FR 40232, June 12, 2002).~~

13 ~~Vessels registered to Hawaii limited access permits are prohibited from using longline gear to catch PMUS or engaging in fish transshipping operations supporting~~

~~longline fishing from April 1 through May 31 in waters between the equator and 15°N lat. and from 145°W to 180° long. (67 FR 40232, June 12, 2002).~~

14 ~~Vessels registered to Hawaii limited-access or general longline permits are prohibited from using longline gear to fish for or target swordfish north of the equator. When fishing north of the equator, these vessels must deploy longline gear such that the deepest point of the main longline between any two floats, i.e., the deepest point in each sag of the mainline, is at a depth greater than 100 m below the sea surface. The length of each float line used to suspend the main longline beneath a float must be longer than 20 m with no fewer than 15 branch lines set between any two floats if the main longline is monofilament set by a line setting machine or no fewer than 10 branch lines between any two floats if the main longline is non-monofilament line set by traditional basket-style technique. In addition, the possession or use of light sticks or any other light-emitting device, such as glow worms or glow beads, as artificial lures to attract and catch swordfish north of the equator is prohibited (67 FR 40232, June 12, 2002).~~

15 ~~Vessels registered to Hawaii limited access or general longline permits are prohibited from possessing or landing more than 10 swordfish on any fishing trip that included any fishing north of the equator (67 FR 40232, June 12, 2002).~~

In December 2000, Congress passed a bill amending the Magnuson-Stevens Act in order to implement a nationwide ban on landing of shark fins without the shark carcass. A final rule became effective March 13, 2002.

Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve: The Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve was established by Presidential Executive Orders 13178 (December 4, 2000) and 13196 (January 18, 2001). The Executive Orders prohibit commercial pelagic fishing within the boundaries of the reserve except for pelagic trolling by fishers who had Federal NWHI bottomfish permits on December 4, 2000. Recreational fishing for pelagic fish in the reserve is capped at historical levels yet to be determined.

State and Territorial Pelagic Fishery Management in EEZ Waters around American Samoa, Guam, CNMI and Hawaii: The Territory of American Samoa has two sets of regulations to manage the longline fishery in EEZ waters that surround it. The first, a framework adjustment, delineates a 50 nm exclusion zone for longliners measuring more than 50 feet in length, and the second defines a limited entry program for longliners (Amendment 11 to the Pelagics FMP). Guam and the CNMI have no regulations that affect pelagic fishing activities in territorial waters, although fishing vessel registration is required. In American Samoa, some villages impose fishing curfews on Sundays (R. Tulafono, Director DMWR, pers. comm.). The State of Hawaii prohibits the sale of yellowfin and bigeye tuna (both known in Hawaii as *ahi*) weighing less than three pounds if landed by any domestic fishery. The State also requires fishers who sell any portion of their catch to hold a commercial marine license and file catch reports.

9.1.4.2 Natural environment

This section provides background information on the natural environment in which the Pelagics FMP fisheries operate and is largely drawn from Chapter 3 of the 2001 FEIS (pp. 3-5 to 3-450, which are hereby incorporated by reference).

The Hawaiian Archipelago and the Marianas Archipelago, which includes Guam and CNMI [the Commonwealth of the Northern Mariana Islands], 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.

A significant source 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).

9.1.4.3 Pelagics FMP fisheries

The Pelagics FMP manages unique and diverse fisheries. 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. These fisheries are discussed below, first by sector (commercial, recreational and charter) and then by gear type.

Due to the issuance of series of court orders and BiOps focused on the Hawaii-based longline fleet's interactions with sea turtles, the swordfish sector of this fishery has been effectively closed since March 31, 2001, when a court order prohibiting swordfish-style gear configurations north of the equator (shallow-setting) was issued.

This remainder of this section provides background information on the fisheries managed under the Pelagics FMP and is drawn from the 2001 FEIS' Chapter 3 (pp. 3-152 - 3-161).

Commercial Fisheries: The Hawaii-based pelagic longline fleet is the largest fishery managed by the FMP. 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. These sets must be placed by use of a line shooter to provide slack in the line which allows it to sink.

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.

Charter and Recreational Fisheries: 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.

Hawaii Fisheries: 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 85 percent of Hawaii's commercial pelagic landings (28.6 million lb) in 1998 (Ito and Machado 1999). 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 permit moratorium. Vessels with a Western Pacific general permit may not land longline caught fish in Hawaii. Conceivably, longline vessels with a general permit could catch swordfish with shallow sets beyond the 200 mile EEZ around Hawaii and tranship to a Hawaii-based vessel with a receiving permit. However there is no record of such an operation over the entire history of the Hawaii-based longline fishery.

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. Float line lengths average 22 m (72 feet) and branch line lengths average 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 4. Fishery information for Hawaii pelagic fisheries for 1998. Source: Adapted from WPRFMC, 1998 Annual Report; Our Living Oceans 1999 Report *in* NMFS, 2000j.

Gear/Vessel Type	Longline	Troll/Handline Fisheries	Pole-and-line Fishery (*Aku* Fishery)
Area Fished	EEZ around Hawaii (25-200 nm) and high seas	Inshore and EEZ	Inshore and EEZ
Total Landings	28.6 million pounds	4,570,000 pounds	696,000 pounds
Catch Composition	24% bigeye tuna 24% pelagic sharks 12% albacore tuna 11% swordfish 6% yellowfin tuna	yellowfin tuna skipjack tuna *mahimahi* Wahoo striped marlin bigeye tuna (catch percentages are unknown)	99.6% skipjack tuna
Season	All year	All year	All year
Active Vessels	114	1,824	6
Total Permits	164 (transferable) (Limited Entry)	NA	NA
Total Trips	1,140	26,203	223
Total Ex-vessel Value	$46.7 million	$7.2 million	$0.9 million

<u>American Samoa, Guam and Northern Mariana Islands Fisheries</u>

American Samoa-based pelagic fisheries consist of a small fleet of *alia* longliners, a growing fleet of mid-size and larger longliners, and a small fleet of trolling vessels. CNMI is home to an active trolling fleet and several charter sportfishing vessels, as was Guam prior to the December 2002 super typhoon. The extent of damage to Guam's fishing fleet and infrastructure is unknown at this time, however, significant losses are anticipated. American Samoa longline vessels currently fish under a general permit, but a limited entry program for this fishery is currently nearing completion. American Samoa vessels could conceivably fish north of the equator and make shallow sets for swordfish but have no history of doing so. Moreover, the American Samoa fleet targets primarily albacore for the two fish canneries in Pago Pago, and there is little to no market for fresh swordfish in American Samoa. More importantly, there is no easy access to markets elsewhere on the U.S. mainland, unlike Hawaii, where most of the swordfish catch was sent. Two general longline permits have been issued in the Mariana Islands, one in Guam and the other in Commonwealth of the Northern Mariana Islands (CNMI). Neither permit is being used to conduct longline fishing from these locations. Further, based on historical data from other fleets, any longline fishing conducted around the Marianas would target tunas and not swordfish.

In general, the fishing fleets in American Samoa, Guam and CNMI target albacore, skipjack tuna, yellowfin tuna, and other pelagic species, and in 1998, made landings ranging from 25,000 pounds by American Samoa trollers to 884,000 pounds by American Samoa *alia* longliners.

Table 5. Pelagic fishery information for American Samoa, Guam, and CNMI, 1998.
Source: Adapted from WPRFMC, 1999d; Our Living Oceans 1999 Report *in* NMFS, 2000j; data provided by Hamm, 2000.

Islands	**American Samoa - 1998**		**Guam - 1998**	**CNMI - 1998**
Gear	**Longline**	**Troll/Charter**	**Troll/Charter**	**Troll/Charter**
Area Fished	Inshore and EEZ	Inshore and EEZ	Inshore and EEZ	Inshore and EEZ
Total Landings	884,154 lb	25,271 lb	817,087 lb	192,568 lb*
Catch Composition	72% albacore tuna 8% yellowfin tuna < 5% all others	74% skipjack tuna 6% barracuda 4% yellowfin tuna < 4% all others	31% mahimahi 23% skipjack tuna 19% yellowfin tuna	70% skipjack tuna 11% mahimhai 8% dogtooth tuna 6% yellowfin tuna
Season	All year	All year	All year	All year
Active Vessels	25	24	438	89
Total Permits	50 (open access)	NA	NA	NA
Total Trips	2,359	123	14,324	2,230
Total Ex-vessel Value	$968,361**	$29,949**	$711,066***	$398,086

*Landings for CNMI are recorded commercial landings, but not all commercial landings are recorded (D. Hamm, NMFS SWSFC-HL, pers. comm., November 3, 2000).
**The ex-vessel value of landings in American Samoa was determined to be inaccurate as originally listed in NMFS 2000j. The values shown were estimated as 97 percent of total gross revenue from longliners, and three percent of total gross revenue for the troll fleet (Hamm, 2000).
***Total ex-vessel value of landings in Guam are estimated from commercial landings, which are less than 50 percent of total landings.

9.1.4.4 Additional information on FMP fisheries

This section presents new and updated information, not available at the time the 2001 FEIS was written, on the fisheries described above.

Table 6. Hawaii-based longline fishery landings 1999-2002 (Source: NMFS, PIFSC, published and unpublished data)

Item	1999	2000	2001	2002	Jan. - June 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	17.2	9.2
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	104
Total Permits	164	164	164	164	164
Total Trips	1,137	1,103	1,034	1,164	650
Total Ex-vessel Value (nominal) ($millions)	$47.4	$50.2	$33.0	$37.5	$17.9

* Number of fish

Table 7. Fishery information for Hawaii pelagic fisheries for 2000 (Sources: Adapted from WPRFMC, 2002)

Gear/Vessel Type	**Troll/Handline**	**Pole-and-line Fishery (*Aku* 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 Permits	NA	NA
Total Trips	18,700	198
Total Ex-vessel Value	$8 million	$1.1 million

Note: Data do not include all landings for recreational fishers.

Table 8. American Samoa-based longline fishery vessel operations and landings (Source: WpacFIN, 2003)

Time period	1999	2000	2001	2002	Jan. - June, 2003
Active vessels	72	35	68	61	43
Total sets	2,112	2,814	4,801	6,861	2,363
Total landings (numbers of fish)	29,540	46,393	216,875	423,023	161,942
Catch composition:					
Albacore	53%	69%	86%	79%	55%
Skipjack	15%	5%	4%	11%	15%
Yellowfin	15%	13%	4%	4%	12%
All others	<2%	<2%	<2%	<4%	6%

Table 9. Pelagic Fishery Information for American Samoa, Guam, and CNMI, 2000. (Source: Adapted from WPRFMC, 2001)

Island Area	**American Samoa**		**Guam**	**CNMI**
Gear	**Longline**	**Troll/Charter**	**Troll/Charter**	**Troll/Charter**
Area Fished	Inshore and EEZ	Inshore and EEZ	Inshore and EEZ	Inshore and EEZ
Total Landings	1,892,423	23,014	643,149	146,880*
Catch Composition	72% albacore tuna 8% yellowfin tuna < 5% all others	74% skipjack tuna 6% barracuda 4% yellowfin tuna < 4% all others	31% mahimahi 23% skipjack tuna 19% yellowfin tuna	70% skipjack tuna 11% mahimahi 8% dogtooth tuna 6% yellowfin tuna
Season	All year	All year	All year	All year
Active Vessels	37	19	416	107
Total Permits	59 (open access)	NA	NA	NA
Total Trips	3,214	283	13,204	2,084
Total Ex-vessel Value	$1,987,044	$24,164	$641,081**	$275,758

Notes:*Landings for CNMI are recorded commercial landings, but not all commercial landings are recorded (D. Hamm, NMFS SWSFC-HL, pers. comm., November 3, 2000).

**Total ex-vessel value of landings in Guam are estimated from commercial landings, which are less than 50 percent of total landings.

Not discussed in the FEIS is the limited historical pelagic fishing activity and effort (other than that conducted by longline vessels) in the Pacific Remote Island Areas (PRIAs, Johnston, Midway and Palmyra Atolls, Wake, Jarvis, Howland and Baker Islands, and Kingman Reef). Although longline vessels that fish in the waters of the Exclusive Economic Zone (EEZ) around the PRIA have been required to be registered under a longline general permit or the Hawaii-based longline limited access permit for some time, other pelagic vessels did not have federal permit and reporting requirements until May of 2002.

Prior to that time, two Hawaii-based troll and handline vessels were known to have fished in EEZ waters around Palmyra Atoll and Kingman Reef targeting pelagic (including yellowfin and bigeye tunas, wahoo, *mahimahi*, and sharks) and bottomfish species. Catch and effort data on these vessels are unavailable.

Since the broad implementation of permit and reporting requirements, there have been no permits issued or reports submitted from non-longline vessels targeting pelagic species around the PRIAs.

Recent plans for a sportsfishery based on Palmyra Atoll appear to have fallen through, as did an earlier attempt to establish a transhipping station utilizing Palmyra's airstrip. Although a small charter and recreational fishery was based on Midway Atoll during the late 1990s, it is now defunct due to a lack of vendor interest.

The presence of a California-based longline fishery was briefly discussed in the FEIS. At the time the FEIS was written, the majority of these were vessels that were based in Hawaii and registered to Hawaii permits, but would move to California to seasonally fish swordfish as this allowed them to target ground further east than they could reach from Hawaii. In the latter part of 1997, 15 longline vessels migrated to California and fished mainly swordfish for the remainder of the year. The number of Hawaii-based longline vessels migrating to California increased slightly in 1998 (WPRFMC, 1999d). There were 18 Hawaii-based longline vessels that transited to California in the latter part of 1998 (Ito and Machado, 1999). Six East Coast vessels returned in 1998, but switched from targeting swordfish to tuna (Ito & Machado, 1999). In 1999,over 30 Hawaii-based longliners fished out of California (NMFS, 2000e; Dang, pers. comm.).

Longline vessels operating out of California primarily target swordfish and retain marketable non-target species such bigeye tuna, albacore tuna, and thresher shark (please refer to Table 10). Logbook information and observer data indicates that the California longline fishery interacts with protected sea turtles. Currently, the Pacific Fisheries Management Council is developing an FMP for Highly Migratory Species and is undergoing a section 7 consultation as required by the ESA.

Table 10. Pelagic fishery information for California-based longline fishery (Source: PIFSC, NMFS logbook data 1995-2002). * number of fish kept

Year	Number of vessels	Number of trips	Number of sets	Number of hooks	Total Landings*	Landings composition
1995	10	36	311	251,704	3,023	22% swordfish 19% blue marlin 9% albacore tuna 9% moonfish <8% all others
1996	15	71	678	550,420	12,815	35% blue marlin 16% swordfish 13% moonfish 12% thresher shark <6% all others
1997	25	55	663	518,841	14,105	40% swordfish 35% blue marlin 10% thresher shark 8% bigeye tuna <2% all others
1998	28	70	922	738,739	16,899	36% swordfish 25% blue marlin 10% bigeye tuna 9% thresher shark 7% blue shark <5% all others
1999	37	101	1,430	1,143,066	27,282	36% swordfish 22% blue marlin 9% moonfish 8% bigeye tuna 7% albacore tuna <5% all others
2000	44	138	2,117	1,621,493	36,169	56% swordfish 27% mahimahi 7% albacore tuna 5% bigeye tuna <2% all others

2001	38	109	1,621	1,218,790	30,551	56% swordfish 18% mahimahi 9% blue shark 7% bigeye tuna 7% albacore tuna <1% all others
2002	21	91	1,294	948,657	25,507	69% swordfish 26% blue shark 2% bigeye tuna <1% all others

9.1.4.5 Other pelagic fisheries in the Central and Western Pacific Ocean

Fisheries managed under the Pelagics FMP compete with a variety of foreign fleets operating on the high seas and within the EEZs of many Pacific nations. Large-scale, distant-water foreign fisheries include three gear types: longline, pole-and-line and purse seine. Between 1999 and 2001, Hawaii-based longline vessels are estimated to have exerted only about 3% of the pelagic longline effort in the Pacific

This section examines patterns and trends in the geographical distribution of US and foreign tuna and swordfish fisheries currently operating in the Pacific Ocean. Information on fishery development and recent activities were incorporated from reports and data from national or regional fisheries agencies (e.g., National Research Institute of Far Seas Fisheries (Japan), National Fisheries Research and Development Institute (Korea) and the Overseas Fisheries Development Council (Taiwan), Inter-American Tropical Tuna Commission (IATTC), the Commonwealth Scientific and Industrial Research Organization (CSIRO) and the Secretariat of the Pacific Community (SPC)).

Tables 11-14 summarize the purse seine, longline, pole-and-line and troll fisheries in the Western and Central Pacific Ocean. Table 15 presents aggregate summaries for purse seine and longline fisheries in the Eastern Pacific Ocean. Purse seine catches form the bulk of the catch in both parts of the Pacific, with fleets targeting primarily skipjack tuna in the Western Pacific and yellowfin tuna in the Eastern Pacific. Current total Pacific purse seine catches are just over 1.6 million mt of fish.

Pole-and -line fishing has declined in the Pacific over the last 50 years, with most of the catch from this method of fishing now produced by Japan’s long-range pole-and-line vessels. Pole-and-line fishing is highly selective, with most of the catch comprising skipjack fished from surface schools.

Longline fisheries across the Pacific catch about 260,000 mt, with most of the catch (80%) being caught in the Western and Central Pacific. Longliners target primarily yellowfin, bigeye and albacore tuna, with significant amounts of swordfish being taken by longliners in New Zealand, New Caledonia, Australia, Japan and Taiwan.

Apart from small near shore coastal trollers, which target a variety of pelagic fishes, there are more than 800 high seas troll vessels which target albacore tuna in the North and South Pacific. These vessels catch annually about 18-20,000 mt of albacore, with the majority of vessels operating in the North Pacific.

Directed swordfish fisheries

In addition to the sector of the Hawaii-based longline fishery which targeted swordfish prior to 2000, there are several foreign fleets (e.g., longline, gillnet and harpoon) that target swordfish in the Pacific. While most of the Pacific longline effort targets tuna species, shallow-set swordfish longlining has a higher incidence of encountering a protected or endangered species. Information on swordfish fisheries largely comes from reviews by Takahashi and Yokawa (1999), and Ward and Elscot (2000).

Foreign longline fisheries specifically targeting swordfish occur in Japan, Chile and Australia. Moderate catches of swordfish occur as bycatch in the tropical tuna fisheries, domestic Taiwan fishery and the Japanese tuna fishery in the eastern Australian fishing zone. Japanese longline fisheries are classified into three categories based on vessel size: coastal (10-20 gt), offshore (20-120 gt) and distant-water vessels (120-500 gt). Japanese offshore and distant-water vessels produce annual catches of about 11,000 mt. In the north Pacific, the longline catch was over 9,000 mt in 1985 and 1987, declined to 4,800 mt during 1991 and fluctuated between 6,000 and 8,000 mt since 1992. The offshore and distant-water Japanese catch in the north Pacific represents about 55 percent of the Pacific-wide catch. Catches in the coastal Japanese longline fleet were less than 1,000 mt in the 1980s, but increased to about 1,300 since 1993. The coastal and offshore fleets participate in a directed swordfish fishery in the Higashioki fishing grounds where the largest longline catches and catch rates occur. The Higashioki grounds are between 140˚-180˚E. and 20˚-45˚N., geographically to the west of where the Hawaii-based longline fishery operates. Fishing methods by the Japanese swordfish fleets are similar to the former Hawaii-based swordfish fleet: night fishing with three or four branchlines between each float which results in a shallow gear configuration.

Activity by domestic Australia longliners increased substantially during the late 1990s, with many larger vessels entering the fishery, thereby extending the range of longline activities further offshore. Fishing effort doubled from four million hooks in 1996 to nine million in 1998 and has remained stable thereafter. Over the same period, swordfish catches increased from 456 mt to 1,355 mt and reached a peak at 1,844 mt in 1999. Bycatch is monitored on CSIRO research cruises and on Japanese fishing vessels. The swordfish fishery is relatively new and there is potential for longliners to interact with turtles (Ward and Elscot, 2000). In particular, the Brisbane grounds are adjacent to major nesting sites of loggerhead turtle at Mon Repos and Capricorn-Bunkers. While Australian observers have monitored over 2,000 longline sets in the

Japanese tuna fishery in the Australian EEZ, the Australian Fisheries Management Authority initiated a domestic observer program in 2003.

New Zealand has a fleet of about 140 longline vessels that target bigeye and southern bluefin tunas, bit which also catches over 1000 mt of swordfish. This domestic longline fleet has grown exponentially since its start in1991, although it has yet to reach a size where effort is equivalent to the historic foreign fleet activity.

Chile has a substantial longline fleet, but most vessels are involved in other fisheries (e.g., Patagonian toothfish). Swordfish fishing is highly seasonal and distributed over a wide latitudinal range (15˚-40˚S.) near Chile. Up to 143 vessels have fished for swordfish since 1985 and annual longline catches have increased to over 2,000 mt in 1998.

Gillnet fisheries that target swordfish and marlin occur in Japan, Mexico and Chile. Large-mesh gillnet operations occur within the 200 nm EEZ of Japan near the Tohuku and Hokkaido regions. Fishing effort has declined substantially since 1990 and the 1996 swordfish catch was 400 mt. A small gillnet fishery in Mexico targets swordfish and marlin beyond 50 nm off the coast. Catches were 800 mt of swordfish in 1991, declined to 100 mt in 1994 and increased to 250 mt in 1998. Similarly, artisanal gillnet fishers in Chile have fished since the early 1980s and average about 3,000 mt. Both Taiwan and Japan have harpoon fisheries that target a complex of marlins and swordfish, but encounters with protected species would be rare.

Table 11. Longline fisheries in the Central and Western Pacific, 2002

Country/Territory	Fleet size	Catch (mt)	Principal catch
American Samoa	60	7,112	tuna
Australia	21	653	tuna, swordfish
China	123	7,941	tuna, sharks
Cook Islands	16	1,118	tuna
Fed. States of Micronesia	25	865	tuna
Fiji	101	16,472	tuna, billfish
French Polynesia	54	7,402	tuna
Japan	1,459	52,270	tuna, swordfish
Korea	162	46,802	tuna
New Caledonia	25	1,165	tuna, swordfish
New Zealand	156	3,996	tuna, swordfish

Papua New Guinea	50	3,819	tuna
Samoa	114	5,359	tuna
Solomon Islands	8	870	tuna
Taiwan	2113	46,514	tuna, swordfish
Tonga	35	1,957	tuna
Vanuatu	13	428	tuna
Total	4535	204,743	

Table 12. Purse seine fisheries in the Central and Western Pacific, 2002

Country/Territory	Fleet size	Catch (mt)	Principal catch
Australia	4	1,755	tuna
Fed. States of Micronesia	7	18,012	tuna
Japan	36	223,519	tuna
Kiribati	1	4,660	tuna
Korea	28	180,087	tuna
Marshall Islands	5	38,242	tuna
Mexico	5	6,600	tuna
New Zealand	11	10,668	tuna
Papua New Guinea	26	119,668	tuna
Philippines	11	27,243	tuna
Solomon Islands	2	8,080	tuna
Spain	1	214	tuna
Taiwan	41	258,126	tuna
USA	29	119,158	tuna
Total	207	1,016,032	

Table 13. Pole-and-line fisheries in the Central and Western Pacific, 2002

Country/Territory	**Fleet size**	**Catch (mt)**	**Principal catch**
Australia	2	39	tuna
Fiji	2	475	tuna
French Polynesia	53	711	tuna
Japan	156	130,497	tuna
Kiribati	N/A	5	tuna
Solomon Islands	11	9,652	tuna
Total	224	141,379	

Table 14. Albacore troll fisheries in the Pacific, 2002

Country/Territory	Fleet size	Catch (mt)	Principal catch
Canada (North Pacific)[1]	60	3,304	
Canada (South Pacific)[2]	4	144	tuna
USA (North Pacific)[1]	440	11,169	
USA (South Pacific)[2]	14	1,038	tuna
New Zealand[2]	325	3,311	tuna
Total	843	18,966	

1. 1999 catches
2. 2002 catches

Table 15. Longline and purse-seine catch in the Eastern Tropical Pacific Ocean, 2001

Fishing gear	Fleet size	Catch (mt)
Longline[1]	1616	≈56,000[3]
Purse Seine[2]	137	587,308

1. Includes Belize, Bolivia, China, Colombia, Costa Rica, Ecuador, El Salvador, Spain, Guatemala, Honduras, Indonesia, Japan, Mexico, Nicaragua, Panama, Peru, Taiwan, USA, St Vincent

2. Colombia, Ecuador, Mexico, Panama, USA, Vanuatu, Venezuela, Belize, Bolivia, El Salvador, Guatemala, Honduras, Nicaragua.

3. Includes only tuna and billfish

9.1.4.6 Ecosystem and Stocks

This section provides background information on the affected ecosystem as well as new and updated information where available on the status of stocks managed under the Pelagics FMP.

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 .

Pelagic Management Unit Species: The Pelagics FMP manages a suite of “pelagic management unit species” (PMUS, see Table 16). 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 16. 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*
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 16th meeting held in June 2003 Hampton et al (2003). Recruitment in all analyses is estimated to have increased since about 1980. It is possible that the pre-1965 levels of recruitment and recruitment variability are poorly estimated in this assessment because of the lack of size composition data for the longline fisheries. Biomass for the Western and Central Pacific Ocean (WPCO) is estimated to have declined to about half of its initial level by about 1970 and has been fairly stable since then. This pattern is characteristic of all regions except the subtropical southwestern Pacific, in which biomass is estimated to have remained fairly stable for most of the time-series, but to have increased strongly during the last five years of the assessment. Fishing mortality for adult and juvenile bigeye tuna is estimated to have increased continuously since the beginning of industrial tuna fishing. Current fishing mortality levels are close to or exceed the levels of natural mortality. Overall, depletion is estimated to have been rapid, particularly in recent years, with recent biomass levels estimated to be about 30% of the unexploited biomass. Even though the estimated biomass has remained fairly stable over time, it appears to have been sustained only by above average recruitment. If recruitment were to return to the average level estimated in this assessment, biomass decline would be rapid. The attribution of depletion to various fisheries or groups of fisheries indicates that the longline fishery has the greatest impact throughout the model domain. The purse seine and Indonesian fisheries also have substantial impact in the equatorial western and central Pacific.

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 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 OY range. Stock and catches are both increasing due to the continuation of a high productivity oceanic regime.

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 16th meeting held in June 2003, employing the Multifan-CL model. Fishing mortality for adult and juvenile yellowfin tuna is estimated to have increased continuously since the beginning of industrial tuna fishing. A significant component of the increase in juvenile fishing mortality is attributable to the Philippines and Indonesian fisheries, which have the weakest catch, effort and size data, which is of continuing concern.

The ratios of biomass (B) to the unexploited biomass (B_0) provide a time-series index of population depletion by the fisheries. Depletion has increased steadily over time, reaching a recent level of 0.65 - 0.80. This represents a moderate level of stock-wide depletion that would be well within the equivalent equilibrium based limit reference point (B_{MSY}/B_0 = 0.37-0.40). This depletion is somewhat greater for some individual model regions, notably the western and central Pacific equatorial regions where recent depletion levels are approximately 0.50. Other regions are much less depleted, with indices of 0.75-0.90 or greater. The assessment model concluded those yellowfin stocks in the central and western equatorial regions were fully exploited, while the remaining regions were under-exploited. The attribution of depletion to various fisheries or groups of fisheries indicates that the Indonesian fishery has the greatest impact, particularly in its home region. The western Pacific purse seine fishery also has high impact in regions 2 and 3. It is notable that the composite longline fishery is responsible for biomass depletion of <5% in each region. These estimates are in stark contrast to a recent analysis (Myers and Worm 2003) claiming that the initial 15 years of industrial longline fishing (i.e. from about 1950 to 1965) had caused an 80% reduction in the biomass of large pelagics generally.

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 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 IATTC 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.

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 10˚N. 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 (Strasburg, 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). There have been no quantitative assessments of Pacific silky shark populations published to date.

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.

9.1.4.7 Biology of potentially affected sea turtles

This section provides information on the biology of potentially affected sea turtles.

Leatherback turtles

Leatherback turtles are the largest of the marine turtles, with a [curved carapace length] CCL often exceeding 150 cm and front flippers that are proportionately larger than in other sea turtles and may span 270 cm in an adult (NMFS and USFWS, 1998c). In view of its unusual ecology, the leatherback is morphologically and physiologically distinct from other sea turtles. Its streamlined body, with a smooth, dermis-sheathed carapace and dorso-longitudinal ridges may improve laminar flow of this highly pelagic species. Adult females nesting in Michoacán, Mexico averaged 145 cm CCL (Sarti, unpublished data, *in* NMFS and USFWS, 1998c), while adult female leatherback turtles nesting in eastern Australia averaged 162 cm CCL (Limpus, *et al*., 1984, *in* NMFS and USFWS, 1998c).

Leatherback turtles have the most extensive range of any living reptile and have been reported circumglobally from 71EN to 47ES latitude in the pelagic Pacific and in all other major pelagic ocean habitats (NMFS and USFWS, 1998c). For this reason, studies of their abundance, life history and ecology, and pelagic distribution are exceedingly difficult. Leatherback turtles lead a completely pelagic existence, foraging widely in temperate waters except during the nesting season, when gravid females return to tropical beaches to lay eggs. Males are rarely observed near nesting areas, and it has been proposed that mating most likely takes place outside of the tropical waters, before females move to their nesting beaches (Eckert and Eckert, 1988). Leatherbacks are highly migratory, exploiting convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Morreale, *et al*., 1994; Eckert, 1998; Eckert, 1999a). In a single year, a leatherback may swim more than 10,000 kilometers (Eckert, 1998). Recent satellite telemetry studies indicate that adult leatherback turtles follow bathymetric contours over their long pelagic migrations and typically feed on cnidarians (jellyfish and siphonophores) and tunicates (pyrosomas and salps), and their commensals, parasites and prey (NMFS and USFWS, 1998c). Because of the low nutritive value of jellyfish and tunicates, it has been estimated that an adult leatherback would need to eat about 50 large jellyfish (equivalent to approximately 200 liters) per day to maintain its nutritional needs (Duron, 1978, *in* Bjorndal, 1997). Compared to greens and loggerheads, which consume approximately 3-5% of their body weight per day, leatherback turtles may consume perhaps 20-30% of their body weight per day (Davenport and Balazs, 1991). Surface feeding has been reported in U.S. waters, especially off the west coast (Eisenberg and Frazier, 1983), but foraging may also occur at depth. Based on offshore studies of diving by adult females nesting on St. Croix, U.S. Virgin Islands, Eckert *et al*. (1989) proposed that observed internesting16 dive behavior reflected nocturnal feeding within the deep scattering layer (strata comprised primarily of vertically migrating zooplankton, chiefly siphonophore and salp colonies, as well as medusae). Hartog (1980, *in* NMFS and USFWS, 1998c) also speculated that foraging may occur at depth, when nematocysts from deep water siphonophores were found in leatherback stomach samples. Davenport (1988, *in* Davenport and Balazs, 1991) speculated that leatherback turtles may locate pyrosomas at night due to their bioluminescence; however, direct evidence is lacking. Leatherback turtles also appear to spend almost the entire portion of each dive traveling to and from maximum depth, suggesting that maximum exploitation of the water column is of paramount importance to the leatherback (Eckert, *et al*., 1989).

Migratory routes of leatherback turtles originating from eastern and western Pacific nesting beaches are not entirely known. Satellite tracking of post-nesting females and genetic analyses of leatherback turtles caught in U.S. Pacific fisheries or stranded on the west coast of the U.S. present some strong insight into at least a portion of their routes and the importance of particular foraging areas. Current data from genetic research suggest that Pacific leatherback stock structure (natal origins) may vary by region.

Migratory corridors of leatherback turtles originating from western Pacific nesting beaches most likely exist along the eastern seaboards of Australia and Asia, including the former Soviet Union (NMFS and USFWS, 1998c). Recent information on leatherbacks tagged off the west coast of the United States has also revealed an important migratory corridor from central California, to south of the Hawaiian Islands, leading to western Pacific nesting beaches. Leatherback turtles originating from western Pacific beaches have been found along the U.S. mainland. Here, leatherback turtles have been sighted and reported stranded as far north as Alaska (60EN) and as far south as San Diego, California (NMFS and USFWS, 1998c). Of the stranded leatherback turtles that have been sampled to date from the U.S. mainland, all have been of western Pacific nesting stock origin (P. Dutton, NMFS, personal communication, 2000).

Loggerhead turtles

The loggerhead is characterized by a reddish brown, bony carapace, with a comparatively large head, up to 25 cm wide in some adults. Adults typically weigh between 80 and 150 kg, with average CCL measurements for adult females worldwide between 95-100 cm CCL (*in* Dodd, 1988) and adult males in Australia averaging around 97 cm CCL (Limpus, 1985, *in* Eckert, 1993). Juveniles found off California and Mexico measured between 20 and 80 cm (average 60 cm) in length (Bartlett, 1989, *in* Eckert, 1993). Skeletochronological age estimates and growth rates were derived from small loggerheads caught in the Pacific high-seas driftnet fishery. Loggerheads less than 20 cm were estimated to be three years or less, while those greater than 36 cm were estimated to be six years or more. Age specific growth rates for the first 10 years were estimated to be 4.2 cm/year (Zug, *et al*., 1995).

The transition from hatchling to young juvenile occurs in the open sea, and evidence is accumulating that this part of the loggerhead life cycle may involve trans-Pacific developmental migration (Bowen, *et a*l.,1995). This is supported by the fact that the high seas driftnet fishery, which operated in the Central North Pacific in the 1980s and early 1990s, incidentally caught juvenile loggerheads (mostly 40-70 cm in length) (Wetherall, *et a*l., 1993). In addition, large aggregations (numbering in the thousands) of mainly juveniles and subadult loggerheads are found off the southwestern coast of Baja California, over 10,000 km from the nearest significant nesting beaches (Pitman, 1990; Nichols, *et a*l., 2000). Genetic studies have shown these animals originate from Japanese nesting subpopulation (Bowen *et a*l., 1995), and their presence reflects a migration pattern probably related to their feeding habits (Cruz, *et a*l., 1991, *in* Eckert, 1993). These loggerheads are primarily juveniles, although carapace length measurements indicate that some of them are 10 years old or older. Loggerheads tagged in Mexico and California with flipper and/or satellite transmitters have been monitored returning to Japanese waters (Resendiz, *et a*l., 1998a-b). In addition, genetic analyses of 135 loggerheads caught and sampled in the Hawaii-based longline fishery indicated that all originated from Japanese nesting stock (P. Dutton, NMFS, personal communication, October 2002). Satellite telemetry studies show that loggerhead turtles tend to follow 17Eand 20EC sea surface isotherms north of the Hawaiian Islands (Polovina, *et al*., 2000; Eckert, unpublished data).

For their first years of life, loggerheads forage in open ocean pelagic habitats. Both juvenile and subadult loggerheads feed on pelagic crustaceans, mollusks, fish, and algae. The large aggregations of juveniles off Baja California have been observed foraging on dense concentrations of the pelagic red crab, *Pleuronocodes planipes* (Pitman, 1990; Nichols, *et al*., 2000). Data collected from stomach samples of turtles captured in North Pacific driftnets indicate a diet of gastropods (*Janthina* sp.), heteropods (*Carinaria* sp.), gooseneck barnacles (*Lepas* sp.), pelagic purple snails (*Janthina* sp.), medusae (*Vellela* sp.), and pyrosomas (tunicate zooids). Other common components include fish eggs, amphipods, and plastics (Parker, *et al*., in press). These loggerheads in the north Pacific are opportunistic feeders that target items floating at or near the surface, and if high densities of prey are present, they will actively forage at depth (Parker, *et al.*, in press). 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). Subadults and adults are found in nearshore benthic habitats around southern Japan, in the East China Sea and the South China Sea (e.g. Philippines, Taiwan, and Vietnam).

Studies of loggerhead diving behavior indicate varying mean depths and surface intervals, depending on whether they were located in shallow coastal areas (short surface intervals) or in deeper, offshore areas (longer surface intervals). Loggerheads appear to spend a longer portion of their dive time on the bottom (or suspended at depth), which may be related to foraging and refuge. Unlike the leatherback, to the loggerhead foraging in the benthos, bottom time may be more important than absolute depth (Eckert, *et al*., 1989). The maximum recorded dive depth for a post-nesting female was 211-233 meters, while mean dive depths for both a post-nesting female and a subadult were 9-22 meters. Routine dive times for a post-nesting female were between 15 and 30 minutes, and for a subadult, between 19 and 30 minutes (Sakamoto, *et al*., 1990 *in* Lutcavage and Lutz, 1997).

Green turtles

The genus *Chelonia* is composed of two taxonomic units at the population level, the eastern Pacific green turtle (referred to by some as "black turtle," *C. mydas agassizii*), which ranges (including nesting) from Baja California south to Peru and west to the Galapagos Islands, and the nominate *C. m.mydas* in the rest of the range (insular tropical Pacific, including Hawaii).

Green turtles are distinguished from other sea turtles by their smooth carapace with four pairs of lateral scutes, a single pair of prefrontal scutes, and a lower jaw-edge that is coarsely serrated. Adult green turtles have a light to dark brown carapace, sometimes shaded with olive, and can exceed one meter in carapace length and 100 kilograms (kg) in body mass. Females nesting in Hawaii averaged 92 cm in straight carapace length (SCL), while at the Olimarao Atoll in Yap, females averaged 104 cm in curved carapace length (CCL) and approximately 140 kg. In the rookeries of Michoacán, Mexico, females averaged 82 cm in CCL, while males averaged 77 cm CCL (*in* NMFS and USFWS, 1998a).

Compared to all other sea turtles, green turtles exhibit particularly slow growth rate, and age to maturity appears to the longest. Based on age-specific growth rates, green turtles are estimated to attain sexual maturity beginning at age 25 to 50 years (Limpus and Chaloupka, 1997, Bjorndal *et al*., 2000, Chaloupka *et al*., in press, *all in* Seminoff, 2002, Zug *et al*., 2002). The length of reproductivity has been estimated to range from 17 to 23 years (Carr *et al*., 1978, Fitzsimmons *et al*., 1995 *in* Seminoff, 2002). In Hawaii, green turtles lay up to six clutches of eggs per year (mean of 3.7), and clutches consist of about 100 eggs each. Females migrate to breed only once every two or possibly many more years. Eastern Pacific green turtles have reported nesting between two and six times during a season, laying a mean of between 65 and 86 eggs per clutch, depending on the area studied (Michoacán, Mexico and Playa Naranjo, Costa Rica) (*in* Eckert, 1993 and NMFS and USFWS, 1998a).

The nonbreeding range of green turtles is generally tropical, and can extend thousands of miles from shore in certain regions. Hawaiian green turtles monitored through satellite transmitters were found to travel more than 1,100 km from their nesting beach in the French Frigate Shoals, south and southwest against prevailing currents to numerous distant foraging grounds within the 2,400 kilometer span of the archipelago (Balazs, 1994; Balazs, *et al*., 1994; Balazs and Ellis, 1996). Three green turtles outfitted with satellite tags on the Rose Atoll (the easternmost island at the Samoan Archipelago) traveled on a southwesterly course to Fiji, approximately 1,500 km distance (Balazs, *et al*., 1994). Tag returns of eastern Pacific green turtles establish that these turtles travel long distances between foraging and nesting grounds. In fact, 75 percent of tag recoveries from 1982-90 were from turtles that had traveled more than 1,000 kilometers from Michoacán, Mexico. Even though these turtles were found in coastal waters, the species is not confined to these areas, as indicated by 1990 sightings records from a NOAA research ship. Observers documented green turtles 1,000-2,000 statute miles from shore (Eckert, 1993). The east Pacific green is also the second-most sighted turtle in the east Pacific during tuna fishing cruises; they are frequent along a north-south band from 15EN to 5ES along 90EW, and between the Galapagos Islands and Central American Coast (NMFS and USFWS, 1998a). In a review of sea turtle sighting records from northern Baja California to Alaska, Stinson (1984) determined that the green turtle was the most commonly observed sea turtle on the U.S. Pacific Coast, with 62% reported in a band from southern California and southward. The northernmost reported resident population of green turtles occurs in San Diego Bay, where about 50-60 mature and immature turtles concentrate in the warm water effluent discharged by a power plant (McDonald, *et al*., 1994). These turtles appear to have originated from east Pacific nesting beaches and the Revillagigedo Islands (west of Baja California), based on morphology, genetic analyses, and tagging data (*in* NMFS and USFWS, 1998a; P. Dutton, NMFS, personal communication, March 2002); however, the possibility exists that some are from Hawaii (P. Dutton, NMFS, personal communication, January, 2001). Green turtles appear to prefer waters that usually remain around 20EC in the coldest month; for example, during warm spells (e.g., El Niño), green turtles may be found considerably north of their normal distribution. Stinson (1984) found green turtles to appear most frequently in U.S. coastal waters with temperatures exceeding 18EC.

Based on the behavior of post-hatchlings and juvenile green turtles raised in captivity, it is presumed that those in pelagic habitats live and feed at or near the ocean surface, and that their dives do not normally exceed several meters in depth (NMFS and USFWS, 1998a). The maximum recorded dive depth for an adult green turtle was 110 meters (Berkson, 1967, *in* Lutcavage and Lutz, 1997), while subadults routinely dive 20 meters for 9-23 minutes, with a maximum recorded dive of 66 minutes (Brill, *et al*., 1995, *in* Lutcavage and Lutz, 1997). Additionally, it is presumed that drift lines or surface current convergences are preferential zones due to increased densities of likely food items. In the western Atlantic, drift lines commonly contain floating *Sargassum* capable of providing small turtles with shelter and sufficient buoyancy to raft upon (NMFS and USFWS, 1998a). Underwater resting sites include coral recesses, the underside of ledges, and sand bottom areas that are relatively free of strong currents and disturbance from natural predators and humans. In the MHI these foraging and resting areas for adults usually occur at depths greater than 10 meters, but probably not normally exceeding 40 meters. Available information indicates that green turtle resting areas are in proximity to their feeding pastures (NMFS, 2000e). Immature Hawaiian green turtles have been found in increasing numbers residing in “foraging pastures” around the eight main Hawaiian Islands. These pastures consist of a narrow band of shallow water around these islands and “accounts for 96% of the benthic habitat potentially available for recruitment by post-pelagic green turtles” (Balazs, 1996). Although most green turtles appear to have a nearly exclusive herbivorous diet, consisting primarily of sea grass and algae (Wetherall *et al*., 1993; Hirth, 1997), those along the east Pacific coast seem to have a more carnivorous diet. Analysis of stomach contents of green turtles found off Peru revealed a large percentage of mollusks and polychaetes, while fish and fish eggs, and jellyfish and commensal amphipods comprised a lesser percentage (Bjorndal, 1997). In the Hawaiian Islands, green turtles are site-specific and consistently feed in the same areas on preferred substrates, which vary by location and between islands (*in* Landsberg, *et al*., 1999).

Olive ridley turtles

Olive ridleys are the smallest living sea turtle, with an adult carapace length between 60 and 70 cm, and rarely weighing over 50 kg. They are olive or grayish green above, with a greenish white underpart, and adults are moderately sexually dimorphic (NMFS and USFWS, 1998e).

Like leatherback turtles, most olive ridley turtles lead a primarily pelagic existence (Plotkin *et al*., 1993), migrating throughout the Pacific, from their nesting grounds in Mexico and Central America to the north Pacific. While olive ridleys generally have a tropical range, with a distribution from Baja California, Mexico to Chile (Silva-Batiz, *et al*., 1996), individuals do occasionally venture north, some as far as the Gulf of Alaska (Hodge and Wing, 2000). Surprisingly little is known of their oceanic distribution and critical foraging areas, despite being the most populous of north Pacific sea turtles. The post-nesting migration routes of olive ridleys tracked via satellite from Costa Rica traversed thousands of kilometers of deep oceanic waters, ranging from Mexico to Peru, and more than 3,000 kilometers out into the central Pacific (Plotkin, *et al*., 1993). The turtles appeared to occupy a series of foraging areas geographically distributed over a very broad range within their oceanic habitat (Plotkin, *et al*., 1994). The species appears to forage throughout the eastern tropical Pacific Ocean, often in large groups or flotillas, and are occasionally found entangled in scraps of net or other floating debris. In a three-year study of communities associated with floating objects in the eastern tropical Pacific, Arenas and Hall (1992) found sea turtles present in 15 percent of observations and suggested that flotsam may provide the turtles with food, shelter, and/or orientation cues in an otherwise featureless landscape. Olive ridleys comprised the vast majority (75%) of these sea turtle sightings. Small crabs, barnacles and other marine life often reside on the debris and likely serve as food attractants to turtles. Thus, it is possible that young turtles move offshore and occupy areas of surface current convergences to find food and shelter among aggregated floating objects until they are large enough to recruit to benthic feeding grounds of the adults.

Olive ridleys feed on tunicates, salps, crustaceans, other invertebrates and small fish. Although they are generally thought to be surface feeders, olive ridleys have been caught in trawls at depths of 80-110 meters (NMFS and USFWS, 1998e), and a post-nesting female reportedly dove to a maximum depth of 290 meters. The average dive length for an adult female and adult male is reported to be 54.3 and 28.5 minutes, respectively (Plotkin, 1994, *in* Lutcavage and Lutz, 1997). Based on two olive ridleys tagged by Hawaii-based longline observers using satellite-linked dive recorders, data indicate that olive ridleys spend about 20 percent of their time at the surface. Sixty percent of the time the animals were in ocean waters less than 40 meters. Forty percent of the time the animals went to depths greater than 40 meters. The maximum depth recorded was 238 meters. The range of water temperatures recorded was between 23E and 28EC (Polovina *et al*., in press).

Olive ridley turtles begin to aggregate near the nesting beach two months before the nesting season, and most mating is generally assumed to occur in the vicinity of the nesting beaches, although copulating pairs have been reported over 100 km from the nearest nesting beach. Olive ridleys are considered to reach sexual maturity between 8 and 10 years of age, and approximately three percent of the number of hatchlings recruit to the reproductive population (Marquez, 1982 *in* Salazar, *et al*., 1998). The mean clutch size for females nesting on Mexican beaches is 105.3 eggs, in Costa Rica, clutch size averages between 100and 107 eggs (*in* NMFS and USFWS, 1998e). Females generally lay 1.6 clutches of eggs per season by Mexico (Salazar, *et al*., 1998) and two clutches of eggs per season in Costa Rica (Eckert, 1993). Data on the remigration intervals of olive ridleys in the eastern Pacific are scarce; in the western Pacific

(Orissa, India), females showed an annual mean remigration interval of 1.1 years. Reproductive span in females of this area was shown to be up to 21 years (Pandav and Kar, 2000).

Hawksbill turtles

The hawksbill is a small to medium-sized sea turtle. In the U.S. Caribbean, nesting females average about 62-94 cm in straight carapace length. Weight is typically to 80 kg in the wider Caribbean, with a record weight of 127 kg. Hatchlings average about 42 mm straight carapace length and range in weight from 13.5-19.5 g. The following characteristics distinguish the hawksbill from other sea turtles: two pairs of prefrontal scales; thick, posteriorly overlapping scutes on the carapace; four pairs of costal scutes; two claws on each flipper; and a beak-like mouth. The carapace is heart-shaped in very young turtles, and becomes more elongate or subovate with maturity. Its lateral and posterior margins are sharply serrated in all , but very old individuals. The epidermal scutes that overlay the bones of the shell are the tortoiseshell of commerce. They are unusually thick, and overlap posteriorly on the carapace in all but hatchlings and very old individuals. Carpacial scutes are often richly patterned with irregularly radiating streaks of brown or black on an amber background. The scutes of the plastron of Atlantic hawksbills are usually clear yellow, with little or no dark pigmentation. The soft skin on the ventral side is cream or yellow, and may be pinkish-orange in mature individuals. The scales of the head and forelimbs are dark brown or black with sharply defined yellow borders. There are typically four pairs of inframarginal scutes. The head is elongate and tapers sharply to a point. The lower jaw is V-shaped.

Hawksbills utilize different habitats at different stages of their life cycle. Posthatchling hawksbills occupy the pelagic environment, taking shelter in weedlines that accumulate at convergence points. Hawksbills reenter coastal waters when they reach approximately 20-25 cm carapace length. Coral reefs are widely recognized as the resident foraging habitat of juveniles, subadults and adults. This habitat association is undoubtedly related to their diet of sponges, which need solid substrate for attachment. The ledges and caves of the reef provide shelter for resting both during the day and night. Hawksbills are also found around rocky outcrops and high energy shoals, which are also optimum sites for sponge growth. Hawksbills are also known to inhabit mangrove-fringed bays and estuaries, particularly along the eastern shore of continents where coral reefs are absent.

There is limited information on the biology of hawksbills, probably because they are sparsely distributed throughout their range and they nest in very isolated locations (Eckert, 1993). Hawksbills have a relatively unique diet of sponges (Meylan, 1985; 1988). While data are somewhat limited on diet in the Pacific, it is well documented in the Caribbean where hawksbill turtles are selective spongivores, preferring particular sponge species over others (Dam and Diez, 1997b). Foraging dive durations are often a function of turtle size with larger turtles diving deeper and longer. As with other sea turtles, hawksbills will make long reproductive migrations between foraging and nesting area (Meylan, 1999), but otherwise they remain within coastal reef habitats. In Australia, juvenile turtles outnumber adults 100:1. These populations are also sex biased with females outnumbering males 2.57:1 (Limpus, 1992). Although hawksbill nesting is broadly distributed, at no one place do hawksbills nest in large numbers, and many areas have experienced notable declines. Hawksbills utilize both low- and high-energy nesting beaches in tropical oceans of the world. Both insular and mainland nesting sites are known. Hawksbills will nest on small pocket beaches, and, because of their small body size and great agility, can traverse fringing reefs that limit access by other species. They exhibit a wide tolerance for nesting substrate type. Nests are typically placed under vegetation. Hawksbills nest throughout the insular tropical Pacific, though only in low density colonies. Hawksbill turtles appear to prefer nesting sites with steep beaches and coarse sand. There is much variation in clutch size from site to site and among sizes of turtles, with the larger turtles laying the largest clutches. Known clutch size in the Pacific averages 130 eggs per clutch, around three clutches per year, and anecdotal reports indicate that hawksbill remigration intervals average around two years (Eckert, 1993; NMFS and USFWS, 1998b). Mrosovsky *et al*. (1995)evaluated the effect of incubation temperature on sex determination in hawksbill hatchlings. Incubation temperatures warmer than approximately 29.2EC produced females, while cooler temperatures produced males (Mrosovsky *et al*., 1995).

The best estimate of sexual maturity for hawksbill turtles is about 20 to 40 years (Chaloupka and Limpus, 1997; Crouse, 1999a). Boulon (1994) estimated that juvenile hawksbills from the U.S. Virgin Islands would require between 16.5 and 19.3 additional years to reach maturity after entering nearshore habitats at several years of age at 21.4 cm straight carapace length. Growth rates within benthic stage (juvenile turtles which have returned from pelagic developmental habitats) Australian hawksbill turtles are sex dependent, with the female growing faster. Maximal growth rates for both males and females occurred at 60 cm curved carapace length (CCL) and then declined to minimal rates of growth as the turtles neared maturity at 80 cm CCL (Chaloupka and Limpus, 1997).

9.1.4.8 Population status of potentially affected sea turtles

This section provides historical and new information on the population status of potentially affected sea turtles.

9.1.4.8.1 Historical population status of sea turtles

This section provides historical information on the population status of potentially affected sea turtles.

Leatherback turtles

The leatherback turtle is listed as endangered under the ESA throughout its global range. Furthermore, the Red List 2000 of the IUCN has classified the leatherback as “critically endangered”[3] due to “an observed, estimated, inferred or suspected reduction of at least 80% over three generations” based on: (a) direct observation; (b) an index of abundance appropriate for the taxon; and (c) actual or potential levels of exploitation. Increases in the number of

3Taxa are categorized as critically endangered when they are facing an extremely high risk of extinction in the wild in the immediate future.

nesting females have been noted at some sites *in the Atlantic*, but these are far outweighed by local extinctions, especially of island populations, and the demise of once large populations *throughout the Pacific*, such as in Malaysia and Mexico. Spotila *et al.* (1996) estimated the *global* population of female leatherback turtles to be only 34,500 (confidence limits: 26,200 to 42,900) nesting females; the eastern Pacific population has continued to decline since that estimate, leading some researchers to conclude that the leatherback is now on the verge of extinction in the Pacific Ocean (e.g. Spotila, *et al*., 1996; Spotila, *et al*., 2000).

Genetic markers in 16 of 17 leatherback turtles sampled to date from the central North Pacific (captured in the Hawaii-based longline fishery) have identified those turtles as originating from nesting populations in the southwestern Pacific; the other specimen, taken in the southern range of the Hawaii fishery, was from nesting beaches in the eastern Pacific (Dutton and Eckert, in press).

Leatherback turtles are widely distributed throughout the oceans of the world. The species is often divided into four main populations in the Pacific, Atlantic, and Indian Oceans, and the Caribbean Sea. Leatherbacks also occur in the Mediterranean Sea, although they are not known to nest there. The four main populations are further divided into nesting aggregations. Leatherback turtles are found on the western and eastern coasts of the Pacific Ocean, with nesting aggregations in Mexico and Costa Rica (eastern Pacific) and Malaysia, Indonesia, Australia, the Solomon Islands, Papua New Guinea, Thailand, and Fiji (western Pacific). In the Atlantic Ocean, leatherback nesting aggregations have been documented in Gabon, Sao Tome and Principe, French Guiana, Suriname, and Florida. In the Caribbean, leatherbacks nest in the U.S. Virgin Islands and Puerto Rico. In the Indian Ocean, leatherback nesting aggregations are reported in India, Sri Lanka, and the Andaman and Nicobar Islands.

In 1980, the leatherback population was estimated at approximately 115,000 (adult females) globally (Pritchard, 1982b). By 1995, this global population of adult females had declined to 34,500 (Spotila *et al.* 1996). Populations have declined in Mexico, Costa Rica, Malaysia, India, Sri Lanka, Thailand, Trinidad, Tobago, and Papua New Guinea. Throughout the Pacific, leatherbacks are seriously declining at all major nesting beaches. The decline can be attributed to many factors, including fisheries interactions, direct harvest, egg collection, and degradation of habitat. On some beaches, nearly 100% of the eggs laid have been harvested. Eckert (1996) and Spotila *et al*. (1996) note that adult mortality has also increased significantly, particularly as a result of driftnet and longline fisheries.

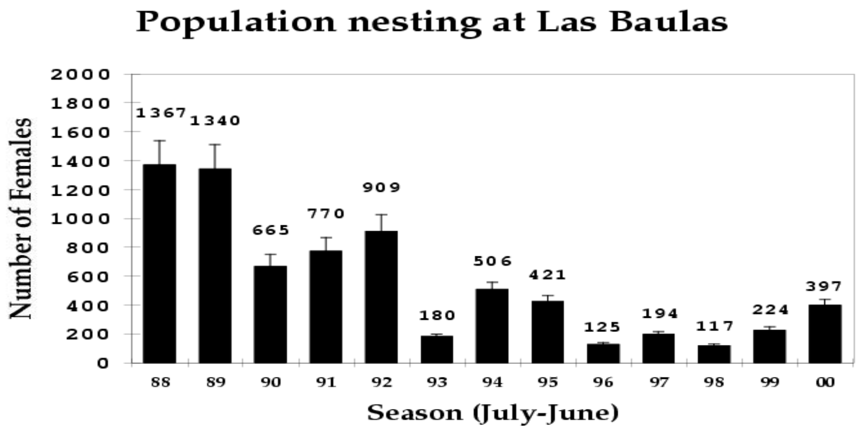
In the Atlantic and Caribbean, the largest nesting assemblages of leatherbacks are found in the U.S. Virgin Islands, Puerto Rico, and Florida. Since the early 1980s, nesting data has been collected at these locations. Populations in the eastern Atlantic (*i.e.* off Africa) and Caribbean appear to be stable; however, information regarding the status of the entire leatherback population in the Atlantic is lacking and it is certain that some nesting populations (*e.g.*, St. John and St. Thomas, U.S. Virgin Islands) have been extirpated (NMFS and USFWS, 1995). Data collected in southeast Florida clearly indicate increasing numbers of nests for the past twenty years (9.1-11.5% increase), although it is critical to note that there was also an increase in the survey area in Florida over time (NMFS SEFSC, 2001). However, the largest leatherback rookery in the western North Atlantic remains along the northern coast of South America in French Guiana and Suriname. Recent information suggests that Western Atlantic populations declined from 18,800 nesting females in 1996 (Spotila *et al.*, 1996) to 15,000 nesting females by 2000 (Spotila, personal communication). The nesting population of leatherback turtles in the Suriname-French Guiana trans-boundary region has been declining since 1992 (Chevalier and Girondot, 1998). Poaching and fishing gear interactions are, once again, believed to be the major contributors to the decline of leatherbacks in the area (Chevalier *et al.* in press; Swinkels *et al.* in press). While Spotila *et al.* (1996) indicated that turtles may have been shifting their nesting from French Guiana to Suriname due to beach erosion, analyses show that the overall area trend in number of nests has been negative since 1987 at a rate of 15.0 -17.3 % per year (NMFS SEFSC, 2001). If turtles are not nesting elsewhere, it appears that the Western Atlantic portion of the population is being subjected to mortality beyond sustainable levels, resulting in a continued decline in numbers of nesting females.

There are known to be many sizeable populations of leatherbacks nesting in West Africa, possibly as many as 20,000 females nesting annually (Fretey 2001). In Ghana, nearly two thirds of the leatherback turtles that come up to nest on the beach are killed by local fishermen.

Based on published estimates of nesting female abundance, leatherback populations are declining at all major Pacific basin nesting beaches, particularly in the last two decades (Spotila *et al*., 1996; NMFS and USFWS, 1998c; Spotila, *et al*., 2000). Declines in nesting populations have been documented through systematic beach counts or surveys in Malaysia (Rantau Abang, Terengganu), Mexico and Costa Rica. In other leatherback nesting areas, such as Irian Jaya and the Solomon Islands, there have been no systematic consistent nesting surveys, so it is difficult to assess the status and trends of leatherback turtles at these beaches. In all areas where leatherback nesting has been documented, however, current nesting populations are reported by scientists, government officials, and local observers to be well below abundance levels of several decades ago. The collapse of these nesting populations was most likely precipitated by a tremendous overharvest of eggs coupled with incidental mortality from fishing (Sarti *et al*., 1996; Eckert, 1997).

Leatherback nesting populations are declining at a rapid rate along the Pacific coast of Mexico and Costa Rica. Leatherback turtles have been studied at Playa Grande (in Las Baulas), the fourth largest leatherback nesting colony in the world, since 1988. As shown in Figure 2, during the 1988-89 season (July-June), 1,367 leatherback turtles nested on this beach, and by the 1998-99 season, only 117 leatherback turtles nested (Spotila, 2000). The 1999-2000 and 2000-01 season showed increases in the number of adult females nesting here, with 224 and 397 leatherbacks nesting, respectively. Although analysis has not been completed for the 2001-02 season, Reina (Drexel University, personal communication, March 2002) preliminarily estimated that 75 females nested here during the full season, “a major decrease from last year.”

Figure III-10 Number of female leatherbacks nesting at Playa Grande (Las Baulas, Costa Rica) (source: Spotila *et al.*, 2000; R. Reina, Drexel University, personal communication, March, 2002).



During the last three nesting seasons in Las Baulas (1996 through 1999), an average of only 25% of the turtles were remigrants (turtles returning to nest that were observed nesting in previous nesting seasons). Less than 20% of the turtles tagged in 1993 through 1995 returned to nest in the next five years (Spotila, *et al*., 2000). Remigration intervals for leatherback turtles at nesting beaches in the U.S. Caribbean have been documented as over 97% returning within five years or less (Dutton *et al*., in press). Comparatively few leatherback turtles are returning to nest on east Pacific nesting beaches and it is likely that leatherback turtles are experiencing abnormally high mortalities during non-nesting years. Since 1993, environmental education and conservation efforts through active law enforcement have greatly reduced egg poaching in Costa Rica (Chaves, *et al*., 1996). For example, during the 1993-94 nesting season, poaching accounted for only 1.3 percent of the loss of nests on Playa Grande. Other losses were due to predation, tidal effects and failure in egg development or infestation by maggots (Schwandt, *et al*., 1996). Researchers at Playa Grande have also found that temperature of the sand surrounding the egg will determine the sex of the hatchlings during a critical phase of their embryonic development. At this beach, temperatures above 29.5°C produce female hatchlings, while below 29.5°C, the hatchlings are male.

The decline of leatherback subpopulations is even more dramatic off Mexico. According to reports from the late 1970s and early 1980s, three beaches located on the Pacific coast of Mexico (Chacahua, Oaxaca, Tierra Colorada, Guerrero and Mexiquillo, Michoacán) sustained a large portion of all global nesting of leatherback turtles, perhaps as much as one-half. Because nearly 100% of the clutches in these areas were poached by local people, a monitoring plan was implemented to evaluate the nesting population and establish measures for the protection of eggs. Surveys indicate that the eastern Pacific Mexican population of adult female leatherback turtles has declined from 70,000[4] in 1980 (Pritchard, 1982b, *in* Spotila *et al*., 1996) to slightly more than 200 adult females during the 1996-97 and 1997-1998 nesting seasons (Table 17) (Sarti *et al*., 2000). Censuses of four index beaches in Mexico (representing approximately 40% of all Pacific leatherback nesting in Mexico) during the 2000-2001 nesting season (October - March) showed a slight increase in the numbers of females nesting compared to the all-time lows observed from 1996 through 1999 (Sarti *et al*. in prep). However, the number of females nesting during the 2001-2002 is the lowest ever recorded - Sarti (Universidad Naçional Autonoma de Mexico, personal communication, March 2002) reports that there have been a total of only 36 turtles seen at all four index beaches - 4 turtles at Mexiquillo, 11 at Tierra Colorada, nine at Llano Grande, and 12 at Barrade La Cruz. Based on aerial surveys and ground surveys, it is estimated that 109-120 leatherbacks nested in 2001/02 (Sarti *et al*., 2002).

4This estimate of 70,000 adult female leatherback turtles comes from a brief aerial survey of beaches by Pritchard (1982), who has commented: "I probably chanced to hit an unusually good nesting year during my 1980 flight along the Mexican Pacific coast, the population estimates derived from which (Pritchard, 1982b) have possibly been used as baseline data for subsequent estimates to a greater degree than the quality of the data would justify" (Pritchard, 1996).

Table 17. Total leatherback nestings counted and total number of females estimated to nest along the Mexican Pacific coast per season.

Season	Nestings	Females
1995-1996	5,354	1,093
1996-1997	1,097	236
1997-1998	1,596	250
1998-1999*	799*	67**

*Value corrected for E1 (error due to track and bodypit aging) and E2 (error due to difficulty of observation from the air) only.
**Number of females only includes tagged females at the key beaches.
Source - Sarti *et al*., 2000

Monitoring of the nesting assemblage at Mexiquillo, Mexico has been continuous since 1982. According to Sarti *et al.* (1996), nesting declined at this location at an annual rate of over 22 percent from 1984 to 1995. Sarti *et al*. (1998) reports:

> "While reporting the results for the 1995-96 nesting season (Sarti *et al*., 1996), we regarded beaches having densities higher than 50 nests per kilometer as the most important. In the present season [1997-98] no beach reached such density values: the main beaches had five or more nests per kilometer, and none were higher than 25. This is evidence of the large decrement witnessed from the start of the aerial surveys, and may indicate that the nesting population still has a declining trend despite the protection efforts in the major beaches."

Furthermore, Sarti, *et al*. (2000) notes that during the 1980s, 30% of the nesting females per season were remigrants, but since the mid-1990s, there has been very little evidence of remigration, even with more efficient tagging methods. Sarti (2002) reported that during the 1999-2000 and 2000-01 nesting seasons, only a small increment in the number of remigrant turtles was observed.

Most conservation programs aimed at protecting nesting sea turtles in Mexico have continued since the early 1980s, and there is little information on the degree of poaching prior to the establishment of these programs. However, Sarti *et al.* (1998) estimates that as much as 100% of the clutches were taken from the Mexican beaches. Since protective measures have been in place, particularly emergency measures recommended by a joint U.S./Mexico leatherback working group meeting in 1999, there has been greater nest protection and nest success (Table 18). Mexican military personnel were present during the 1999-2000 season at three of the primary nesting beaches in Mexico (Llano Grande, Mexiquillo, and Tierra Colorado), responsible for approximately 34% of all nesting activity in Mexico. Of 1,294 nests documented, 736 were protected (57%), resulting in a total of 25,802 hatchlings. Monitoring and protection measures at two secondary nesting beaches resulted in the protection of 67% and

10% at Barra de la Cruz and Playa Ventura, respectively. Beginning in 2000, the primary management objective has been to protect over 95% of nests laid at the three index beaches (includes protecting nesting females, eliminating illegal egg harvest, and relocating nests to protected hatcheries) and to maximize protection of all the secondary nesting beaches over the next three years. NMFS has committed funding for three years to help implement these objectives (Dutton *et al*., 2002).

Table 18. Leatherback nest protection at index beaches on the Pacific coast of Mexico (Source: Sarti *et al*., personal communication, 2000)

Season	Number of clutches laid	Number of clutches protected	Percentage of clutches protected
1996-97	445	86	19.3%
1997-98	508	101	19.9%
1998-99	442	150	33.9%
1999-00	1590	943	58.7%

The most recent results for 2000-01 indicate that nearly 68% of clutches laid in key beaches in Mexico were relocated to hatcheries. This is a significant increase since 1996, when only 12% of nests were relocated. Although data are not available, most of the nests that were not moved are believed to have survived in situ in 2000-01, unlike previous years when it is assumed that all nests that are not relocated are taken by poachers. This has been due to successful involvement of community leaders in Cahuitan, the most important leatherback nesting beach in the nest protection program. At this beach 24,797 eggs representing 80% of the nests laid were protected, producing a total of 12,275 hatchlings (L. Sarti, INP Preliminary Report).

On the Pacific coast of Guatemala, leatherbacks nest in limited numbers (2-3 nests per night from November to December), primarily on the beach at Hawaii. Since an average nest can bring in one quarter of the monthly income of a typical agricultural worker or fishermen, most leatherback eggs are collected (Juarez and Muccio, 1997), and in the Hawaii area, “it is very rare that a nest is laid without being detected by an egg collector” (Muccio, 1998).

From tagging and aerial surveys, Spotila *et al.* (2000) have estimated that there are currently 687 adult females and 518 subadults comprising the Central American population of leatherback turtles. With an estimated Mexican population of 1,000 adults and 750 subadults (by Spotila *et al*., 2000), the entire east Pacific leatherback population has been estimated by Spotila *et al.* (2000) to contain approximately 2,955 females (1,687 adults and 1,268 subadults); however, insufficient foundation was given for these estimates (i.e. derivation of estimates are unclear, and models rely on theoretical assumptions that need further evaluation and testing).

Based on aerial surveys and ground censuses during the 2000-2001 season and using an estimated clutch frequency of 5.8, Sarti *et al*. (in preparation) has estimated the total number of female leatherbacks (nesters only) in the eastern Pacific:

(a) primary beaches in Mexico - 396 females;
(b) total Mexico (without primary beaches) - 452 females;
(c) Central America (including data from Costa Rica) - 751 females; and
(d) grand total - 1,599 females.

Similar to their eastern Pacific counterparts, leatherback turtles originating from the western Pacific are also threatened by poaching of eggs, killing of nesting females, human encroachment on nesting beaches, incidental capture in fishing gear, beach erosion, and egg predation by animals. Little is known about the status of the western Pacific leatherback nesting populations , but once major leatherback nesting assemblages are declining along the coasts of Malaysia, Indonesia and the Solomon Islands. Low density and scattered nesting of leatherback turtles occurs in Fiji, Thailand, and Australia (primarily western and to a lesser extent, eastern).

In Fiji, leatherbacks are uncommon, although there are recorded sightings and four documented nesting attempts on Fijian beaches. They have been seen in the Savusavu region, Qoma, Yaro passage, Vatulele and Tailevu, and researchers estimate approximately 20-30 individual leatherbacks in Fijian waters (Rupeni, *et al*., 2002).

In Papua New Guinea, between 200-300 females were estimated to nest annually between the two villages of Labu Tali and Busama in 1989. Leatherback eggs are an important source of protein for the local people (Hirth *et al*., 1993), and egg collection continues in this country, although the extent is unknown (P. Dutton, NMFS, personal communication, March 2002). Phillips (2002) reports an estimated 1,000 to 1,500 nests in the Morobe coast between Labu Butu and Busama beach which would correspond to approximately 250 nesting females. Kamiali nesting beaches (within the Kamiali Wildlife Management Area) is approximately 11 km long and contains approximately 150 nesting females producing 500-600 clutches per season. Due to increasing awareness and concern about the local declines in nesting leatherbacks, the Kamiali community agreed to a 500 km no-take zone, effective from December 2001 to February 2002 (nesting season) (Philip, 2002).

In the Solomon Islands, the rookery size is estimated to be less than 100 females nesting per year (D. Broderick, personal communication, *in* Dutton, *et al*., 1999). In Indonesia, low density nesting occurs along western Sumatra (200 females nesting annually) and in southeastern Java (50 females nesting annually), although the last known information is from the early 1980s (*in* Suarez and Starbird, 1996a).

The decline of leatherback turtles is severe at one of the most significant nesting sites in the western Pacific region - Terengganu, Malaysia, with current nesting representing less than two percent of the levels recorded in the 1950s, and the decline is continuing. The nesting population at this location has declined from 3,103 females estimated nesting in 1968 to two nesting females in 1994 (Chan and Liew, 1996) (Table 19). With one or two females reportedly nesting each year, this population has essentially been eradicated (P. Dutton, personal communication, 2000). Years of excessive egg harvest, egg poaching, the direct harvest of adults in this area, as well as incidental capture in various fisheries in territorial and international waters, have impacted the Malaysian population of leatherback turtles. There were two periods in which there were sharp declines in nesting leatherback turtles at this location: 1972-74 and 1978-80. Between 1972 and 1974, the number of females nesting declined 21% and coincided with a period of rapid development in the fishing industry, particularly trawling, in Terengganu (Chan *et al*., 1988 *in* Chan and Liew, 1996). Between 1978 and 1980, nestings dropped an average of 31% annually, and coincided directly with the introduction of the Japanese high seas squid fishery of the North Pacific in 1978 (Yatsu *et al*., 1991, *in* Chan and Liew, 1996). Because tagged individuals from Rantau Abang have been recovered from as far away as Taiwan, Japan and Hawaii, this fishery, as well as fisheries operating within the South China Sea, may have impacted the Malaysian leatherback population (Chan and Liew, 1996). After 1980, rates of decline averaged 16% annually, suggesting continuing threats from fisheries (Chan and Liew, 1996).

Table 19. Number of nesting leatherback females per year in Terengganu, Malaysia (summarized in Spotilla, *et al*., 1996)

1968	1970	1972	1974	1976	1978	1980	1984	1987	1988	1993	1994
3,103	1,760	2,926	1,377	1,067	600	200	100	84	62	20	2

In the past decade (i.e. 1990s to present), the nesting populations of leatherback turtles in Irian Jaya, Indonesia appear to be steady, although without systematic consistent surveys of nesting beaches, a reliable assessment of the trends and status of leatherback turtles here is difficult. Currently, however, there has yet been no evidence of the collapse documented in Malaysia or the in the eastern Pacific. Leatherback nesting generally takes place on two major beaches, located 30 km apart, on the north Vogelkop coast of Irian Jaya, Jamursba-Medi (18 km) and War-Mon beach (4.5 km) (Starbird and Suarez, 1994). In 1984, the World Wildlife Fund (WWF) began a preliminary study to assess the status of the leatherback nesting population and found at least an estimated 13,000 nests on Jamursba Medi. A subsequent survey undertaken in 1992 reported a decline of nesting levels to 25% of the 1984 levels (Table 20). A near total collection of eggs during this time period may have contributed to this decline. Out of concern for the rapid declines in nestings, the WWF proposed the designation of five beaches as protected areas - Sauapor (14 km), Wewe-Kwoor (20 km), Jamursba-Medi (28 km), Sidei-Wibain (18 km) and Mubrani-Kaironi (20 km). These beaches are monitored for leatherback nesting activities and patrolled for potential poaching activities (Hittipeuw and Maturbongs *in* Proceedings of W. Pacific Sea Turtle Coop Research and Management Workshop, 2002).

A summary of data collected from leatherback nesting surveys from 1984 to 2001 for Jamursba-Medi has been compiled, re-analyzed, and standardized and is shown in Table 20 (Hittipeuw and Maturbongs (2002). The number of nests were adjusted to correct for the days or months of the survey missed during the nesting season, and the average number of nests per female is assumed to range between 4.4 and 5.8 (see footnotes in Table 20). Gaps in the data for the year 1998 and 2000 were due to lack of financial support and transition of management changes of WWF Indonesia, which has been helping to monitor the leatherback nesting populations at these beaches since the early 1980s.

Table 20. Estimated numbers of female leatherback turtles nesting along the north coast of Irian Jaya (Summarized by Hittipeuw and Maturbongs *in* Proceedings of W. Pacific Sea Turtle Coop Research and Management Workshop, 2002 (Jamursba-Medi Beach)) and Suarez *et al*. in press (War-Mon Beach)

Survey Period	# of Nests	Adjusted # Nests	Estimated # of Females[3]
Jamursba-Medi Beach:			
September, 1981	4,000+	7,143[1]	1,232 - 1,623
April - Oct. 1984	13,360	13,360	2,303 - 3,036
April - Oct. 1985	3,000	3,000	[(658) - 731]
June - Sept. 1993	3,247	4,091[2]	705 - 930
June - Sept. 1994	3,298	4,155[2]	716 - 944
June - Sept. 1995	3,382	4,228[2]	729 - 961
June - Sept., 1996	5,058	6,373[2]	1,099 - 1,448
May - Sept., 1997	4,001	4,481[4]	773 - 1,018
May - Sept. 1999	2,983	3,251	560 - 739
April - August, 2001	2,561	2,644	456 - 601
War-Mon Beach:			
Nov. 1984 - Jan. 1985	1,012	N/A	175-230
Dec. 1993	406	653	128 - 169

[1]The total number of nests reported during aerial surveys were adjusted to account for loss of nests prior to the survey. Based on data from other surveys on Jamursba-Medi, on average 44% of all nests are lost by the end of August.
[2]The total number of nests have been adjusted based on data from Bhaskar's surveys from 1984-85 from which it was determined that 26% of the total number of nests laid during the season (4/1-10/1) are laid between April and May.
[3]Based on Bhaskar's tagging data, an average number of nests laid by leatherback turtles on Jamursba-Medi in 1985 was 4.4 nests per female. This is consistent with estimates for the average number of nests by leatherback turtles during a season on beaches in Pacific Mexico, which range from 4.4 to 5.8 nests per female (Sarti *et al*., unpub. report). The range of the number of females is estimated using these data.
[4]Number adjusted from Bhaskar (1984), where percentage of nests laid in April and September is 9% and 3%, respectively, of the total nests laid during the season.

Suarez *et al*. (in press) has also compiled information on the estimated number of nests lost due to both natural and anthropogenic causes. For example, during 1984 and 1985, on Jamursba-Medi, 40-60% of nests were lost to inundation and erosion, while 90% of those nests not taken by poachers[5] or by the sea were destroyed by feral pigs (*Sus scrofa*). Eggs from poached nests were commercially harvested for sale in the Sarong markets until 1993, when the beaches first received protection by the Indonesian government (J. Bakarbessy, personal communication, *in* Suarez and Starbird, 1996a). During the 1993-96 seasons, environmental education activities in nearby villages and protection measures on this same beach were put into place, with unreported results. Again, approximately 90% of those nests not taken by poachers or the sea[6] were destroyed by pigs (Suarez *et al.* in press). War-Mon beach supports a lower percentage of nesting females, yet egg poaching for subsistence accounted for over 60% of total nest loss during 1993-94, and total loss of nests due to pig predation was 40% (because there are more people in this region, there is more pig hunting, hence less pig predation of leatherback eggs (Starbird and Suarez, 1994)). In 2001 and 2002, conservation measures have reduced predation of eggs by pigs (P. Dutton, NMFS, personal communication, October 2002).

As shown in Table 20, since the early 1990s, the number of female leatherback turtles nesting annually on the two primary beaches of Irian Jaya appears to be stable. However, given the current, serious threats to all life stages of the Indonesian leatherback populations, this trend may not be sustained and this population could collapse, similar to what occurred in Terrengganu, Malaysia. As human populations in Indonesia increase, the need for meat and competition between the expanding human population and turtles for space increases, all leading to more direct takes of leatherback turtles or incidental take by local fisheries. There is no evidence to

5Suarez, *et al.* (in press) provided no information on the estimated percentage of nests lost to poachers.
6No information on percentage of nests lost to poachers or the sea were given, except that it was "noted."

indicate that the preceding threats are not continuing today, as problems with nest destruction by feral pigs, beach erosion, and harvest of adults in local waters have been reported (Suarez et al., unpublished report). In addition, local Indonesian villagers report dramatic declines in local sea turtle populations (Suarez, 1999); without adequate protection of nesting beaches, emerging hatchlings, and adults, this population will continue to decline.

Regarding the status of the Irian Jaya population of nesting leatherback turtles, Suarez *et al*. (in press) comment: "Given the high nest loss which has occurred along this coast for over thirty years it is not unlikely that this population may also suddenly collapse. Nesting activity must also continue to be monitored along this coast, and nest mortality must be minimized in order to prevent this population of leatherback turtles from declining in the future."

Loggerhead turtles

The loggerhead turtle is listed as threatened under the ESA throughout its range, primarily due to direct take, incidental capture in various fisheries, and the alteration and destruction of its habitat. The loggerhead is categorized as endangered by the IUCN, where taxa so classified are considered to be facing a very high risk of extinction in the wild in the near future. Loggerheads are circumglobal, inhabiting continental shelves, bays, estuaries, and lagoons in temperate, subtropical, and tropical waters. Major nesting grounds are generally located in temperate and subtropical regions, with scattered nesting in the tropics (*in* NMFS and USFWS, 1998d).

Loggerhead turtles are a cosmopolitan species, found in temperate and subtropical waters and inhabiting pelagic waters, continental shelves, bays, estuaries and lagoons. The species is considered to be divided into five populations: the Atlantic Ocean, Pacific Ocean, Indian Ocean, Caribbean Sea and Mediterranean Sea populations. These populations are further divided into nesting aggregations. In the Pacific Ocean, loggerhead turtles are represented by a northwestern Pacific nesting aggregation (located in Japan) and a smaller southwestern nesting aggregation that occurs in Australia (Great Barrier Reef and Queensland), New Caledonia, New Zealand, Indonesia, and Papua New Guinea. Of the loggerheads taken in the Hawaii-based longline fishery, all were determined to have originated from Japanese nesting beaches, based on genetic analyses (P. Dutton, NMFS, personal communication, October 2002).

In the western Atlantic Ocean, there are five major nesting aggregations: (1) a northern nesting aggregation that occurs from North Carolina to northeast Florida, about 29° N; (2) a south Florida nesting aggregation, occurring from 29° N on the east coast to Sarasota on the west coast; (3) a Florida panhandle nesting aggregation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida; (4) a Yucatán nesting aggregation, occurring on the eastern Yucatán Peninsula, Mexico; and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (NMFS SEFSC, 2001). In addition, Atlantic and Caribbean nesting aggregations are found in Honduras, Colombia, Panama, the Bahamas, and Cuba. In the Mediterranean Sea, nesting aggregations in Greece, Turkey, Israel, Italy, and several other sites have been recorded. One of the largest loggerhead nesting aggregations in the world is found in Oman, in the Indian Ocean.

Based on genetic analyses conducted at nesting sites, there are five distinct subpopulations of loggerheads in the western Atlantic: (1) a northern nesting subpopulation that occurs from North Carolina to northeast Florida, about 29º N (approximately 7,500 nests in 1998); (2) a south Florida nesting subpopulation, occurring from 29º N on the east coast to Sarasota, Florida on the west coast (approximately 83,400 nests in 1998); (3) a Florida panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida (approximately 1,200 nests in 1998); (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (TEWG, 2000); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (approximately 200 nests per year) (NMFS SEFSC, 2001). The status of the northern population based on the number of loggerhead nests has been classified as stable or declining (TEWG, 2000). Although nesting data from 1990 to the present for the northern loggerhead subpopulation suggests that nests have been increasing annually (2.8 - 2.9%) (NMFS SEFSC, 2001), there are confidence intervals about these estimates that include no growth[1]. Adding to concerns for the long-term stability of the northern subpopulation, genetics data has shown that, unlike the much larger south Florida subpopulation which produces predominantly females (80%), the northern subpopulation produces predominantly males (65%; NMFS SEFSC 2001).

The diversity of the loggerheads' life history renders them susceptible to many natural and human impacts, including impacts while they are on land, in the benthic environment, and in the pelagic environment. Hurricanes are particularly destructive to sea turtle nests. Sand accretion and rainfall that result from these storms as well as wave action can appreciably reduce hatchling success. For example, in 1992, all of the eggs over a 90-mile length of coastal Florida were destroyed by storm surges on beaches that were closest to the eye of Hurricane Andrew (Milton *et al.*, 1994). Other sources of natural mortality include cold stunning and biotoxin exposure. Anthropogenic factors that impact hatchlings and adult female turtles on land, or the success of nesting and hatching includes: beach erosion, beach armoring and nourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; beach driving; coastal construction and fishing piers; exotic dune and beach vegetation; and poaching. An increased human presence at some nesting beaches or close to nesting beaches has lead to secondary threats such as the introduction of exotic fire ants, feral hogs, dogs and an increased presence of native species (*e.g.*, raccoons, armadillos, and opossums) which raid and feed on turtle eggs. Although sea turtle nesting beaches are protected along large expanses of the northwest Atlantic coast, other areas along these coasts have limited or no protection. Sea turtle nesting and hatching success on unprotected high density east Florida nesting beaches from Indian River to Broward County are affected by all of the above threats.

Loggerhead turtles are affected by a completely different set of anthropogenic threats in the

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1 Meta-analyses conducted by NMFS' Southeast Fisheries Science Center to produce these estimates were unweighted analyses and did not consider a beach's relative contribution to the total nesting activity of a subpopulation. Consequently, the results of these analyses must be interpreted with caution.

marine environment. These include oil and gas exploration, coastal development, and transportation; marine pollution; underwater explosions; hopper dredging, offshore artificial lighting; power plant entrainment and/or impingement; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; poaching, and fishery interactions. In the pelagic environment loggerheads are exposed to a series of longline fisheries that include the U.S. Atlantic tuna and swordfish longline fisheries, an Azorean longline fleet, a Spanish longline fleet, and various fleets in the Mediterranean Sea (Aguilar *et al.*, 1995, Bolten *et al.*, 1994, Crouse, 1999). In the benthic environment in waters off the coastal U.S., loggerheads are exposed to a suite of fisheries in federal and state waters including trawl, purse seine, hook and line, gillnet, pound net, longline, and trap fisheries

Loggerhead nesting in the Pacific basin is restricted to the western region, primarily Japan and Australia. In the western Pacific the only major nesting beaches are in the southern part of Japan (Dodd, 1988), but the population status of the loggerhead nesting colonies here and the surrounding region is less clear. Balazs and Wetherall (1991) speculated that 2,000 to 3,000 female loggerheads may nest annually in all of Japan; however, more recent data suggest that only approximately 1,000 female loggerhead turtles may currently nest there (Bolten *et al*. 1996; Sea Turtle Association of Japan, 2002). Nesting beach monitoring at Gamoda (Tokushima Prefecture) has been ongoing since 1954. Surveys at this site showed a marked decline in the number of nests between 1960 and the mid-1970s. Since then, the number of nests has fluctuated, but has been downward since 1985 (Bolten *et al*., 1996; Sea Turtle Association of Japan, 2002). Recent information from the Sea Turtle Association of Japan (N. Kamezaki, personal communication, August 2001) indicates that the number of nests at Gamoda is still very low, fluctuating between near zero (1999) to near 50 (1996 and 1998). Monitoring on several other nesting beaches, surveyed since the mid-1970s, revealed increased nesting during the 1980s before declining during the early 1990s. Recent data reflect a continuing decline N. Kamezaki, Sea Turtle Association of Japan, personal communication, August 2001). Low density nesting of loggerheads has been documented on the Ryukyu Archipelago (between Taiwan and Kyushu Island, Japan), but information on abundance or trends is limited (Kikukawa, *et al*., 1999). Recent genetic analyses on female loggerheads taken at nesting sites in Japan suggest that this "subpopulation" is comprised of genetically distinct nesting colonies (Hatase, *et al.*, 2002) with precise natal homing of individual females. As a result, Hatase, *et al*,(2002) indicate that loss of one of these colonies would decrease the genetic diversity of Japanese loggerheads; recolonization of the site would not be expected on an ecological time scale. Nesting of loggerheads may also occur along the south China Sea, but it is a rare occurrence (Marquez, 1990, *in* Eckert, 1993). In addition, coastal fisheries off Japan may be impacting loggerhead populations. The Sea Turtle Association (2002) reports that approximately 80 mature loggerheads strand every year. This may be significant if they are pre- or post-nesting females.

In the south Pacific, Limpus (1982) reported an estimated 3,000 loggerheads nesting annually in Queensland, Australia during the late 1970s. However, long-term trend data from Queensland indicate a 50 percent decline in nesting by 1988-89, due to incidental mortality of turtles in the coastal trawl fishery. This decline is corroborated by studies of breeding females at adjacent feeding grounds (Limpus and Reimer, 1994). Currently, approximately 300 females nest annually in Queensland, mainly on offshore islands (Capricorn-Bunker Islands, Sandy Cape, Swains Head) (Dobbs, 2001). In southern Great Barrier Reef waters, nesting loggerheads have declined approximately 8% per year since the mid-1980s (Heron Island), while the foraging ground population has declined 3% and were comprised of less than 40 adults by 1992. Researchers attribute the declines to perhaps recruitment failure due to fox predation of eggs in the 1960s and mortality of pelagic juveniles from incidental capture in longline fisheries since the 1970s (Chaloupka and Limpus, 2001).

Scattered nesting has also been reported on Papua New Guinea, New Zealand, Indonesia, and New Caledonia; however, population sizes on these islands have not been ascertained. Survey data are not available for other nesting assemblages in the south Pacific. (NMFS and USFWS, 1998d).

There are no records of nesting loggerheads in the Hawaiian Islands (Balazs, 1982), or in any of the islands of Guam, Palau, the Northern Mariana Islands (Thomas, 1989), the Federated States of Micronesia (Pritchard, 1982b), Fiji (Rupeni *et al*., 2002), or American Samoa (Tuato'o-Bartley, *et al*., 1993). In addition, loggerheads are not commonly found in U.S. Pacific coastal waters, and there has only been one documented stranding of a loggerhead in the Hawaiian Islands in the past 20 years (1982-2002 stranding data, G. Balazs, NMFS, personal communication, 2002). There are very few records of loggerheads nesting on any of the many islands of the central Pacific, and the species is considered rare or vagrant on islands in this region (NMFS and USFWS, 1998d).

As mentioned, aggregations of juvenile loggerheads off Baja California Mexico have been reported, although their status with regard to increasing or declining abundance has not been determined. NMFS and USFWS (1998d) report "foraging populations ... range from 'thousands, if not tens of thousands' (Pitman, 1990) to 'at least 300,000 turtles' (Bartlett, 1989). Extrapolating from 1988 offshore census data, Ramirez-Cruz et al. (1991) estimated approximately 4,000 turtles in March, with a maximum in July of nearly 10,000 turtles."

Green turtles

Green turtles are listed as threatened under the ESA, except for breeding populations found in Florida and the Pacific coast of Mexico, which are listed as endangered. The International Union for Conservation of Nature and Natural Resources (IUCN) has classified the green turtle as "endangered"[2] due to an "observed, estimated, inferred or suspected reduction of at least 50% over the last 10 years or three generations, whichever is longer," based on: (a) direct observation; (b) an index of abundance appropriate for the species; and (c) actual or potential levels of exploitation. Using a conservative approach, Seminoff (2002) estimates that the global green turtle population has declined by 34% to 58% over the last three generations (approximately 150 years) although actual declines may be closer to 70% to 80%. Causes for this decline include harvest of eggs, subadults and adults, incidental capture by fisheries, loss of habitat, and disease.

2Under the IUCN, taxa are classified as endangered when they are not "critically endangered, but are facing a very high risk of extinction in the wild in the near future."

The genus *Chelonia* is composed of two taxonomic units at the population level, the eastern Pacific green turtle (referred to by some as “black turtle,” *C. mydas agassizii*), which ranges (including nesting) from Baja California south to Peru and west to the Galapagos Islands, and the nominate *C. m. mydas* in the rest of the range (insular tropical Pacific, including Hawaii).

Green turtles encountered by U.S. vessels fishing managed under the Pelagics FMP may originate from a number of known proximal, or even distant, breeding colonies in the Pacific Ocean. Genetic sampling of green turtles taken by the Hawaii-based longline fishery on observer trips indicates representation from nesting beaches on Hawaii (French Frigate Shoals) and the eastern Pacific (Mexico - both Revillagigedos and Michoacan and Galapagos). Preliminary genetic analysis has revealed that of 14 green turtles sampled by observers in the Hawaii-based longline fishery from 1994 to 2001, six were of eastern Pacific (Mexico) stock origin, five were of Mexican (Islas Revillagigedos) or Hawaiian nesting stock origin, two were of Hawaii stock origin, and one was of unknown origin, although it is most likely to be of eastern Pacific stock due to similarities in mtDNA sequence. (P. Dutton, NMFS, personal communication, October 2002).

Green turtles are found throughout the world, occurring primarily in tropical, and to a lesser extent, subtropical waters. The species is considered to consist of five main populations: the Pacific Ocean, Atlantic Ocean, Indian Ocean, Carribean Sea, and Mediterranean Sea. These populations can be further divided into nesting aggregations, within the eastern, central, and western Pacific Ocean; the western, northern, and eastern Indian Ocean; Mediterranean Sea; and eastern, southern, and western Atlantic Ocean, including the Carribean Sea. Primary nesting aggregations of green turtles (i.e. sites with greater than 500 nesting females per year) include: Ascension Island (south Atlantic Ocean), Australia, Brazil, Comoros Islands, Costa Rica, Ecuador (Galapagos Archipelago), Equatorial Guinea (Bioko Island), Guinea-Gissau (Bijagos Archipelago), Iles Eparses Islands (Tromelin Island, Europa Island), Indonesia, Malaysia, Myanmar, Oman, Philippines, Saudi Arabia, Seychelles Islands, Suriname, and United States (Florida) (Seminoff, 2002).

Smaller nesting aggregations include: Angola, Bangladesh, Bikar Atoll, Brazil, Chagos Archipelago, China, Costa Rica, Cuba, Cyprus, Democratic Republic of Yemen, Dominican Republic, d'Entrecasteaux Reef, French Guiana, Ghana, Guyana, India, Iran, Japan, Kenya, Madagascar, Maldives Islands, Mayotte Archipelago, Mexico, Micronesia, Pakistan, Palmerston Atoll, Papua New Guinea, Primieras Islands, Sao Tome é Principe, Sierra Leone, Solomon Islands, Somalia, Sri Lanka, Taiwan, Tanzania, Thailand, Turkey, Scilly Atoll, United States (Hawaii), Venezuela, and Vietnam (Seminoff, 2002).

While some nesting populations of green turtles appear to be stable and/or increasing in the Atlantic Ocean (e.g. Bujigos Archipelago (Guinea-Bissau), Ascension Island, Tortuguero (Costa Rica), Yucatan Peninsula (Mexico), and Florida), declines of over 50% have been documented in the eastern (Bioko Island, Equatorial Guinea) and western Atlantic (Aves Island, Venezuela). Nesting populations in Turkey (Mediterranean Sea) have declined between 42% and 88% since the late 1970s. Differences in population trends also appear in the Indian Ocean. Declines greater than 50% have been documented at Sharma (Republic of Yemen) and Assumption and Aldabra (Seychelles), while no changes have occurred at Karan Island (Saudi Arabia) or at Ras al Hadd (Oman). The number of females nesting annually in the Indian Ocean has increased at the Comoros Islands, Tromelin and maybe Europa Island (Iles Esparses) (*In* Seminoff, 2002).

Despite international conservation efforts to protect green turtles in all areas of the world, threats to their survival continue. In the Atlantic and Indian Oceans and the Mediterranean Sea, intentional harvest continues. Egg collection is ongoing at nesting beaches in the eastern Atlantic, western Atlantic and in the Caribbean, while nesting females continue to be harvested in the Caribbean, eastern Atlantic and Indian Ocean. High numbers of juveniles and adults are intentionally captured at foraging habitats in the eastern Atlantic, Caribbean, Indian Ocean, and in the Mediterranean (*in* Seminoff, 2002).

Green turtles are thought to be declining throughout the Pacific Ocean, with the exception of Hawaii, as a direct consequence of a historical combination of overexploitation and habitat loss (Eckert, 1993; Seminoff, 2002).

In the western Pacific, the only major (> 2,000 nesting females) populations of green turtles occur in Australia and Malaysia. In Queensland, Australia there are three distinct genetic breeding stocks of green turtles; although they occupy the same foraging habitats, very little interbreeding exists. The southern Great Barrier Reef subpopulation (located at the Capricorn/ Bunker group of islands and in the Coral Sea Islands Territory) has an average annual nesting population of 8,000 females; the northern Great Barrier Reef subpopulation (Raine Island and Moulter Cay) consists of an average of 30,000 nesting females; and the Gulf of Carpenteria (nesting concentrated around Wellesley) averages 5,000 nesting females. Threats to green turtles in this area include boat strikes, indigenous harvest of adults and eggs, increased incidence of disease, ingestion of synthetic materials, incidental catch in shark control programs and by commercial fisheries, predation of eggs at nesting beaches, and tourism (*in* Dobbs, 2001). In a study conducted between 1985 and 1992 on foraging greens near southern Great Barrier Reef waters, researchers documented an 11% per year increase in the resident green turtle population, while the female nesting population increased at 3% per year. In 1992, the resident green turtle population was estimated to be comprised of 1,300 individuals (Chaloupka and Limpus, 2001).

Although there are no current estimates available, Pulau Redang, a coral fringed island located approximately 45 kilometers off the coast of Terengganu, Malaysia contains one of the largest green turtle rookeries in peninsular Malaysia, and a one nautical mile no-fishing zone has been established around the island to prevent interactions between fishing gear and internesting females (Liew and Chan, 1994).

Smaller colonies of green turtles occur in the islands of Polynesia, Micronesia, and Malaysia (Wetherall *et al.*, 1993). Although green turtles used to nest in large numbers at Scilly, Motu-one, and Mopelia, located in the western limits of French Polynesia, their populations have declined in recent decades due mainly to commercial exploitation for markets in Tahiti (Balazs, *et al*., 1995).

Currently, Scilly is the only known sea turtle nesting site of any magnitude throughout the 130 islands and atolls that comprise French Polynesia. Although residents of Scilly are allowed to harvest 50 adult turtles annually, Balazs *et al*. (1995) estimate that the number of green turtles nesting annually in 1991 is approximately 300-400 turtles, similar to what Lebeau (1985 *in* Balazs, *et al*., 1995) estimated several years earlier.

Sangalaki Island in the Berau region of East Kalimantan, Indonesia contains one of the largest known nesting populations of green turtles in the Sulawesi Sea. During the post-World War II period, nearly 200 turtles reportedly nested per night. In 1993-94, 20-50 turtles nested per night, while during 2000-2001, 10 turtles on average nested nightly. In the past, egg collectors collected 100% of the eggs. In February 2001, the Turtle Foundation instituted measures to protect approximately 20% of the eggs laid by female green turtles (approximately 2000 eggs saved per week), and the latest information from the Foundation is that as of January 1, 2002, Bupati and the government of Berau stopped granting licenses to collect turtle eggs on Sangalaki (Turtle Foundation, 2002).

In Fiji, there is very little information on population trends of green turtles. Although 4,000-5,000 green turtles are found foraging or migrating in Fijian waters, only 30-40 green turtles nest in Fiji. The only nesting sites are located on the islands of Heemskereq Reef and Ringgold reefs. Threats to green turtles in this country are not well known, although green turtles are the most prized food of the Fijians, and they are used as important ceremonial gifts (Rupeni, *et al*., 2002).

Greens and hawksbills make up most of the composition of sea turtle species in the Pacific island groups under U.S. jurisdiction. Unfortunately, there is a serious shortage of information on the population sizes, distribution, and migration patterns of these turtles, which can hamper recovery efforts. Recently, an assessment of resident sea turtles and their nearshore habitats on two islands of the Commonwealth of the Northern Mariana Islands (CNMI) was conducted. The study took place from March 12-21, 2001 on the islands of Tinian and Aguijan. An estimated 351 individual green turtles were observed in surveys covering approximately 59% of Tinian's total shore and outer reef perimeter, while only 14 greens were observed during tow surveys covering 95% of Aguijan's shore and reef perimeter. Most of the turtles sighted were juveniles, suggesting recent and continuing recruitment at both islands. Based on data from surveys of four of the five CNMI southern arc islands, Kolinski (2001) also projected sea turtle densities and abundances in these areas and concluded that "the small uninhabited islands of Farallon de Medinilla and Aguijan sustain tens of turtles, turtle numbers around the larger inhabited islands of Saipan and Tinian range in the hundreds, while the CNMI portion of the southern arc (which includes Rota) likely supports between 1,000 and 2,000 resident green turtles." The Division of Fish and Wildlife (2002) report that sea turtles in the Northern Marianas still face problems such as poaching,

disturbance of nesting habitat, and the Carolinian and Chamorros (natives) have put in a request to take a limited number of turtles for culture practices.

Based on limited data, green turtle populations in the Pacific islands have declined dramatically, due foremost to harvest of eggs and adults by humans. In the green turtle recovery plans, directed take of eggs and turtles was identified as a "major problem" in American Samoa, Guam, Palau, CNMI, Federated States of Micronesia, Republic of the Marshall Islands, Wake, Jarvis, Howland, Baker, and Midway Islands, Kingman Reef, Johnston and Palmyra Atoll. Severe overharvests have resulted in modern times from a number of factors: 1) the loss of traditional restrictions limiting the number of turtles taken by island residents; 2) modernized hunting gear; 3) easier boat access to remote islands; 4) extensive commercial exploitation for turtle products in both domestic markets and international trade; 5) loss of the spiritual significance of turtles; 6) inadequate regulations; and 7) lack of enforcement (NMFS and USFWS, 1998a).

Scattered low density nesting of green turtles occurs on beaches in Taiwan and Vietnam. In Taiwan, Cheng and Chen (1996) report that between 1992 and 1994, green turtles were found nesting on 9 of 11 beaches on Wan-An Island (Peng-Hu Archipelago). The numbers, however, were small, between 8 and 14 females nested during each of these three years. Cheng (2002) recently reported similar numbers of nesting greens for those areas: 2-19 nesters on Wan-an Island and 4 to 11 nesters on Lanyu Island.

In Vietnam, researchers have only recently been documenting green turtle nesting populations on their beaches; however, anecdotal reports are that the population has declined sharply, due in part to the harvest of turtles, egg collection for food and wildlife trade, and coastal development. Sea turtles were considered an economic resource until the mid-1990s, when the World Wildlife Fund helped educate the government in the importance of protecting sea turtles and their habitat. Presently, Con Dao National Park is the most important sea turtle nesting site in Vietnam. Data from 1995 through October 2001 show that for all years except one (1996) over 200 green turtles and hawksbills (combined) nested on 14 beaches. Limited numbers of green turtles (23 nests in 2001) have also been documented nesting in Nui Chua Nature Preserve (Hien, 2002).

In Japan, the Ogasawara Islands, located approximately 1,000 km south of Tokyo, serve as the northern edge of green turtles rookeries in the western Pacific. In the late 1800s, when Japan first colonized the islands, the government encouraged a sea turtle fishery. Declines in catch were steady from 1880-1890s (1,000-1,800 adults taken annually) through the mid-1920s (250 taken annually). Data from 1945-1972 (American occupation) indicate that 20-80 turtles were taken annually, and since then, annual harvests have fluctuated from 45-225 turtles per year (Horikoshi, *et al*., 1994). Suganuma, *et al*. (1996) estimates 100 mating adults are speared by fishermen annually. Beach census data from 1985-93 indicate that 170-649 clutches were deposited each year (43 to 162 nesting females, assuming a female deposited four clutches during a nesting season). The Ogasawara population has declined in part due to past commercial exploitation, and it is likely to continue if fishery effort continues (Horikoshi, *et al*., 1994).

In Hawaii, green turtles nest on six small sand islands at French Frigate Shoals, a crescent-shaped atoll situated in the middle of the Hawaiian Archipelago (Balazs, 1995). Green turtles in Hawaii are considered genetically distinct and geographically isolated although recently a nesting population at Islas Revillagigedos in Mexico has been discovered to have some animals with the same mtDNA haplotype that commonly occurs in Hawaii. Ninety percent of the nesting and breeding activity of the Hawaiian green turtle occurs at the French Frigate Shoals, where 200-700 females are estimated to nest annually (NMFS and USFWS, 1998a). Important resident areas have been identified and are being monitored along the coastlines of Oahu, Molokai, Maui, Lanai, Hawaii, and at large nesting areas in the reefs surrounding the French Frigate Shoals, Lisianski Island, and Pearl and Hermes Reef (Balazs, 1982; Balazs *et al*., 1987). Since the establishment of the ESA in 1973, and following years of exploitation, the nesting population of Hawaiian green turtles has shown a gradual, but definite increase (Balazs, 1996). For example, the number of green turtles nesting at an index study site at East Island has tripled since systematic monitoring began in 1973 (NMFS and USFWS, 1998a).

Unfortunately, the green turtle population in the Hawaiian Islands area is afflicted with a tumor disease, fibropapilloma, which is of an unknown etiology and often fatal, as well as spirochidiasis, both of which are the major causes of strandings of this species (G. Balazs, NMFS, personal communication, 2000). The presence of fibropapillomatosis among stranded turtles has increased significantly over the past 17 years, ranging from 47-69 percent during the past decade (Murakawa, *et al*., 2000). Green turtles captured off Molokai from 1982-96 showed a massive increase in the disease over this period, peaking at 61% prevalence in 1995 (Balazs, *et al*., 1998). Preliminary evidence suggests that there is an association between the distribution of fibropapillomatosis in the Hawaiian Islands and the distribution of toxic benthic dinoflagellates (*Prorocentrum* spp.) known to produce a tumor promoter, okadaic acid (Landsberg, *et al*., 1999). Fibropapillomatosis is considered an inhibiting factor to the full recovery of the Hawaiian green turtle populations, and the incidence of decreased growth rates in afflicted turtles is a minimum estimate of the impact of the disease (Balazs, *et al*., 1998). Stranding reports from the Hawaiian Islands from 1982-1999 indicate that the green turtle is the most commonly stranded sea turtle (96.5 percent, compared to other species), averaging around 150 per year (2,689 total/18 years).

The primary green turtle nesting grounds in the eastern Pacific are located in Michoacán, Mexico, and the Galapagos Islands, Ecuador (NMFS and USFWS, 1998a). Here, green turtles were widespread and abundant prior to commercial exploitation and uncontrolled subsistence harvest of nesters and eggs. More than 165,000 turtles were harvested from 1965 to 1977 in the Mexican Pacific. In the early 1970s nearly 100,000 eggs per night were collected from these nesting beaches (*in* NMFS and USFWS, 1998a). The nesting population at the two main nesting beaches in Michoacán (Colola, responsible for 70% of total green turtle nesting in Michoacán (Delgado and Alverado, 1999), and Maruata) decreased from 5,585 females in 1982 to 940 in 1984. Despite long-term protection of females and their eggs at these sites since 1990, the population continues to decline, and it is believed that adverse impacts (including incidental take in various coastal fisheries as well as illegal directed take at forage areas) continue to prevent recovery of endangered populations (P. Dutton, NMFS, personal communication, 1999; Nichols, 2002). In addition, the black market for sea turtle eggs in Mexico has remained as brisk as before the ban (Delgado and Alvarado, 1999). On Colola, an estimated 500-1,000 females nested nightly in the late 1960s. In the 1990s, that number dropped to 60-100 per night, or about 800-1,000 turtles per year (Eckert, 1993). During the 1998-99 season, based on a comparison of nest counts and egg collection data, an estimated 600 greens nested at Colola. Although only about 5% of the nests were poached at Colola during this season, approximately 50% of the nests at Maruata were poached, primarily because of difficulties in providing protections as a result of political infighting

(Delgado and Alvarado, 1999).

There are few historical records of abundance of green turtles from the Galapagos - only residents are allowed to harvest turtles for subsistence, and egg poaching occurs only occasionally. An annual average of 1,400 nesting females was estimated for the period 1976-1982 in the Galapagos Islands (NMFS and USFWS, 1998a).

Olive ridley turtles

Although the olive ridley is regarded as the most abundant sea turtle in the world, olive ridley populations on the Pacific coast of Mexico are listed as endangered under the ESA; all other populations are listed as threatened. The olive ridley is categorized as endangered by the IUCN, where taxa so classified are considered to be facing a very high risk of extinction in the wild in the near future (IUCN Red List, 2000).

Olive ridley turtles occur throughout the world, primarily in tropical and sub-tropical waters. The species is divided into three main populations in the Pacific Ocean, Indian Ocean, and Atlantic Ocean. Nesting aggregations in the Pacific Ocean are found in the Marianas Islands, Australia, Indonesia, Malaysia, and Japan (western Pacific) and Mexico, Costa Rica, Guatemala, and South America (eastern Pacific). In the Indian Ocean, nesting aggregations have been documented in Sri Lanka, east Africa, Madagascar, and very large aggregations in India at Orissa. In the Atlantic Ocean, nesting aggregations occur from Senegal to Zaire, Brazil, French Guiana, Suriname, Guyana, Trinidad, and Venezuela.

While olive ridleys generally have a tropical to subtropical range, individuals do occasionally venture north, some as far as the Gulf of Alaska. The post-nesting migration routes of olive ridleys, tracked via satellite from Costa Rica, traversed thousands of kilometers of deep oceanic waters ranging from Mexico to Peru and more than 3,000 kilometers out into the central Pacific (Plotkin *et al*. 1993).

Recent genetic information analyzed from 39 olive ridleys taken in the Hawaii-based longline fishery indicate that 74% of the turtles (n=29) originated from the eastern Pacific (Mexico and Costa Rica) and 26% of the turtles (n=10) were from the Indian and western Pacific rookeries (P. Dutton, NMFS, personal communication, January 2001), indicating the animals from both sides of the Pacific converge in the north Pacific pelagic environment. An olive ridley taken in the CA/OR drift gillnet fishery originated from an eastern Pacific stock (i.e. Costa Rica or Mexico) (P. Dutton, NMFS, personal communication, October 2002).

As mentioned, the Mexican nesting population of olive ridley is listed as endangered, while all other populations of olive ridleys are listed as threatened. Since its listing in 1978, there has been a decline in abundance of this species, and it has been recommended that the olive ridley for the western Atlantic be reclassified as endangered. This is based on continued direct and incidental take of olive ridleys, particularly in shrimp trawl nets. Since 1967, the western North Atlantic (Surinam and adjacent areas) nesting population has declined more than 80 percent. In general, anthropogenic activities have negatively affected each life stage of the olive ridley turtle populations, resulting in the observed declines in abundance of some olive ridley turtle nesting aggregations. Other aggregations, however, have experienced significant increases in abundance in recent years, often as a result of decreased adult and egg harvest pressure, indicating populations in which the birth rates are now exceeding death rates.

Declines in olive ridley populations have been documented in Playa Nancite, Costa Rica; however, other nesting populations along the Pacific coast of Mexico and Costa Rica appear to be stable or increasing, after an initial large decline due to harvesting of adults. Historically, an estimated 10 million olive ridleys inhabited the waters in the eastern Pacific off Mexico (Cliffton, *et al*., 1982 *in* NMFS and USFWS, 1998e). However, human-induced mortality led to declines in this population. Beginning in the 1960s, and lasting over the next 15 years, several million adult olive ridleys were harvested by Mexico for commercial trade with Europe and Japan. (NMFS and USFWS, 1998e). Although olive ridley meat is palatable, it was not widely sought after; its eggs, however, are considered a delicacy, and egg harvest can certainly be considered one of the major causes for its decline. Fisheries for olive ridley turtles were also established in Ecuador during the 1960s and 1970s to supply Europe with leather (Green and Ortiz-Crespo, 1982).

In the Indian Ocean, Gahirmatha supports perhaps the largest nesting population, with an average of 398,000 females nesting annually. This population continues to be threatened by nearshore trawl fisheries. Direct harvest of adults and eggs, incidental capture in commercial fisheries, and loss of nesting habits are the main threats to the olive ridley's recovery.

In the eastern Pacific, nesting occurs all along the Mexico and Central American coast, with large nesting aggregations occurring at a few select beaches located in Mexico and Costa Rica. Few turtles nest as far north as southern Baja California, Mexico (Fritts, *et al*., 1982) or as far south as Peru (Brown and Brown, 1982). A single olive ridley nested in 1985 on the island of Maui, Hawaii, but the eggs did not hatch (Balazs and Hau, 1986 *in* NMFS and USFWS, 1998e), and the event was most likely an anomaly. Where population densities are high enough, nesting takes place in synchronized aggregations known as *arribadas*. The largest known *arribadas* in the eastern Pacific are off the coast of Costa Rica (~475,000 - 650,000 females estimated nesting annually) and in southern Mexico (~800,000+ nests/year at La Escobilla, in Oaxaca (Millán, 2000).
The nationwide ban on commercial harvest of sea turtles in Mexico, enacted in 1990, has improved the situation for the olive ridley. Surveys of important olive ridley nesting beaches in Mexico indicate increasing numbers of nesting females in recent years (Marquez, *et al*., 1995; Arenas, *et al*., 2000). Annual nesting at the principal beach, Escobilla Beach, Oaxaca, Mexico, averaged 138,000 nests prior to the ban, and since the ban on harvest in 1990, annual nesting has increased to an average of 525,000 nests (Salazar, *et al*., in press). At a smaller olive ridley nesting beach in central Mexico, Playon de Mismalayo, nest and egg protection efforts have resulted in more hatchlings, but the population is still "seriously decremented and is threatened with extinction" (Silva-Batiz, *et al*., 1996). Still, there is some discussion in Mexico that the species should be considered recovered (Arenas, *et al*., 2000).

In Costa Rica, 25,000 to 50,000 olive ridleys nest at Playa Nancite and 450,000 to 600,000 turtles nest at Playa Ostional each year (NMFS and USFWS, 1998e). In an 11-year review of the nesting at Playa Ostional, (Ballestero, *et al*., 2000) report that the data on numbers of nests deposited is too limited for a statistically valid determination of a trend; however, there does appear to be a six-year decrease in the number of nesting turtles. Under a management plan, the community of Ostional is allowed to harvest a portion of eggs. Between 1988 and 1997, the average egg harvest from January to May ranged between 6.7 and 36%, and from June through December, the average harvest ranged from 5.4 to 20.9% (Ballestero, *et al*., 2000). At Playa Nancite, concern has been raised about the vulnerability of offshore aggregations of reproductive individuals to "trawlers, longliners, turtle fishermen, collisions with boats, and the rapidly developing tourist industry" (Kalb, *et al*., 1996). The greatest single cause of olive ridley egg loss comes from the nesting activity of conspecifics on *arribada* beaches, where nesting turtles destroy eggs by inadvertently digging up previously laid nests or causing them to become contaminated by bacteria and other pathogens from rotting nests nearby. At a nesting site in Costa Rica, an estimated 0.2 percent of 11.5 million eggs laid during a single *arribada* produced hatchlings (*in* NMFS and USFWS, 1998e). In addition, some female olive ridleys nesting in Costa Rica have been found afflicted with the fibropapilloma disease (Aguirre, *et al*., 1999).

In Guatemala, the number of nesting olive ridleys nesting along their Pacific coast has declined by 34% between 1981 and 1997. This is only based on two studies conducted 16 years apart, however: in 1981, the estimated production of olive ridley eggs was 6,320,000, while in 1997, only 4,300,000 eggs were estimated laid (*in* Muccio, 1998). This decline most certainly can be attributed to the collection of nearly 95% of eggs laid, and the incidental capture of adults in commercial fisheries (Muccio, 1998).

At Playa La Flor, the second most important nesting beach for olive ridleys on Nicaragua, Ruiz (1994) documented 6 *arribadas* (defined as 50 or more females nesting simultaneously). The main egg predators were domestic dogs and vultures (*Coragyps atratus* and *Cathartes aura*).

Although olive ridley *arribadas* in Orissa, India are among the largest such sites in the world, in the western Pacific, olive ridleys are not as well documented as in the eastern Pacific, nor do they appear to be recovering as well (with the exception of Orissa, India, only in recent years). There are a few sightings of olive ridleys from Japan, but no report of egg-laying. Similarly, there are no nesting records from China, Korea, the Philippines, or Taiwan. No information is available from Vietnam or Kampuchea (*in* Eckert, 1993). In Thailand, olive ridleys occur along the southwest coast, on the Surin and Similan islands, and in the Andaman Sea. On Phra Thong Island, on the west coast of Thailand, the number of nesting turtles have declined markedly from 1979 to 1990. During the 1996-97 survey, only six olive ridley nests were recorded, and of these, half were poached, and one was predated by feral dogs. During the 1997-98 survey, only three nests were recorded. The main threats to turtles in Thailand include egg poaching, harvest and subsequent consumption or trade of adults or their parts (i.e. carapace), indirect capture in fishing gear, and loss of nesting beaches through development (Aureggi, *et al*., 1999).

Indonesia and its associated waters also provides habitat for olive ridleys, and there are some recently documented nesting sites. On Jamursba-Medi beach, on the northern coast of Irian Jaya, 77 olive ridley nests were documented from May to October, 1999 (Teguh, 2000 *in* Putrawidjaja, 2000). However, as mentioned in the leatherback subsection, extensive hunting and egg collection, in addition to rapid rural and urban development, have reduced nesting activities in this area. In Jayapura Bay, olive ridleys were often seen feeding, and in June, 1999, an estimated several hundred ridleys were observed nesting on Hamadi beach, despite heavy human population in the nearby area. Locals report daily trading and selling of sea turtles and their eggs in the local fish markets (Putrawidjaja, 2000). At Alas Purwo National Park, located at the eastern-most tip of East Java, olive ridley nesting was documented from 1992-96. Recorded nests were as follows: from September, 1993 to August, 1993, 101 nests; between March and October, 1995, 162 nests; and between April and June, 1996, 169 nests. From this limited data, no conclusions could be reached regarding population trends (Suwelo, 1999).

Olive ridleys nest on the eastern and western coasts of peninsular Malaysia; however, nesting has declined rapidly in the past decade. The highest density of nesting was reported to be in Terengganu, Malaysia, and at one time yielded 240,000 *eggs* (2,400 nests, with approximately 100 eggs per nest) (Siow and Moll, 1982, *in* Eckert, 1993)), while only 187 *nests* were reported from the area in 1990 (Eckert, 1993). In eastern Malaysia, olive ridleys nest very rarely in Sabah and only a few records are available from Sarak (*in* Eckert, 1993).

Olive ridleys are the most common sea turtle species found along the east coast of India, migrating every winter to nest en-masse at three major rookeries in the state of Orissa, Gahirmatha, Robert Island, and Rushikulya (*in* Pandav and Choudhury, 1999). The Gahirmatha rookery, located along the northern coast of Orissa, hosts the largest known nesting concentration of olive ridleys. Unfortunately, uncontrolled mechanized fishing in areas of high sea turtle concentration, primarily illegally operated trawl fisheries, has resulted in large scale mortality of adults during the last two decades. Records of stranded sea turtles have been kept since 1993. Since that time, over 50,000 strandings of olive ridleys have been documented (*in* Shanker and Mohanty, 1999), and much of it is believed to be due to near-shore shrimp trawling. Fishing in coastal waters off Gahirmatha was restricted in 1993 and completely banned in 1997 with the formation of a marine sanctuary around the rookery. However, mortality due to shrimp trawling reached a record high of 13,575 ridleys during the 1997-98 season, and none of the approximately 3,000 trawlers operating off the Orissa coast use turtle excluder devices in their nets (Pandav and Choudhury, 1999), despite mandatory requirements passed in 1997. “Operation Kachhapa” was developed in the late 1990s to protect sea turtles and their habitat by enabling strict enforcement of the 5 km non-mechanized fishing zone limit, as well as putting forward efforts to monitor nestings and educate local inhabitants and fishermen (Shanker and Mohanty, 1999). However, shrimp boats continue to fish close to shore within this protected zone and continue to not use turtle excluder devices. Threats to these sea turtles also include artificial illumination and unsuitable beach conditions, including reduction in beach width due to erosion (Pandav and Choudhury, 1999).

According to Pandav and Choudhury (1999), the number of nesting females at Gahirmatha has declined in recent years, although after three years of low nestings, the 1998-99 season showed an increasing trend (Noronha, Environmental News Service, April 14, 1999), and the 1999-2000 season had the largest recorded number of olive ridleys nesting in 15 years (The Hindu, March 27, 2000; The Times of India, November 15, 2000). During the 1996-97 and 1997-98 seasons, there were no mass nestings of olive ridleys. During the 1998-99 nesting season, around 230,000 females nested during the first arribada, lasting approximately a week (Pandav and Kar, 2000); unfortunately, 80% of the eggs were lost due to inundation and erosion (B. Pandav, personal communication, *in* Shanker and Mohanty, 1999). During 1999-2000, over 700,000 olive ridleys nested at Nasi islands and Babubali island, in the Gahirmatha coast. It is not known how many eggs and nests were lost to high winds and strong waves, predicted to cause erosion on the islands (The Hindu, March 27, 2000), and an estimated 6,000 turtles were killed during this period due to illegal mechanized trawlers and non-use of the prohibited turtle excluder devices (S. Sahoo, January, 2001 in rediff.com[3]).

There are no records of nesting on the unincorporated U.S. territories in the North Pacific. In the central Pacific, a single nesting was reported in September, 1985 on the island of Maui, Hawaii (*in* Eckert, 1993). In October 2002, an olive ridley turtle was reported to have nested on the shores of Hilo Bay, on the Island of Hawaii. If confirmed upon hatching, this nesting event marks the second recorded nesting of an olive ridley in the main Hawaiian Islands.

Hawksbill turtles

The hawksbill turtle is listed as endangered under the ESA and in the International Union for the Conservation of Nature (IUCN) Red Data Book. Under Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the hawksbill is identified as “most endangered.” Anecdotal reports throughout the Pacific indicate that the current population is well below historical levels. In the Pacific, this species is rapidly approaching extinction primarily 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 (Meylan and Donnelly 1999, NMFS, 2001)

The hawksbill occurs in tropical and subtropical seas of the Atlantic, Pacific and Indian Oceans. The species is widely distributed in the Caribbean Sea and western Atlantic Ocean, with representatives of at least some life history stages regularly occurring in southern Florida and the northern Gulf of Mexico (especially Texas);in the Greater and Lesser Antilles; and along the Central American mainland south to Brazil. Within the United States, hawksbills are most common in Puerto Rico and its associated islands, and in the U.S. Virgin Islands. In the continental U.S., hawksbill turtles have been recorded from all the gulf states and from along the eastern seaboard as far north as Massachusetts, with the exception of Connecticut, but sightings north of Florida are rare (Meylan and Donnelly 1999).

Hawksbills are observed in Florida with some regularity on the reefs off Palm Beach County, where the warm Gulf Stream current passes close to shore, and in the Florida Keys. Texas is the only other state where hawksbills are sighted with any regularity. Most sightings involve

3http://www.rediff.com/news/2001/jan/22oris.htm posthatchlings and juveniles. These small turtles are believed to originate from nesting beaches in Mexico.

Nesting within the southeastern United States occurs principally in Puerto Rico and the U.S. Virgin Islands, the most important sites being Mona Island and Buck Island. Nesting also occurs on other beaches of St. Croix, and on Culebra Island, Vieques Island, mainland Puerto Rico, St. John and St. Thomas. Within the continental United States, nesting is restricted to the southeast coast of Florida and Florida Keys.

In the U.S. Pacific Ocean, there have been no hawksbill sightings off the west coast ((Meylan and Donnelly 1999). Hawksbills have been observed in the Gulf of California as far as 29˚N, throughout the northwestern states of Mexico, and south along the Central and South American coasts to Columbia and Ecuador (Meylan and Donnelly 1999). In the Hawaiian Islands, hawksbill turtles nest in the main islands, primarily on several small sand beaches on the Islands of Hawaii and Molokai. Two of these sites are at a remote location in the Hawaii Volcanos National Park.

Along the far western and southeastern Pacific, hawksbill turtles nest on the islands and mainland of southeast Asia, from China to Japan, and throughout the Philippines, Malaysia, Indonesia, Papua New Guinea, the Solomon Islands (McKeown, 1977) and Australia (Limpus, 1982). Along the eastern Pacific rim, hawksbill turtles were common to abundant in the 1930s (Cliffton *et al*., 1982). By the 1990s, the hawksbill turtle was rare to absent in most localities where it was once abundant (Cliffton *et al*., 1982); Cornelius, 1982).

Like other sea turtles, hawksbills are highly migratory, although they are less of a long-distant migrant. An adult female tagged in its foraging ground in the Torres Strait was observed nesting 322 days later in the Solomon Islands, a distance of over 1,650 km (Pritchard and Trebbau 1984). Another female traveled 1,400 km from the Solomon Islands to its foraging grounds in Papua New Guinea (Parmenter 1983). Tag return data (Pritchard and Trebbau 1984) and recent genetic studies (Bowen *et al*., 1996) suggest that individual foraging areas support hawksbills from distant breeding populations rather than just from nearby rookeries. They are found in all tropical seas between about 30°N and 30°S latitudes (NMFS and USFWS, 1998b). They are generally associated with coral reefs or other hard substrate structures close to shore where they feed on sponges and small crustaceans. Adult and immature hawksbill turtles are found in Hawaiian waters, but they are uncommon.

The hawksbill is a solitary nester, and thus, population trends or estimates are difficult to determine. There are no world population estimates for hawksbill turtles, but a minimum of 15,000 to 25,000 females are thought to nest annually in more than 60 geopolitical entities (Groombridge and Luxmoore 1989, Meylan and Donnelly 1999). Moderate population levels appear to persist around the Solomons, northern Australia, Palau, Persian Gule islands, Oman, and parts of the Seychelles (Groombridge 1982). In more recent reviews, Groombridge and Luxmoore (1989) and Meylan and Donnelly (1999) list Papua New Guinea, Queensland, and Western Australia as likely to host 500-1,000 nesting females per year, while Indonesia and the Seychelles may support >1,000. The largest known nesting colony in the world is located on Milman Island, Queensland, Australia where Loop (1995) tagged 365 hawksbills nesting within an 11-week period. With the exception of Mexico, and possibly Cuba, nearly all Wider Caribbean countries are estimated to receive <100 nesting females per year (Meylan 1989).

Hawksbills appear to be declining throughout their range. By far the most serious problem hawksbill turtles face is the harvest by humans, while a less significant threat, but no less important, is loss of habitat due to expansion of resident human populations and/or increased tourism development. Dramatic reductions in the numbers of nesting and foraging hawksbills have occurred in Micronesia and the Mexican Pacific coast, probably due largely to technological advances in fishing gear, which facilitate legal and illegal harvest. In addition, the hawksbill tortoiseshell trade probably remains an important contributing factor in the decline of the hawksbill. Although the Japanese market was closed in 1994, southeast Asia and Indonesia markets remain lucrative (NMFS and USFWS, 1998b). In addition to the demand for the hawksbill's shell, there is a demand for other products including leather, oil, perfume, and cosmetics. Prior to being certified under the Pelly Amendment, Japan had been importing about 20 metric tons of hawksbill shell per year, representing approximately 19,000 turtles. A negotiated settlement was reached regarding this trade on June 19, 1992. The hawksbill shell commands high prices (currently $225/kilogram), a major factor preventing effective protection[4]

In 1983, the only known apparently stable populations were in Yemen, northeastern Australia, the Red Sea, and Oman.

The Palau nesting population of hawksbills is the largest in Oceania north of the equator; nesting is concentrated on small beaches of the Rock Islands between Koror and Peleliu islands (Maragos 1991). This population is severely stressed by chronic egg poaching and the hunting of turtles for jewelry and crafts (Maragos 1991). Residents are nearly unanimous in their opinion that nesting numbers are down significantly during their lifetimes. Maragos (1991) reported an average of 58 nests found per year (1982-1990), of which 76% were identified as "nests without eggs" or nests that were illegally poached. The annual number of nests in the Rock Islands might approach one hundred under the most favorable of circumstances. This would represent 20-25 nesting females per season, assuming 4-5 nests per turtle per season. If 40% of adult female hawksbills return to nest each year, given an average remigration interval of 2.5 years for the population, then approximately 50-60 adult females might remain in the Rock Island nesting population today.

Based on interviews, Tuato'o-Bartley *et al*. (1993) estimated 50 nesting females per year on Tutuila and 30 nesting females per year on the Manu'a island group of Ofu, Olosega and Ta'u, using an average 2.8 nesting turtles per active beach. However, since untrained observers almost always seem to underestimate individual fecundity (numbers of clutches per female), the actual number of turtles nesting at Tutuila and Manu'a could be significantly lower than Tuato'o-Bartley's estimates.

4Http://www.nmfs.noaa.gov/prot_res/species/turtles/hawksbill.html

There are no reports of hawksbills nesting in the Commonwealth of the Northern Mariana Islands (CNMI) (Pritchard, 1982a). This is partly because there is a long history of occupation on the more southern islands of Saipan, Rota, and Tinian, and partly because almost no hawksbill nesting surveys of small pocket beaches have ever been done in remote areas of the CNMI. However, lack of evidences does not rule out the possibility of hawksbills nesting at low levels at unknown locations.

9.1.4.8.2 Primary threats to sea turtle species

The following primary threats and associated conservation strategies for sea turtles in the Pacific were developed by experts in attendance at the *Western Pacific Sea Turtle Cooperative Research and Management Workshop* in February of 2002. It is important to note that these summarized threats are also in accordance with all six US Sea Turtle Recovery Plans (NMFS 1998a; NMFS 1998b; NMFS 1998c; NMFS 1998d; NMFS 1998e; NMFS 1998f). Issues and threats common to all species include legal and illegal harvest of adults, juveniles and/or eggs; feral predation of nests; beach erosion and beach armoring; artificial lighting; marine debris (entanglement and ingestion); data deficiencies; lack of resources and coordination for international collaboration; poor education and public awareness; coastal habitat development (i.e., nesting beach and foraging habitat degradation); incidental capture in fisheries (trawl, gillnet and longline); and loss of ecosystem function.

Leatherback turtles

Primary threats	**Conservation strategies**

• Over-harvests of eggs • Predation on nesting females and eggs by feral animals • Mortality of leatherbacks in international pelagic fisheries • Population status of West Pacific poorly understood • Global warming (LB very sensitive to beach temp fluctuations)	• Implement harvests to sustainable levels • *In-situ* hatchery management techniques • Nesting beach management, nest relocation (erosion), and feral animal control (poison baiting, fencing) • Fisheries Mitigation (TED's, tending gillnets, handling techniques, time/area closures), bait/hook combinations, technology to reduce bycatch. • Identify nesting areas/key index areas, genetic stock identification research

Loggerhead turtles

Primary threats	**Conservation strategies**
• Precarious population drop, probably less than 2,000 nesting annually throughout entire Pacific • Nesting beach degradation through coastal development (beach armament) in Japan • Fisheries: ▸ N. Pac. longline ▸ Australia prawn trawling ▸ Japan sub-surface pound nets ▸ Mexico coastal longline and gillnets	• Protection of nesting habitat • Fisheries Mitigation (TED's, tending gillnets, handling techniques, time/area closures), bait/hook combinations, technology to reduce bycatch. • Investigate mortality in longline & coastal gillnet fishing activities off South America • Acquire info re: high seas developmental habitats

Green turtles

Primary threats	**Conservation strategies**
• Over-harvest of eggs • Direct harvest of adults/juveniles • Management and conservation programs jeopardized by political considerations	• Implement harvests to sustainable levels • *In-situ* hatchery management techniques. • Fisheries Mitigation (TED's, tending gillnets, handling techniques, time/area closures), bait/hook combinations, technology to reduce bycatch. • Development of international conservation initiatives and linkages to other regional bodies and commissions

Olive Ridley turtles

Primary threats	**Conservation Strategy**

• Over-harvest of eggs • Coastal Development (nesting beach degradation) • Fisheries interactions: LL, trawl, coastal gillnet	• Implement harvests to sustainable levels • *In-situ* hatchery management techniques • Identify nesting areas/key index areas, genetic stock identification research • Fisheries Mitigation (TED's, tending gillnets, handling techniques, time/area closures), bait/hook combinations, technology to reduce bycatch

Hawksbill turtles

Primary threats	**Conservation strategy**
• Population status of West Pacific poorly understood • Intense over-harvest of adults, juveniles and eggs	• Implement harvests to sustainable levels • *In-situ* hatchery management techniques • Identify nesting areas/key index areas, genetic stock identification research

9.1.4.8.3 Threats in perspective

Marine turtles have provided nutritional, economic and spiritual sustenance to peoples around the world, and are part of the cultural fabric of many coastal communities (Frazier 2003). Despite their protected status, sea turtles continue to face challenges from human activities and are affected at every stage of their life cycle, from the loss of nesting beach and foraging habitats, to over exploitation and fishery interactions. Recently, pelagic longlining has been named a primary threat to sea turtle populations (Asilomar Resolution, April 25, 2002). In considering the level of impact to sea turtles, it is important to put all threats into perspective.

Natural mortality

From the moment a sea turtle lays her eggs in the sand, natural mortality begins. Before the eggs are covered, on some beaches raccoons or monitor lizards help themselves to an easy meal (Mrosovsky 1997). Other animals, such as feral dogs, pigs, foxes, coyotes, mongoose and cats dig up nests (Stancyk 1995). Birds and crabs eat hatchlings as they emerge from nests, and fish eat hatchlings when they enter the water. Mrosovsky (1997) estimates that between 45-85% of hatchlings are eaten by fish within the first hour of entering the water. But predators are not the only agents of natural mortality.

A turtle's own behavior can be a major factor. For instance, clutches can be laid below the high tide line are subsequently washed away. Mrosovsky (1997) estimates that a quarter of a million eggs per year are doomed in this way. In addition, turtles sometimes dig up nests of other turtles. This source of natural morality is especially important when olive ridleys come ashore in *arribadas* (mass nesting). For example, a good sized *arribada* at Nancite, Costa Rica can destroy 1.7 million eggs from the 100,000 nests laid (Mrosovsky 1997).

Human consumption
Sea turtles have been exploited for their meat, eggs, shell, leather, and oil for centuries. Archaeological evidence suggests both over fishing that lead to decimation of localized populations as well as possible evidence of implemented conservation measures (Frazier 2003; Woodrom-Luna 2003a; Woodrom-Luna 2003b; Lutcavage et al 1997; McCoy 1997; Nietschmann 1973). The oldest archaeological evidence of interactions between humans and turtle comes from the Arabian Peninsula dating about 5,000 BC (Frazier 2003). However, the expansion of Western capitalism appears to have shaped sea turtle consumption; economies that might previously have used turtle for subsistence purposes now have cash needs that may be met through selling sea turtles and their by-products (Balazs 1995; Campbell 2003; Nietschmann 1979).

The consumptive use of sea turtles and their eggs around the world has been documented by Thorbjarnarson et al 2000 (in Campbell 2003). Countries that have used sea turtle meat in the past few decades includes: the U.S. (Florida, Georgia, Louisiana, Mississippi, North Carolina, Texas and Virginia), Central America, Costa Rica, Belize, Mexico, Ecuador, Peru, Madagascar, Seychelles, India, Sri Lanka, Japan, Indonesia, Australia, Torres Strait, Papua New Guinea, Fiji, Solomon Islands, the Caroline Islands, Philippines, Bangladesh, Thailand, Liberia, Egypt, Equatorial Guinea, Guinea-Bissau, Kenya, Tanzania, Cuba, Nicaragua, and the Caribbean Islands.

The list of countries that have been documented to consumed sea turtle eggs in the past few decades, both legally and illegally, includes: Central America (Costa Rica, Guatemala, Panama, Honduras, Nicaragua), Mexico, Iran, Saudi Arabia, India, Thailand, Malaysia, Indonesia, Philippines, Papua New Guinea, Indonesia, Suriname, Bangladesh and Myanmar (Thorbjarnarson et al 2000 in Campbell 2003). For example, coastal villagers in Terengganu, Malaysia have engaged in the collection of leatherback eggs for consumption and sale since time immemorial, with egg harvest approaching 100% for decades (Chan & Liew 1996). In Indonesia, over 80% of leatherback nests laid on the north Vogelkop coast of Irian Jaya are lost each nesting season due to poaching, predation by wild pigs, and beach erosion (Suarez 1996). Intense egg harvest up until 1991 of leatherbacks at Las Baulas, Costa Rica (>90% of all nests) has contributed to the documented population decline (Spotila 1996). In contrast, Colin Limpus emphasizes that 70% of eggs need to be preserved to sustain population size (Lumpus 1994; Chan & Liew 1996)

Turtles have also been exploited for their parts (summarized from Campbell 2003). This includes olive ridley skin (manufactured in Mexico and Ecuador, imported by Japan, France Spain, Italy and the U.S.), turtle oil, turtle parts for aphrodisiacs, turtle blood to treat ailments, and for medicinal purposes. Animal collection and taxidermy has had its place in Western culture, both for scientific purposes and amateur collectors. Unfortunately, stuffed turtles continue to supply the tourist trade in developing countries. Tortoiseshell, traditionally obtained from the hawksbill turtle, has ranked among the world's luxury goods. Some countries, such as Japan, Seychelles and Palau, have a long history of crafting hawksbill shell and view turtle shells as an integral part of their culture and economy. Japan, for example, has crafted "bekko" for over 1,000 years. Today, tortoiseshell is apparently still available, despite CITES law, to tourists in Barbados, Belize, Costa Rica, Cuba, the Dominican Republic, Fiji, Indonesia, Japan, Maldives, Mexico, Nicaragua, Sao Tome, Sri Lanka, Thailand and Vietnam (Campbell 2003).

Commercial sea turtle meat and egg fisheries

The worldwide decline of nearly all sea turtle populations can be attributed in part to the direct take of turtles and their eggs by commercial and subsistence sea turtle fisheries (Lutcavage et al 1997). All sea turtle rookeries worldwide have undergone large-scale adult and egg harvest (Limpus 1994). Although all sea turtle life stages have been exploited, breeding adults and their eggs have been most vulnerable. Since prohibited by the Endangered Species Act of 1973, the directed harvest of sea turtles and eggs is prohibited within the U.S., and was banned in Mexico in 1990. Nonetheless, directed illegal harvest undoubtedly still occurs in Mexico and Indonesia and other countries.

Most of the global commercial harvest of sea turtles remains unquantified, however, there are a few documented fisheries. Fiji, for example, attributes the dwindling sea turtle stocks in Fiji to the over-harvest for commercial purposes (Batibasaga 2002). In the 1970s, between 16,494 and 37,651 sea turtles were harvested each year in Bali, Indonesia (Barr 1991). There are at least six slaughterhouses in Bali, and each process about 5 to 12 turtles a day, except during religious occasions when considerably more may be harvested (Barr 1991). Limpus (1994) states that 30,000 green sea turtles are harvested annually in Bali, and are collected from areas throughout the western Pacific region. Salm (1984) on the other hand, estimates at least 50,000 green sea turtles are harvested every year in Indonesia. In Manus, Papua New Guinea, every nesting female found is harvested by local people (Suarez 1996). In two documented traditional fisheries in Indonesia, approximately 70 leatherbacks are taken every year in the Kai Islands and 30 leatherbacks are harvested annually in the southern Aru Islands (Suarez 1996). In addition to the exploitation of all age-classes of green and hawksbill turtles, virtually every sea turtle egg (all species) laid on major nesting beaches in Indonesia is collected for human consumption; an estimated seven to nine million eggs per year (Barr 1991).

Prior to joining CITES in 1990, Japan was a major importer of bekko, hawksbill turtle shell. Since 1970, 60 countries have been involved in the export or re-export of bekko to Japan. The principal exporters have been Panama, Cuba, Haiti, Jamaica, Honduras, Belize, Indonesia, Singapore, Philippines, Tanzania, Kenya, Maldives, Comoros Islands, Solomon Islands, Fiji, and the Netherlands (Canin 1991). From 1970 to 1990, Japan imported a documented 752,620 kg of bekko (an average of 37,631 kg/yr), representing approximately 710,000 hawksbills. In addition, 587,000 stuffed hawksbills and approximately 400,000 stuffed green turtles have been imported (1970-1987), as has the skin and leather from 568,000 olive ridleys (1970-1988). Between 1970 and 1990, Japan imported sea turtle products representing a minimum of 2,250,000 sea turtles (Barr 1991; Canin 1991).

When the Japanese first colonized the Ogasawara Islands in 1876, the government encouraged a green turtle fishery. The fishery records show a steady decline from 1880 -1890 when around 1,000 to 1,800 adult turtles were harvested until the mid 1920s when fewer than 250 were caught each year (Horikoshi 1995). Since 1973, annual harvest rates have fluctuated between 45 and 225 turtles per year (Horikoshi 1995).

In Mexico, directed harvest of sea turtles has caused a decrease of 80 to 90% of the green turtle population (Nichols 2002a). During the peak of the turtle trade in the 1960s, a sea turtle slaughterhouse in Puerto Magdalena, Baja California, Mexico processed between 150 and 250 turtles per week (Nichols 2002a). Mexico banned the harvest of turtles in 1990, however, the demand for green turtles is still high especially during the Easter holiday when approximately 7,800 green turtles or more may be poached (Nichols 2002a). Additional information from The Universidad Autonoma de Baja California Sur suggest that the actual annual harvest of green turtles in Baja may number 23,000 to 31,000 per year (Nichols 2002b).

In addition, the sea turtle fishery in Mexico annually harvested hundreds of thousands of olive ridleys (Lutcavage et al 1997; Marquez 2002). Starting in the mid 1960s the exploitation of olive ridleys contributed more than 80% of the total world market production, nearly 14,500 tons (Marquez 2002). This level of exploitation was not sustainable and stocks collapsed in the early 1970s, and lead to the demise of at least three local nesting populations, and a precipitous decline of the species until conservation measures became effective in 1990.

India and Pakistan have a long history of trade in turtle products, primarily olive ridleys from the Orissa coast. Between 1963 and 1974, India exported 102,022 kg of sea turtle products (Mohanty-Hejmadi 2000). Up until 1970, it is estimated that 50,000 to 75,000 mature adults were harvested, and it was not unusual for a boat load of turtle eggs to number between 35,000 and 100,000 eggs (Mohanty-Hejmadi 2000). The estimated legal egg harvest during the 1974-75 nesting season was 800,000 eggs (Mohanty-Hejmadi 2000).

Alteration of habitat

The degradation of nesting habitats due to coastal development poses a serious and detrimental impact to sea turtles (Lutcavage et al 1997; Spotila et al 1996). The global impact to turtles, other than in a few isolated cases, remains predominantly unquantified. Nesting beach threats brought about through habitat degradation includes urban development, agriculture activities, timber harvest, mining, pollution, beach armoring, sand mining, vehicular traffic on beaches, artificial lighting and direct impacts through human presence (Mitchell and Klemens 2000). Additional anthropogenic near shore threats, other than fishery impacts, also include dredging activities and boat strikes.

Pollution and marine debris on beaches can cause physical obstructions and prevent beach access by adults or inhibit hatchlings from reaching the sea (Sarti 1996). Beach armoring consist of hardening structures (concrete sea walls, wooden walls, rock revetments, and sandbag structure) is meant to protect coastlines from erosion, however, it also results in the elimination of nesting habitat (Schroeder 2000; Mosier 2002). Artificial lighting disrupts critical adult nesting behavior and the nocturnal sea-finding behavior of hatchlings. Impacts of lights to sea turtles have been studied extensively and conservation strategies exist to educate visitors, hotels, residents and the public to ameliorate impacts (Lutcavage et al 1997; Witherington & Bjorndal 1991).

Pollution, marine debris & entanglement

Sea turtles can achieve life spans greater than 50 years and have a potential to bioaccumulate heavy metals and pesticides (Lutcavage et al 1997). Pollution and contaminate effects are difficult to quantify, however, chronic pollution from industry, agriculture and urban runoff are known to negatively impact sea turtles (Lutcavage et al 1997). Pollutants have been found in eggs, gonads, fat liver, muscle, scutes, and tissues of turtles which may function to compromise a turtle's immune system, and are further implicated in disease expression such as fibropapilloma (Seminoff 1999; Work 1998; Ceron 2000; Sakai et al 1995; Sakai et al 2000).

Reports have documented that marine pollution by plastic debris, tar balls, heavy metals and persistent organochlorine compounds are of great concern and may play a role in declining populations of sea turtles (Bjorndal et al 1994; Carr 1987; Musick et al 1995). Plastics are the most abundant type of anthropogenic debris found on beaches and in the oceans (Lutcavage et al 1997). In 1985, Balazs published a report which documented 79 cases of ingested plastics and 60 cases of entanglement in marine debris by sea turtles. This report brought global attention to the issue, and there has been an increased effort to quantify the impacts of entanglement and ingestion. Published reports of debris ingestion exist for all sea turtle species in all life stages. However, the dependence of pelagic juveniles upon convergence zones, where floating debris concentrates, and their omnivore foraging strategy leave pelagic turtles most susceptible to debris ingestion (Lutcavage et al 1997; Witherington 2002; Witherington 2000; Mrosovsky 1981; Bjorndal et al 1994).

Numerous reports also exist implicating both ingested plastics and entanglement in the death of turtles (Balazs 1985; Chatto 1995; Bjorndal et al 1994; Wallace 1985; Almengor 1994; Mrosovsky 1981). Small quantities of ingested debris can kill turtles by obstructing the gut (Bjorndal et al 1994), and entanglement in marine debris or derelict fishing gear can result in reduced mobility, making a turtle unable to feed or flee from predators (Balazs 1985). Derelict fishing gear, in particular monofilament line, is one of the most commonly encountered anthropogenic debris items that entangle turtles and may account for 68% of all entanglement cases (NRC 1990; Lutcavage et al 1997). Trailing debris may trap turtles between rocks or ledges resulting in death from drowning, constrict the neck and/or flippers, amputate limbs, and consequently lead to death from infection (Lutcavage et al 1997; Balazs 1985).

Fishery interactions

Trawling

Shrimp trawls are considered to capture and drown more sea turtles worldwide than any other form of incidental capture (Richardson et al 1995). Furthermore, the National Academy of Science concludes that capture in shrimp trawls accounts for more deaths than all other source of human activities combined (Lutcavage et al 1997). Prior to the twentieth century, shrimp harvesting probably did not significantly impact turtles because the main gear, haul seines, which allow turtles to surface and breath, was pulled by hand in very shallow waters (Epperly 2003). Commercial and large scale expansion began with the introduction of the otter trawl in the early 1900s, and expanded in the U.S. after World War II. In 1973, trawling was identified as a principal source of turtle mortality, and in 1978 NMFS undertook development of Turtle Excluder

Device (TEDs) that would allow captured turtles to escape capture in shrimp trawls. In 1989, U.S. law made the use of TEDs mandatory. In 1993, Mexico also required that offshore trawlers use TEDs, however, noncompliance by trawlers prompted the U.S. to impose a trade embargo on countries importing shrimp to the U.S , but not utilizing TEDs. As a result Public Law 101-162, Section 609 has made TEDs a mandatory requirement to importing shrimp to the U.S. As of 2002, 17 nations met the certification standards for sea turtle conservation, although loopholes do exist (e.g. Europe accepts shrimp harvested without TEDs) (Epperly 2003). The effectiveness of the embargo, however, has recently come under severe criticism as noncompliance and improper use of TEDs (in Costa Rica for example) remains a serious issue (Arauz, in prep).

All species of sea turtle are captured by shrimp trawlers, , but the majority of captures appears to consist of loggerhead, Kemp's ridley, olive ridley, and green sea turtles (Richardson et al 1995). Before implementation of TEDs, direct mortality of an estimate 5,000 to 50,000 loggerheads and 500 to 5,000 Kemp's ridleys was believed to occur yearly in the U.S. (Lutcavage et al 1997). Arauz (1998) estimates that the Costa Rican shrimp fleet catches approximately 20,000 turtles per year with a mortality rate around 50%.

Leatherbacks and loggerhead turtles, however, have also been impacted by trawling activities. Between 1972 and 1974 the leatherback nesting population at Terengganu, Malaysia decline averaged 723 nests or 21% annually. This period coincided with the period of rapid development in the trawling industry in Terengganu during the early 1970s (Chan & Liew 1996). Chan et al (1988) estimated that on average 321 leatherbacks, 245 green and 176 olive ridley turtles may be captured per year in Malaysian trawl fisheries. In Australia, the northern prawn fishery and the Queensland east coast trawl fishery are estimated to capture a combined total of 11,000 sea turtles per year (Robins et al 1999). The main species caught are flatback, loggerhead, green and olive ridley turtles. Furthermore, drowning in trawl nets is suggested to be a major reason for the decline in loggerheads in eastern Australia (Limpus and Reimer 1994 in Robins et al 1999).

Coastal gillnets

Collectively, unattended nets set in shallow waters and fisheries other than shrimping are the second largest source of morality to sea turtles (Lutcavage et al 1997). Incidental take records and anecdotal observations from fisheries document notable abundance of sea turtle on shelf break (200 m depth contour) or at edges of oceanic gyre systems (Lutcavage et al 1997). Coastal fishing practices include coastal gillnets, trammel nets, pound nets and setnets. Sea turtle mortality associated with these fisheries varies in response to the seasonal abundance of turtles, target species, and to the intensity and timing of fishing effort. For example, preliminary data obtained by Wildcoast suggests that seasonal halibut gillnetting coincides with loggerhead foraging activity and fishery activity results in high, and possibly significant loggerhead mortality (Wildcoast 2003 unpublished progress report to NMFS-SWFSC; Nichols et al 2000). Fishers operating off Puerto Lopez Mateos report an average of 6 loggerheads captured per week per boat (range 0-40 turtles caught per day per boat) through the entire halibut season (May to Sept). 90% of turtles are reported dead in nets and survivorship of the remaining 10% is unknown (Wildcoast 2003 unpublished progress report to NMFS-SWFSC).

Chan et al (1988) estimated that on average 55 leatherback, 100 green turtles and 267 olive ridley turtles may be captured per year in Malaysian coastal gillnet fisheries.
In Taiwan, coastal setnet fisheries provide the second largest total fish yields, after gillnets (Cheng 1997). From 1991 to 1994, for every thousand tones of fish caught, setnets trapped two to four turtles. During these years, 70 green turtles, 16 loggerhead, five olive ridley, eight hawksbill and one leatherback turtle were captured (Cheng 1997).

In India, coastal nets including driftnets, fixed nets, gillnets, seine nets and trawlers have been implicated in the capture of thousands of olive ridley turtles. According to Dutton (2000), 30% of olive ridley interactions with the Hawaii-based longline fleet are from the western Pacific stock, possibly originating from India. This is a concern, as a staggering 75,000 sea turtles are known to have been incidentally captured (based on stranding data) off the Orissa coast over the last six years (Wright & Mohanty 2002). In one example, 205 olive ridley turtles were found dead in one multifilament gill net (Wright & Mohanty 2002).

Coastal driftnet fishery
The California/Oregon drift gillnet fishery targets swordfish and thresher shark. Between July 1990 and December 2001, NMFS has observed 6,312 sets (NMFS unpublished data). This fishery seems to interact more with leatherback turtles than any other species. During this observed time period, there have been 23 leatherback interactions, 14 loggerhead interactions, one green turtle, and one olive ridley turtle. Almost all leatherback interactions occurred north of Point Conception and 78% of the interactions occurred during the months of August to October. Loggerhead interactions, however, occurred south of Point Conception and occurred primarily during El Nino events.

Pelagic driftnets
Four species of marine turtle have been documented in the bycatch of North Pacific high-seas driftnet fisheries conducted by Japan, Korea and Taiwan. The risk of mortality in driftnets is greatest for species which spend much of their lives in the open ocean, such as leatherbacks and loggerheads. Between 1978 and 1980, leatherback nesting at Terengganu, Malaysia dropped an average of 469 nests per year or 31% annually. This coincided directly with the introduction of the Japanese high seas squid driftnet fishery of the North Pacific in 1978 (Chan & Liew 1996). It is believed that similar fisheries operating within the South China Sea also compounded the problem (Chan & Liew 1996). Sarti et al (1996) also attributes the precipitous decline of eastern Pacific leatherbacks, of 22.66% over the last 12 years, to uncontrolled domestic harvest and the high seas driftnet fishery in the North Pacific. Eckert and Sarti (1997) estimated 1,000 leatherbacks captured by the driftnet fishery in 1990-91. The high seas driftnet fishery peaked during 1978 – 1990, and the annual incidental take of leatherbacks throughout this period was probably at least as high as that reported for 1990-91 (Eckert and Sarti 1997). Furthermore, Eckert and Sarti (1997) considered the swordfish gillnet fishery in Peru and Chile to have represented the single largest source of mortality for east Pacific leatherbacks.

The overall impact to turtles by pelagic driftnets has not been well documented. However, efforts by Wetherall and Balazs (1993) indicated a total marine turtle bycatch of about 6,100 turtles, with a mortality rate of 1,700 turtles, in 1990 based on observer data combined with driftnet fleet effort. In December 1992, a United Nations resolution banned high seas drift nets thus instituting a global moratorium on pelagic driftnets based on the indiscriminate nature of the gear (Crouse 1999), yet illegal gillnetting is still believed to occur (G. Nitta, NMFS, pers. comm.).

Pelagic longlines
Since the moratorium on pelagic driftnet fishing, longline fishing effort has expanded throughout the Pacific. Longlining is cleaner than driftnets in terms of total bycatch, however, fleets do interact with sea turtles (Crouse 1999). Bycatch data for the longline fleets operating in the Pacific is neither comprehensive nor complete. The Hawaii-based longline fishery has the most comprehensive bycatch data of all longline fleets in the Pacific based on fishery effort and observer data (see Section 9.1.4.9). The study by Nishimura and Nakahigashi (1990) is a frequently quoted paper that estimated 0.1 turtles hooked per 1,000 hooks, or 21,200 turtles captured (and 12,296 mortalities) annually in the Western Pacific and South China Sea region. However, this estimate was based on questionnaires and the assumption, for "statistical purposes," that turtles are distributed homogeneously throughout the Pacific. Current research has proven otherwise; sea turtles are not homogeneously distributed throughout the Pacific (e.g., Polovina et al 2000 and Polovina et al 2001).

Additional work in 1988 and 1989 by Frazier (1990) regarding the Chilean swordfish fishery identified 30 leatherback captures, but extrapolated that "several hundreds of animals may be captured yearly." Genetic analysis by Dutton (1999) identified that leatherbacks captured by the Chilean fleet originated from nesting beaches in the eastern Pacific. Papers by Spotila et al (1996) and Eckert and Sarti (1997) suggest that fishery interactions (namely longline, costal gillnet and pelagic driftnet) may have attributed to the decline of the eastern Pacific leatherback stock. Aguilar et al (1995) estimated 20,000 loggerhead interactions and between 4,600 – 10,700 turtle mortalities by Spanish swordfish fleet operating in the Mediterranean and Atlantic oceans. Undoubtedly, a comprehensive assessment of all pelagic longline fleets operating throughout the Pacific is necessary to accurately quantify interaction rates.

Summary
Archaeological evidence indicates that sea turtles have been a part of human culture dating back to at least 5000 B.C (Frazier 2003). It is evident that turtles played an economic, spiritual and culturally valued role, and in many ways continue to do so in the 21st century. Unfortunately, traditional practices and authority, which may have once managed turtle resources through tabu or meat sharing practices, have disappeared (Balazs 1995; McCoy 1995, 1997; Suarez 1996; Woodrom-Luna 2003b; Frazier 2003; Campbell 2003; Nietschmann, 1973, 1979). The introduction of market economies, commerce and the expansion of the human population has been a severe detriment to turtle populations worldwide. According to Limpus (pers. comm.), every coastal community of the Pacific Ocean, which has turtle resources, eats turtles and/or turtle eggs. The cumulative effects of this sustenance harvest in the 21st century may not be sustainable given centuries of past exploitation and in light of current, modern day threats such as habitat degradation, pollution, anthropogenic impacts and fishery interactions. Centuries of unregulated exploitation and mismanagement has jeopardized populations. Longline fisheries alone are not

responsible for the current status of sea turtles. However, fishing impacts have now emerged as the modern day problem to be solved. Today, both new fishing technologies to reduce and mitigate sea turtle interactions, and conservation measures to protect turtles in their coastal habitats are necessary to recover and sustain sea turtle populations.

9.1.4.8.4 Summary of current population information on sea turtles

Leatherback turtles

Western Pacific

In 2001, data indicated that between 456-601 leatherback turtles nested in Jamursba-medi, Papua (formerly Irian Jaya) and approximately 128 to 169 turtles nested at War-mon beach, Papua in 1993 (the last available monitoring information) (Hitipeuw 2002). Preliminary data for the 2003 summer nesting season in Papua (Jamusba-medi) indicates that nesting numbers were a bit lower than last year, , but well within normal variability (P. Dutton, pers. comm.). The second major nesting area in the western Pacific occurs in Papua New Guinea where it is estimated that approximately 350 females nest per year (Philips 2002).

Western Pacific Leatherback Nesting Activity		
Nesting Season	**No. Nests**	**No. Females**
Malaysia, Terengganu (Liew 2002)		
1994		2
1970		1, 760
Papua, Jamursba-Medi (Hitipeuw 2002)		
2001	2,644	456 - 601
2000	no data	
1999	3,251	560 - 739
1998	no data	
1997	4,481	773 - 1,018
1996	6,373	1,099 - 1,448
Papua, War-mon beach (Hitipeuw 2002)		
1993	406	128
1984	1,012	174
PNG, Kamiali Wildlife Area (Philips 2002)		
2000/01	500-600	150
PNG, Morobe coast (Philips 2002)		
yearly average	~1,000 - 1,500	~250

Eastern Pacific

The eastern Pacific population has been monitored since the 1980s and the data indicate declining population trends based on the number of nesting females per year (Sarti 2000; Sarti 2002). During the 2001/02 nesting season, preliminary data revealed only 75 leatherbacks nested in Costa Rica and approximately 109 to 120 leatherback turtles nested in Mexico (NMFS 2002).

The longest monitored leatherback nesting beach, and one of the largest colonies, was located at Mexiquillo Beach, Michoacan, Mexico. Nesting surveys were initiated at that beach in 1984 when 4,681 nests were recorded. By 1995 the number of nests was down to 708 (Sarti *et al.*, 1996b) and the decline has continued since then (Arenas *et al.*, 1998). Other beaches in Mexico have exhibited similar declines in nesting, though survey coverage has been less complete at those beaches (Sarti *et al.*, 1996b). A rough estimate for the entire Mexican Pacific population for the 2002-2003 nesting season is approximately 60 nesting females (L. Sarti pers. comm., 2003)

Mexican Leatherback Nesters - 2002/2003 (Source: L. Sarti, pers. comm., 2003)	
Location	**No. of Nesters**
Mexiquillo, Michoacán	6
Tierra Colorada, Guerrero	1
Cahuitan, Oaxaca	16
Barra de la Cruz, Oaxaca	2

At Las Baulas National Park, Costa Rica, the number of nesting leatherbacks has declined from 1,300 -1,500 in 1988-1989 to 180 - 193 in 1993-1994 (Steyermark *et al.*, 1996; Las Baulas Leatherback Turtle Project, 2003). Leatherbacks have been studied at Playa Grande (in Las Baulas), the fourth largest leatherback nesting colony in the world, since 1988. During the 1988-1989 season (July-June), 1,367 leatherbacks nested on this beach, and by the 1998-1999 season, only 117 leatherbacks nested. Furthermore, during the last three nesting seasons (1996 through 1999), an average of only 25 percent of the turtles were remigrants. Less than 20 percent of the turtles tagged in 1993 through 1995 returned to nest in the next five years (Spotila *et al*., 2000). With over 91 percent of leatherbacks having a remigration interval of five years or less (Hughes, 1996; Boulon *et al.*, 1996), it is likely that leatherbacks are experiencing mortalities during non-nesting years.

East Pacific Leatherback Nesting Activity		
Mexico		
Nesting Season	No. Nests	No. Females
2002/03 (Sarti, pers comm)		60
2001/02 (2002 BiOp)		109-120

2000/01 (Not Available)		
1998/99 (Sarti 2000)	799	67
1997/98(Sarti 2000)	1,596	250
1996/97(Sarti 2000)	1,097	236
1995/96 (Sarti 2000)	5,354	1,093

Costa Rica, Las Baulas (Source: NMFS 2002)		
Nesting Season	**No. Nests**	**No. Females**
2001/02*		69
2000/01		397
1999/00		224
1998/99		117
1997/98		194
1996/97		125
1995/96		421
1994/95		506
1993/94		180
1992/93		909
1991/92		770
1990/91		665
* 2001/02 Source: http://www.leatherback.org/lasbaulas/costa-rica/Las_Baulas/Project/History.html)		

Loggerhead turtles
There are approximately 42 nesting beaches in Japan, of which nine are considered primary nesting beaches (Kamezaki et al. 2003). Approximately 1,000 females nest in Japan every year (Suganuma 2002; Kamezaki et al. 2003). In the south Pacific, approximately 300 to 500 loggerhead females nest in eastern Australia every year (Dodd 2002; Limpus 2002)

Loggerhead nesting activity in Japan (Suganuma 2002; Kamezaki et al. 2003)	
Nesting Season	No. Nests
2000	2,589
1999	2,255
1998	2,479

Although population data indicate a declining trend in loggerhead nesting numbers compared to historic numbers, a recent presentation given by the Fisheries Research Agency of Japan reveal a slight upswing in nesting population numbers at five loggerhead nesting sites in Japan, Figure 3 (Kiyota *et al.* 2003).

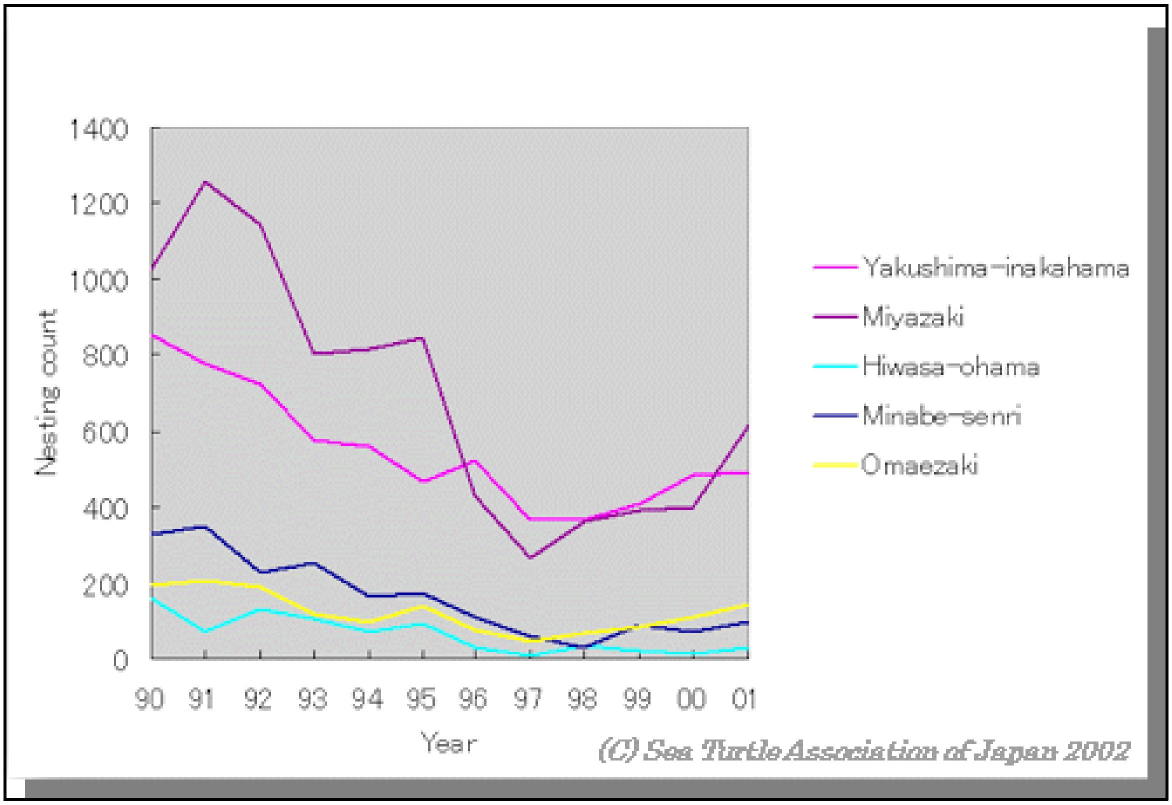

Figure 3. Data on five loggerhead nesting sites in Japan (Source: Kiyota *et al.* 2003).

Olive ridley turtles

Primary olive ridley nesting sites in the Pacific occur along the west coast of Mexico and Central America and in India. However, small aggregations of nesting activity also occurs in areas such as Thailand, Vietnam, Indonesia and Australia (NMFS 2002).

Annual population estimates at major nesting sites (NMFS 2002)	
Location	**Avg. No. per year (unless specified)**
La Escobilla, Mexico	800,000 nests
Ostional, Costa Rica	450,000 - 600,000 females

Playa Nancite, Costa Rica	25,000-50,000 females
Guatemala	4,300,000 eggs (1997)
Gahirmatha, India	398,000 females
Jamursba-medi, Papua (Hitipeuw 2002)	227 nests (2001)

Hawksbill turtles
Hawksbill turtles are widely distributed throughout the Pacific, yet nest in low abundance. The following table is a summary of major nesting sites. Additional nesting may also occur in the Seychelles, Papua New Guinea, Palau, Vietnam and Thailand (NMFS 2002).

Annual population estimates at major nesting sites	
Location	**Avg. No. per year (unless specified)**
Queensland, Australia (Dobbs 2002)	4,000 females
Terengganu, Malaysia (Liew 2002)	20 nests (2000)
Sabah, Malaysia (Bastinal 2002)	337 females (2000)
Jamursba-medi, Papua (Hitipeuw 2002)	40 nests (2001)
Solomon Islands (Mortimer 2002)	600 nests
Hawaii (L. Katehira pers. comm.)	18 nests
Mexico (Marquez 2002)	6,000 nests (2000)

9.1.4.9 Historical Pelagics FMP fishery interactions with sea turtles

This section presents historical information on sea turtle interactions with the pelagic fisheries managed under the Pelagics FMP.

Hawaii-based Longline Fishery

Leatherback turtles - Based on observations of the Hawaii-based longline fishery, leatherback turtles primarily appear to be taken by being hooked externally or entangled rather than by ingesting the hook. This is probably due to their foraging strategy as well as their physiology. Whereas some hard-shelled turtle species (e.g., loggerheads) are piscivores and will forage on the bait used on longlines and, therefore, become hooked internally, leatherbacks tend to target cnidarians (e.g., medusae and siphonophores). Thus leatherbacks may have been attracted to the lightsticks, once used on the longlines (, but now prohibited) at night to attract squid, and subsequently were hooked externally or entangled. Turtles could be captured while feeding or swimming at the surface when the longline is being set or hauled back or when the longline is fishing at depth.

Leatherbacks appear to be very susceptible to entanglement in fishing gear. Of 11 sea turtles examined port-mortem after being captured by Hawaii-based longline fishers, the only two turtles with leaders around their body parts were leatherback turtles (Work 2000). This susceptibility is probably the result of long pectoral flippers and active swimming behavior that are probably risk factors for entanglement in fishing gear and ocean debris. Leatherback turtles appear to rest for a very small percentage of their daily activity (0-7%, S. Eckert, manuscript in prep. May 2000). Leatherback hatchlings studied in captivity for almost two years swam persistently without ever recognizing the tank sides as a barrier (Deraniyagala 1939, in Wyneken 1997). As a result, leatherback turtles that become entangled with longlines will probably continue trying to swim (Rudloe 1979, in Witzell 1984), expending energy and oxygen while becoming more entangled in the process.

As the amount of oxygen available to an animal diminishes, anaerobic glycolysis takes over, producing high levels of lactic acid in the blood. Although leatherback turtles, like marine mammals, store enormous amounts of oxygen in their tissues, they have less oxygen available to them for dives. The maximum dive duration for leatherback turtles is substantially lower than that of other turtles (Lutcavage and Lutz 1997). Because they cannot remain underwater for long, despite their deep dives, they are more vulnerable to drowning in long, longline sets.

From observer data, and using a model-based predictor, McCracken (2000) estimated that between 88 and 132 leatherback turtles (average 112) were captured each year, during the period 1994-1999, by the Hawaii-based longline fishery, and of these, an average of nine died [given an 8% mortality rate, see Section 10.4.2]

Table 21. Estimated numbers of leatherback turtles captured and killed in the longline fisheries (1994-1999) with 95% prediction intervals (PI) Source: McCracken, 2000 and McCracken, personal communication, March 2001

Year		**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**Annual Avg**
Takes	Estimate	109	99	106	88	139	132	112
	95% PI	[68-153]	[62-141]	[69-148]	[55-124]	[79-209]	[76-193]	[75-157]
Kills	Estimate	9	8	9	7	12	11	9
	95% PI	[0-22]	[0-21]	[1-21]	[0-18]	[1-28]	[1-27]	

NMFS-Honolulu Laboratory (2002b) estimated the incidental take of leatherback turtles under the current fishery (July 2001 through June 2002 data; Table 22). Comparisons between these estimates and the estimates in Table 21 indicate a reduction in the interaction rates between leatherback turtles and the Hawaii-based longline fishery since the current regime took effect.

Table 22. Estimates of the incidental capture (hooking and entanglement) of leatherback turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002

Predicted Total Take	95% P.I.	Estimated mean take per 1000 sets	95% C. I.	Mortality
8	[2 – 21]	.57	[≈0 - 1.71]	3

Loggerhead turtles - Loggerhead turtles have been the species most often captured by the Hawaii-based longline fishery. Loggerheads in north Pacific pelagic habitats are opportunistic feeders that generally forage on items floating near or at the surface, although they will actively feed at depth if there are high densities of prey available. Loggerheads captured and killed by the international high-seas driftnet fishery in the Pacific Ocean, were opportunistically necropsied to determine stomach contents. Based on the results from 52 turtles, it appears that loggerheads are omnivorous predators of the surface layer, feeding both by swallowing floating prey whole and/or biting off prey items from larger floating objects. In samples that contained pyrosomas, the prey items often comprised a high percent of the total gut content, indicating that the turtles were encountering dense patches of this item. In addition, prey items normally found in the upper photic zone (within 100 m of the surface) , but not the surface layer were also found in the gut, indicating that the loggerheads actively hunted for these species (Parker *et al*. in press). With 57% of loggerheads observed hooked internally, it is likely that they are foraging at depth and may have been confusing lightsticks for prey items or were attracted to the baited hooks. In addition, the presence of a float in the water may have caused the initial interest and attraction to the gear.

McCracken (2000) estimated the take and kill of loggerheads per year, as shown in Table 23. Of 2,505 loggerheads estimated taken by the fishery from 1994-1999, 438 were estimated killed (given a 17.5 % mortality rate).

Table 23. Estimates of the number of loggerhead turtles captured and killed in the longline fisheries, with 95% prediction intervals (PI) Source: McCracken, 2000 and McCracken, personal communication, March 2001

Year		1994	1995	1996	1997	1998	1999	Annual Avg
Takes	Estimate	501	412	445	371	407	369	418
	95% PI	[315-669]	[244-543]	[290-594]	[236-482]	[259-527]	[234-466]	[273-527]
Kills	Estimate	88	72	78	65	71	64	73

	95% PI	[36-141]	[31-115]	[34-127]	[28-102]	[32-112]	[28-102]	

NMFS-Honolulu Laboratory (2002b) estimated the incidental take of loggerhead turtles under the current fishery (July 2001 through June 2002 data; Table 24). Comparisons between these estimates and the estimates in Table 23 indicate a substantial reduction in the interaction rates between loggerhead turtles and the Hawaii-based longline fishery since the current regime took effect. During February 2002, (after the fishery was modified to eliminate the targeted swordfish fishery and the shallow sets associated with it), three loggerhead turtles were captured in the fishery. Two of those three turtles were captured on sets that are believed to have been illegally using shallow-set methods to target swordfish. As a result, the numbers presented below may overestimate the past incidental take of loggerheads under the current fishery, indicating that loggerhead interaction rates have significantly decreased.

Table 24. Estimates of the incidental capture (hooking and entanglement) of loggerhead turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002

	Predicted Total Take	95% P.I.	Estimated mean take per 1000 sets	95% C. I.	Mortality
trips north of 22°N	12	[3-26]	3.7	[≈0 - 9.86]	8
trips south of 22°N	2	[0-8]	0.26	[≈0 - 1.11]	na

Green turtles - The Hawaii-based longline fishery rarely captures green turtles. Based on observer data, green turtles appear to be more likely to be hooked externally than to be entangled or hooked internally. Therefore, it is likely that green turtles may not be attracted to the baited hooks. The principal food sources for the green turtle are benthic marine algae. These algae are restricted to shallow depths where sunlight, substrate and nutrients are conducive to plant growth. As a consequence, the feeding pastures used by green turtles are usually less than 10 m deep and frequently not more than three m deep, often right up to the shoreline. Because of these foraging strategies and food preferences, interactions between green turtles and the Hawaii-based longline fishery are rare. From observer data (1994 through 1999) and using a model-based predictor, the estimated that between 37 and 45 green turtles (average 40) were taken each year by the Hawaii-based longline fishery, and of these, an average of five were killed (given a 13% mortality rate).

Table 25. Estimated numbers of green turtles captured and killed in the longline fishery with 95% prediction intervals (PI) Source: McCracken, 2000 and McCracken, personal communication, March 2001

Year		1994	1995	1996	1997	1998	1999	Annual Avg

Take s	Estimate	37	38	40	38	42	45	40
	95% PI	[15-65]	[15-70]	[19-70]	[14-73]	[18-76]	[18-76]	[18-71]
Kills	Estimate	5	5	5	5	5	6	5
	95% PI	[0-16]	[0-17]	[1-17]	[0-17]	[1-19]	[1-19]	

NMFS-Honolulu Laboratory (2002b) estimated the incidental take of green turtles under the current fishery (July 2001 through June 2002 data; Table 26). Comparisons between these estimates and the estimates in Table 25 indicate a reduction in the interaction rates between green turtles and the Hawaii-based longline fishery since the current regime took effect.

Table 26. Estimates of the incidental capture (hooking and entanglement) of green turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002

Predicted Total Take	95% P.I.	Estimated mean take per 1000 sets	95% C. I.	Mortality
8	[2 – 21]	.57	[≈0 - 1.71]	7

Olive ridley turtles - None of the olive ridleys observed taken by the Hawaii longline fishery were entangled; all were hooked. Therefore, it is likely that the olive ridleys may have been attracted to the baited hook or to the lightsticks, which may be confused for pyrosomas by the turtle. While the habitat of juvenile olive ridleys is not well-known, adults use a wide range of foraging habitats, feeding pelagically in deep water as well as in shallow benthic waters. They feed on a wide variety of items, ranging from jellyfish, to crabs, mollusks and algae (in NMFS and USFWS 1998). Stomach contents of seven olive ridleys captured by the fishery were found to contain salps, cowfish and pyrosomas. One animal had seabird feathers and pelagic snails, while another had large amounts of plastic, fishing line and cellophane. Four of the olive ridleys examined had bait in their esophagus. One of these four turtles was found with three fish used as longline bait, indicating that it had ingested bait from more than one hook (Work and Balazs in press).

Based on observer data, olive ridleys had the highest mortality rate of all sea turtles captured in the Hawaii-based longline fisheries, probably because more olive ridleys were captured and killed in deep sets than any other species of sea turtle. As shown in Table 27, of 878 olive ridleys estimated to have been captured in the fisheries from 1994-1999, an estimated 292 died (assuming a 33.25% mortality rate). Although pathological lesions were noted in five olive ridleys necropsied after being taken and killed by the fishery, these were considered mild and incidental (i.e. the turtles were probably not predisposed to being taken as a result of the lesions) (Work, 2000). Therefore, the turtles that died as a result of the interaction probably drowned, suffocated, or died from injuries they suffered as a result of their being hooked. Of the six olive ridley turtles captured in deep sets, five died, probably because the turtles were unable to surface, because of the deep sets, and drowned.

Table 27. Estimates of the number of olive ridley turtles captured and killed in the longline fisheries with 95% prediction intervals (PI) Source: McCracken, 2000 and McCracken, personal communication, March 2001

Year		1994	1995	1996	1997	1998	1999	Annual Avg
Takes	Estimate	107	143	153	154	157	164	146
	95% PI	[70-156]	[90-205]	[103-210]	[103-216]	[102-221]	[111-231]	[99-203]
Kills	Estimate	36	47	51	51	52	55	49
	95% PI	[8-64]	[7-84]	[11-90]	[8-92]	[11-92]	[11-96]	

NMFS-Honolulu Laboratory (2002b) estimated the incidental take of olive ridley turtles under the current fishery (July 2001 through June 2002 data; Table 28). Comparisons between these estimates and the estimates in Table 27 indicate a reduction in the interaction rates between olive ridley turtles and the Hawaii-based longline fishery since the current regime took effect.

Table 28. Estimates of the incidental capture (hooking and entanglement) of olive ridley turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002

Predicted Total Take	95% P.I.	Estimated mean take per 1000 sets	95% C. I.	Mortality
26	[12-47]	2.00	[≈086-4.00]	24

Hawksbill turtles -There is only one record of a hawksbill turtle observed to interact with the longline fishery.

In all species, year-end estimates of fleet-wide interactions were below those anticipated by NMFS in the (now invalidated) 2001 BiOp.

American Samoa-based Longline Fishery

Because NMFS does not have an observer program in place for the American-Samoa-based longline fishery, the only information available is from logbooks. For the American Samoa-based longline fishery, the federal logbooks from 1992 through 1999 indicate six interactions with sea turtles (i.e. hooking/entanglement). In 1992, one vessel interacted with a green turtle. In 1998, one vessel interacted with an unidentified sea turtle; it was released alive. In 1999, one vessel reported interactions with four sea turtles. Three turtles released alive were recorded as a hawksbill, a leatherback, and an olive ridley. One turtle, identified as a green, was reported to have died from its interaction with this vessel. None of the species' identification were validated by NMFS' Southwest Fisheries Science Center; and NMFS cannot attest to the local knowledge of fishermen regarding the identity of various turtle species, particularly hard-shelled turtles. From 2000 through October 2002, there have been no reported interactions with sea turtles in this fishery (S. Pooley, NMFS, personal communication, October 2002). Based on logbooks from 1992 through 2001, it is apparent that this fishery takes sea turtles, but NMFS cannot quantitatively estimate the amount or extent of take of sea turtles by this fishery. Effort has greatly increased in this fishery in the last few years, but if a limited entry program is established as proposed in FMP Amendment 11, effort is unlikely to substantially increase in the future. Increases in effort are likely to result in potentially increased levels of incidental take of sea turtles; however, on the 96 longline sets observed to date there have been no observed interactions.

Other FMP longline fisheries. Although one or two general longline permits have been recently issued for domestic longline fishing vessels based in Guam and the CNMI, none have been successful to date and they are not currently fishing. Of far greater concern is the likelihood that foreign vessels which tranship through Guam and CNMI (and American Samoa) are illegally fishing in U.S. EEZ waters and potentially interacting with sea turtles. Such activities are likely as monitoring and enforcement levels are low in these areas.

Pelagics FMP Troll Fisheries

There have been no reported interactions with sea turtles in these fisheries. There is a chance, based on fishing methods including bait used and gear-type, that these fisheries do interact with sea turtles although the information is not reported. However, due to low effort and target-species selectivity of the gear, incidental take and mortality in these fisheries is likely minimal. Although the spatial distribution of trolling overlaps with the distribution of sea turtles, there have been no reported interactions by vessel operators. In addition, sea turtles are not likely to interact with troll fishing gear because the gear is towed through the water faster than sea turtles may be traveling. Furthermore, sea turtles do not prey on the bait species used by the troll fisheries. A small potential exists that the fishing gear may incidentally hook or entangle a sea turtle when the gear is towed through the water. However, NMFS considers this type of an interaction extremely rare, and the lack of any reported interactions in this fishery may confirm this assessment, although, a lack of reported information does not necessarily equate to a lack of interactions. Therefore, incidental capture of sea turtles in this fishery is expected to be rare and, due to the immediate retrieval of the gear, not likely to result in serious injury or mortality of the captured animal.

Pelagics FMP Pole-and-Line Fisheries

There have been no reported interactions with sea turtles in these fisheries. Although the distribution of the pole-and-line fishery overlaps with the distribution of sea turtles there is a very low likelihood of an interaction with a sea turtle because the turtle would need to be in the vicinity and the fisher would need to hook the animal or the animal would need to strike the hook. This type of an event is unlikely to occur because sea turtles are not likely to prey on the anchovy which is broadcast as bait, and the activity of the fish feeding frenzy would deter turtles from remaining in the area.

Pelagics FMP Handline Fisheries

There have been no reported interactions between gear used in the handline fishery and sea turtles. Although there is the risk that sea turtles may become hooked or entangled in the fishing gear, any caught animal can be immediately dehooked or disentangled and released. Moreover, most turtles found in the area of the handline fisheries are not likely to prey on the baited hooks.

9.1.4.10 Non-FMP fishery interactions with sea turtles

This section provides historical information on interactions between sea turtles and regional pelagic fisheries not managed under the Pelagics FMP. Very few fisheries in the Pacific Ocean are observed or monitored for bycatch. Rough estimates can be made of the impacts of coastal, offshore, and distant water fisheries on sea turtle populations in the Pacific Ocean by extrapolating data collected on fisheries with known effort that have been observed to incidentally take sea turtles. However, it is important to note that a straight extrapolation of this data contains a large degree of uncertainty and variability. Sea turtles are not uniformly distributed, either by area, or by time of year. In addition, observer coverage of a fishery may be very low, observers may not always be randomly assigned to vessels, or they may be placed on vessels that use fishing strategy that may be uncharacteristic of the fleet. Also, surveys and logbooks may contain biased or incomplete information. Lastly, such take estimates are also hampered by a lack of data on pelagic distribution of sea turtles.

Information on turtle interactions with most Pacific fisheries is fragmentary and often reported anecdotally. Only the Hawaii longline fleet has had an observer program in place for a decade, with the express intent of collecting information on sea turtle interactions with longlines. Turtles also interact with other fishing gear, particularly gillnets and set nets. Table 29, presents a synopsis of information on turtle interactions with both longline and net fisheries in the Pacific. Most of tis information comes from countries on the Pacific Rim, and from high seas fisheries. Not generally included are takes by coastal fisheries throughout the Pacific Islands, although given the profusion of gillnets and seine nets (Dalzell et al. 1996), these may be significant, particularly for turtles common in nearshore areas such as greens and hawksbills.

Table 29. Synopsis of turtle interactions in Pacific pelagic fisheries

Country	Fishery	Comments	Source
Japan	Longline	Estimated take of 21,200 turtles, with mortality of 12,300. Includes LB, LH, GR, OR, and HB turtles[1]	Nishimura &Nakahigashi (1990)
Japan	Coastal gillnets, pound nets & trawls	Estimated 80 LH strandings per year	Sea Turtle Assn of Japan (2002)

Taiwan	Set nets & gillnets	≈30 LB, LH, GR and OR turtles caught each year	Weidener & Serano (1997)
Chile	Drift gillnets & longlines	≈175 LB, LH, GR and OR turtles taken annually in artisinal swordfish drift net fishery (1989-1996). Estimated 500 LB taken in Chile swordfish gillnetters in mid 1990s.	Weidener & Serrano (1997) Eckert (1997)
Colombia	Shrimp trawls	Turtle excluder devices implemented	Weidener & Serrano (1997)
Ecuador	Longlines	Incidental catches of turtles reported by tuna and swordfish longliners	Weidener & Serrano (1997)
Peru	Longlines	Foreign longliners operating off Peru thought to take significant numbers of turtles. Turtle fishery in Peru operating up to 1990	Weidener & Serrano (1997); Brown & Brown (1982)
Costa Rica	Longlines	247 turtle takes observed in 7 months (Arauz 2001), 423 dead turtles stranded between September-December 2000. Takes include LB, OR, and GR turtles	Arauz (2001)
Fed. States of Micronesia	Longlines	47 turtles observed in 971 sets between 1990 - 1997. Includes LH, GR, OR and HB turtles	Heberer (1997)
West Central Tropical Pacific Ocean	Purse-seine	Estimated 105 turtles taken in WCPO purse seine fisheries with 20 mortalities. Turtles include GR, OR, and HB turtles	SPREP (2001)
West Central Tropical Pacific Ocean	Longline	Estimated 2,182 turtles taken in WCPO longline fisheries with 500-600 mortalities. Turtles include GR and OR turtles	SPREP (2001)
Eastern Tropical Pacific Ocean	Purse-seine	Estimated 137 turtles taken by fishery in 2001, comprising LB, LH, GR and OR turtles	IATTC (2002)
Mexico	Gillnet, longline & direct harvest	Tota of 1,020 turtles recorded killed between 1994 and 1999 on Gulf of California coast, comprising LB, LH, GR and OR, turtles. Estimated 7,800 GR turtles killed in Baja California	Nichols (2002

1. LB (Leatherback), LH (Loggerhead), GR (Green), OR (Olive Ridley), HB (Hawksbill)

In summary, Hawaii-based longline effort is a small percent of the total pelagic fishing which is widespread across the Pacific. In addition, there are currently a number of foreign fleets that contain elements that utilize shallow-set longlines to catch swordfish, and which are continuing to interact with far more turtles than the Hawaii-based fleet ever did or would be anticipated to do under the proposed action.

However, interactions are not restricted to longline fishing, and are routinely reported for a variety of net and other fisheries, particularly gillnets. For this reason, solutions to interactions between turtles and other fishing gear need to be found, particularly for gillnets.

California/Oregon drift gillnet fishery

The California/Oregon (CA/OR) drift gillnet fishery targets swordfish and thresher shark. The fishery has been observed by NMFS since July 1990, and observer coverage has ranged from 4.4 percent in 1990 to an estimated 22.9 percent in 2000. Between July 1990 and December 31, 2001, NMFS has observed 6,312 sets (NMFS unpublished data). The fishery occurs primarily within 200 nautical miles (nm) of the California coastline and to a lesser extent off the coast of Oregon. Under California state regulations, the fishery is restricted to waters outside 200 nm from February 1 through April 30 and outside 75 nm from May 1 through August 14. Fishing is allowed inside 75 nm from August 15 through January 31. Because of these restrictions, the fishery is not active during February, March, and April. In addition, very little fishing effort occurs during the months of May, June, and July since CA/OR drift gillnet vessels targeting swordfish tend to set on warm ocean water temperature breaks which don’t appear along the California coast until late summer. Currently, approximately 90 percent of the fishing effort occurs between August 15 and December 31. On average, about nine percent of the fishing effort occurs during the month of January, 0 percent occurs February through April, and slightly more than one percent occurs between May 1 and August 14 (California Department of Fish and Game, unpublished data).

Fishers use nets constructed from 3-strand twisted nylon, tied to form meshes. The meshes range from 16 to 22 inches stretched, and average 19 inches stretched. Although termed “gillnets,” the nets actually entangle fish, rather than trap them by the gills. Net length ranges from 750 to 1000 fathoms, averaging 960 fathoms. The top of the net is attached to a float line by hanging lines laced through several meshes and tied at intervals of 8 to 24 inches. The number of meshes per hanging determines the slack or tautness of the net. The bottom of the net is attached to a weighted lead line. The number of meshes between the float line and the lead line determines the depth of the net, which ranges from 100 to 150 meshes. The depth at which the float line is suspended in the water column is determined by the length of the buoy line (extender length). Nets are often set perpendicular to currents, or across temperature, salinity, or turbidity fronts. Nets are typically set in the evening, allowed to soak overnight, then retrieved in the morning. The average soak time is 10.5 hours (NMFS 1997b). The vessel remains attached to one end of the net during the soak period, drifting with the net.

The CA/OR drift gillnet fishery has been subject to the Pacific Offshore Cetacean Take Reduction Plan (PCTRP) since October 1997 (62 FR 51805). The PCTRP requires that nets be fished at a minimum depth of 36 feet below the water surface, that acoustic warning devices ("pingers") be used during all sets, and that skipper workshops be held to educate fishers about the take reduction plan requirements and solicit input on additional ways to possibly reduce marine mammal take. Based on a comparison of observer data collected prior to and since the implementation of the PCTRP, there does not appear to be a significant difference in sea turtle entanglement rates, although interactions are rare events in this fishery.

Green and olive ridley turtles are rarely taken by the CA/OR drift gillnet fishery; in fact, the most recent available data indicate only one green and one olive ridley turtle have been observed taken since NMFS began observing the fishery in 1990. Both of these observed takes occurred in 1999. The green turtle was discarded at sea dead, and the olive ridley was released alive. In addition, there have been 23 leatherback turtles observed taken by this fishery since 1990. Almost all of these interactions occurred north of Point Conception (34º 25' N), and 78% of these interactions occurred during the months of August, September, and October with the majority of the interactions occurring during October (61%). There have been 14 loggerhead turtle interactions observed in the CA/OR drift gillnet fishery. All of these interactions were south of Point Conception and occurred during El Niño events. Table 30 shows the annual estimated mortality of sea turtles incidentally taken by the CA/OR drift gillnet fishery, based on extrapolated observer data. Animals released alive or injured are not included in the table.

Table 30. Estimated mortality (and coefficients of variation) of sea turtles by the California/Oregon drif based on observer data (Sources are identified below)

Species	1990[1]	1991[1]	1992[1]	1993[1]	1994[1]	1995[1]	1996[2]	1997[3]	1998[3]	1999
Green	0	0	0	0	0	0	0	0	0	5 (0.90
Loggerhead	0	0	7 (0.93)	0	0	0	0	6 (0.95)	5 (0.89)	0
Leatherback	23 (0.97)	0	15 (0.65)	15 (0.66)	0	26 (0.55)	24 (0.64)	7 (0.95)	0	0

Table … of sea turtles by the California/Oregon dr…

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Olive Ridley	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified Turtle	0	0	0	7 (0.93)	0	0	0	0	0	0	0	0

[1] Julian and Beeson, 1998.
[2] Julian 1997.
[3] Cameron and Forney, 1999.
[4] Cameron and Forney, 2000.
[5] Carretta, 2001.
[6] Carretta, 2002.

On October 23, 2000, NMFS issued a Biological Opinion on the issuance of a permit under section 101(a)(5)(E) of the MMPA for the incidental taking of marine mammal species listed under the ESA during commercial fishing operations. After reviewing the available scientific and commercial data, current status of Pacific leatherback and loggerhead turtles, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, the opinion found that the issuance of section 101(a)(5)(E) permits and the associated continued operation of the CA/OR drift gillnet fishery, as regulated under the PCTRP, was likely to jeopardize the continued existence of Pacific leatherback and loggerhead turtles. Based on this opinion, NMFS has implemented regulations that eliminate drift gillnet fishing effort from August 15 through November 15 north of Point Conception in the area bounded by straight lines connecting the following coordinates in the order listed: (A) Point Sur (36º18.5' N) to 34º27' N 123º35' W; (B) 34º27' N 123º35' W to 34º27' N 129º W; (C) 34º27' N 129º W to 45º N 129º W; (D) 45º N 129º W to the point 45º N intersects the Oregon coast to reduce the likelihood of interactions with leatherback turtles. In addition, fishing effort south of Point Conception will be eliminated during El Niño events in August and January to reduce the likelihood of an interaction with loggerhead turtles.

California-based pelagic longline fishery

Longline vessels which fish on the high seas (i.e. outside of U.S. EEZ waters) and unload their catch and re-provision in California ports comprise the California-based pelagic longline fishery. These vessels fish up to 1,000 miles offshore and are prohibited, by state regulations, from fishing within 200 miles of the California coast. This fishery primarily targets swordfish and occasionally tuna, especially bigeye tuna. Preliminary and unedited data from logbooks submitted to the CDFG show that the California-based longline fishery does interact with sea turtles. Between August 1, 1995 through December 31, 1999, 33 different vessels fished a total of 2,090 days and deployed 7,071,745 hooks. Although some of the vessels began and ended their fishing trips in California, others may have begun their trip in Hawaii and ended in California. The data have not been standardized for effort, seasonality, size, or any other variables. Furthermore the data represent a subset of the results of an unknown amount of fishing effort expended in the areas of the ocean in which the reporting captains fished (CDFG, 2000). Given those caveats, Table 31 is a summary of reported sea turtle interactions in the California-based longline fishery between October and May 2002.

Table 31. Sea turtle interactions August, 1995 - December, 1999 in the California-based longline fishery based on reported logbook data (Source: unedited data from high-seas longline logbooks submitted to CDFG, and reported by M. Vojkovich (CDFG) on 9/29/00)

Species	Animals Released		
	Alive	Injured	Dead
Green	12	0	0
Leatherback	33	2	0
Loggerhead	21	0	0
Olive ridley	19	0	0
Unidentified Turtle	7	0	0

NMFS began placing observers aboard California-based pelagic longline fishing vessels on a voluntary basis in October 2001 as a pilot project to assess levels of sea turtle interactions and to collect socio-economic data from vessel owners and operators. Three vessels volunteered to carry observers during the 2001-2002 fishing season and the overall coverage level achieved was <5%. This limited observer data supports the logbook data that the California-based pelagic longline fishery does interact with sea turtles. The data have not been standardized for effort, seasonality, size, or other variables. The data represent a subset of an unknown amount of fishing effort expended in the areas of the ocean in which the observed vessels fished. Given these caveats, Table 32 summarizes observed sea turtle interactions in the California-based pelagic longline fishery.

Table 32. Observed sea turtle interactions in 59 sets between October 2001 - May 2002 in the California-based longline fishery (Source: NMFS California Pelagic Longline Observer Program, July 2002)

Species	Animals Released		
	Alive	Injured[1]	Dead
Green	0	0	0
Leatherback	0	0	0
Loggerhead	0	7	0
Olive ridley	0	1	0
Unidentified Turtle	0	0	0

[1] Animals released injured equals caught hooked.

Beginning in August 2002, NMFS started a mandatory observer program for this fishery. Each observer is equipped to collect tissue biopsies, apply flipper tags, and attach satellite tags to hardshell turtles. Table 33 presents available data collected under this mandatory program.

Table 33. Observed sea turtle interactions in 280 sets between May 2002 - May 2003 in the California-based longline fishery (Source: NMFS California Pelagic Longline Observer Program)

Species	Animals Released		
	Alive	Injured[1]	Dead
Green	0	0	0
Leatherback	0	2	0
Loggerhead	0	17	0
Olive ridley	0	0	0
Unidentified Turtle	0	0	0

[1] Animals released injured equals caught hooked.

At both per set and per 1000 hooks levels for shallow-set longlining, loggerhead and leatherback sea turtle take rates are higher east of 150° W., whereas, take rates of olive ridley sea turtles are higher west of 150° W.. Observed take rates west and east of 150° W. are 0.021 and 0.033 per 1000 hooks for leatherbacks, respectively; 0.085 and 0.112 per 1000 hooks for loggerheads, respectively; and 0.025 and 0.004 for olive ridleys, respectively. In addition, interaction rates vary temporally for fishing operations east of 150° W., as more leatherbacks are caught in the 4th quarter of the year and more loggerhead sea turtles are caught in the 1st quarter (Caretta 2003).

9.1.4.11 New information on FMP fishery interactions with sea turtles

Hawaii-based longline fishery

Tables 34 and 35 present the latest available information on interactions between the Hawaii-based longline fishery and sea turtles. Table 34 presents estimates of fleet-wide interactions for 2002, while Table 35 presents (unextrapolated) observer data for the first half of 2003.

Table 34. Estimated fleet-wide sea turtle interactions with the Hawaii-based longline fishery, 2002 Source: McCracken 2003

Species	Total interactions	Mortalities
Leatherback	6	2
Loggerhead	19*	8*
Green	3	3
Olive ridley	31	29
Hawksbill	0	0

* These numbers includes data on two turtles caught on illegal shallow sets

Table 35. Observed sea turtle interactions with the Hawaii-based longline fishery, January - June, 2003 Note: observer coverage was 18.4% - 21.4% (Source PIRO web page of observer reports)

Species	Number	Release condition
Leatherback	1	dead
Loggerhead	0	NA
Green	0	NA
Olive ridley	2	dead
Hawksbill	0	NA

California-based Longline Fishery

The California-based longline fishery currently operates on the high seas mostly east of 150° W. longitude. At both per set and per 1000 hooks levels for shallow-set longlining, loggerhead and leatherback sea turtle take rates are higher east of 150° W., whereas, take rates of olive ridley sea turtles are higher west of 150° W.. Observed take rates west and east of 150° W. are 0.021 and 0.033 per 1000 hooks for leatherbacks, respectively; 0.085 and 0.112 per 1000 hooks for loggerheads, respectively; and 0.025 and 0.004 for olive ridleys, respectively. In addition, interaction rates vary temporally for fishing operations east of 150° W., as more leatherbacks are caught in the 4^{th} quarter of the year and more loggerhead sea turtles are caught in the 1^{st} quarter (Caretta 2003).

Table 36. Observed sea turtle interactions in 280 sets between May 2002 - May 2003 in the California-based longline fishery (Source: NMFS California Pelagic Longline Observer Program, July 2002)

Species	Animals Released		
	Alive	Injured[1]	Dead
Green	0	0	0
Leatherback	0	2	0
Loggerhead	0	17	0
Olive ridley	0	0	0
Unidentified Turtle	0	0	0

[1] Animals released injured equals caught hooked.

Based on interactions with sea turtles, NMFS is currently facing a request for a preliminary injunction to enjoin this fishery pending completion of a Biological Opinion. Obviously if the fishery is closed in response to this request, or curtailed in response to measures in its forthcoming Biological Opinion, its impact on sea turtles will be removed or lessened and the baseline status of sea turtle populations will correspondingly improve. To the extent that California longline effort is transferred to the Hawaii-based fishery, it will subject be to the measures proposed here and its impacts will thus be significantly reduced (see Section 10.5 for a further discussion of the effect of such transfers of effort between fisheries).

9.1.4.12 Biology and population status of potentially affected listed marine mammals

Based on research, observer, and logbook data, the following listed marine mammals occur in the region and may be affected by the fisheries managed under the Pelagics FMP:

Hawaiian monk seal (*Monachus schauinslandi*)
Humpback whale (*Megaptera novaeangliae*)
Sperm whale (*Physeter macrocephalus*)
Blue whale (*Balaenoptera musculus*)
Fin whale (*Balaenoptera physalus*)
Northern right whale (*Eubalaena glacialis*)
Sei whale (*Balaenoptera borealis*)

This section provides available information on the biology and population status of potentially affected listed marine mammals.

Although blue whales, fin whales, northern right whales, and sei whales are found within the area and could potentially interact with the Pelagics FMP fisheries, there have been no reported or observed incidental takes of these species in these fisheries. Therefore, these species are not discussed in this document.

Humpback whales

The International Whaling Commission first protected humpback whales in the North Pacific in 1965. Humpback whales were listed as endangered under the ESA in 1973. They are also protected by the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) and the MMPA. Critical habitat has not been designated for this species.

Humpback whales typically migrate between tropical/sub-tropical and temperate/polar latitudes. Humpback whales feed on krill and small schooling fish on their summer grounds. The whales occupy tropical areas during winter months when they are breeding and calving, and polar areas during the spring, summer, and fall, when they are feeding, primarily on small schooling fish and krill (Caldwell and Caldwell, 1983). It is believed that minimal feeding occurs in wintering grounds, such as the Hawaiian Islands (Balcomb, 1987; Salden, 1987). Humpback whales summer throughout the central and western portions of the Gulf of Alaska, including Prince William Sound, around Kodiak Island (including Shelikof Strait and the Barren Islands), and along the southern coastline of the Alaska Peninsula. The few sightings of humpback whales in offshore waters of the central Gulf of Alaska are usually attributed to animals migrating into coastal waters (Morris et al. 1983), although use of offshore banks for feeding is also suggested. The continental shelf of the Aleutian Islands and Alaska Peninsula was once considered the center of the North Pacific humpback whale population (Berzin and Rovnin 1966; Nishiwaki 1966). The northern Bering Sea, Bering Strait, and the southern Chukchi Sea along the Chukchi Peninsula appear to form the northern extreme of the humpback whale's range (Nikulin 1946, Berzin and Rovnin 1966).

Humpback whales occur off all eight Hawaiian Islands, but particularly within the shallow waters of the "four-island" region (Kaho'olawe, Molokai, Lanai, Maui), the northwestern coast of the island of Hawaii (Big Island), and the waters around Niihau, Kauai and Oahu (Wolman and Jurasz, 1977; Herman et al., 1980; Baker and Herman, 1981). The whales are generally found in shallow water shoreward of the 182 m (600-ft) depth contour (Herman and Antinoja, 1977), although Frankel et al. (1989) reported some vocalizing individuals up to 20 km (10.8 nm) off South Kohala on the west coast of the Big Island, over bottom depths of 1400 m (4593 ft). Cow and calf pairs appear to prefer very shallow water less than 18 m deep (10 fm [60 ft]) (Glockner and Venus, 1983).

Humpback whale reproductive activities occur primarily in winter. They become sexually mature at age four to six. Annual pregnancy rates have been estimated at about 0.40–0.42 (NMFS unpublished; Nishiwaki 1959) and female humpback whales are believed to become pregnant every two to three years. Cows will nurse their calves for up to 12 months. The age distribution of the humpback whale population is unknown, but the proportion of calves in various populations has been estimated at about 4–12% (Chittleborough 1965; Whitehead 1982, Bauer 1986; Herman et al. 1980; and Clapham and Mayo, 1987).

The information available does not identify natural causes of death among humpback whales or their number and frequency over time, but potential causes of natural mortality are believed to include parasites, disease, predation (killer whales, false killer whales, and sharks), biotoxins, and entrapment in ice.

Humpback whales exhibit a wide range of foraging behaviors, and feed on a range of prey types including small schooling fishes, euphausiids, and other large zooplankton. In Hawaiian waters, the distribution of humpback whales is almost exclusively within the 1820 m isobath and usually within the 182 m isobath. Maximum diving depths for humpbacks are approximately 150 m (492 ft) (but usually <60 m [197 ft]), with a very deep dive (240 m [787 ft]) recorded off Bermuda (Hamilton et al., 1997). They may remain submerged for up to 21 min (Dolphin, 1987). Dives on feeding grounds ranged from 2.1 - 5.1 min in the north Atlantic (Goodyear unpubl. manus.). In southeast Alaska average dive times were 2.8 min for feeding whales, 3.0min for non feeding whales, and 4.3min for resting whales (Dolphin 1987). In the Gulf of California humpback whale dive times averaged 3.5min (Strong 1990). Because most humpback prey is likely found in waters shallower than 300 m most humpback dives are probably relatively shallow.

Estimates of the number of individuals in the Northern Pacific stock have recently risen. Estimates in the 1980s ranged from 1,407 to 2,100 (Baker, 1985; Darling and Morowitz, 1986; Baker and Herman, 1987), while recent estimates of abundances were approximately 6,000 (Calambokidis et al., 1997; Cerchio, 1998; Mobley et al., 1999b).

Studies based on resighting individuals through photographs resulted in an estimate of 6,010 animals (S.E. = 474) for the entire North Pacific (Calambokidis et al., 1997). The central North Pacific stock of humpback whales winters in the waters of the main Hawaiian Islands and feeds on the summer grounds of Southeast Alaska and Prince William Sound. A population estimate of 1,407 whales was derived using capture-recapture methodology (95% CI 1,113 - 1,701) for data collected in 1980-83 (Baker and Herman, 1987).

Cerchio (1998) estimated that about 4,000 animals visit Hawaii annually. Aerial surveys conducted between 1976 and 1990 found a significant increase in sighting rates of humpbacks over that time (Mobley et al., 1999a), consistent with the increase in photographic estimates. Finally, aerial surveys using line-transect methodologies were conducted in 1993, 1995 and 1998. Hawaii population estimates for nearshore waters derived from the sighting data show an increase from 2,717 (+/- 608) in 1993, to 3,284 (+/- 646) in 1995 and 3,852 (+/- 777) in 1998 (Mobley et al., 1999b).

There were two observed interactions with the Hawaii-based longline fleet between 1994 and 2002, and both whales were recorded as “released injured” (one each in 2001 and 2002). Scientists at PIFSC have extrapolated the 2002 information to estimate that there were in fact a total of three interactions for the fishery as a whole in 2002 (McCracken 2003).

Hawaiian monk seals

The Hawaiian monk seal was listed as endangered under the ESA in 1976. The species is endemic to the Hawaiian Archipelago and Johnston Atoll, and is one of the most endangered marine mammals in the United States. It is also the only endangered marine mammal that exists wholly within the jurisdiction of the United States.

Monks seals are one of the most primitive genera of seals. They 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 Sniff, 1998). Counts of individuals or shore compared with enumerated subpopulations 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)

Females reach breeding age at about 5 to 10 years of age depending on their condition, and give birth about once every year at most. It is estimated that 40%-80% of adult females giver birth in a given year (NMFS unpub. data, 2001). After birth, pups take up to six weeks to wean. During this time, the mother suckles the pup, rarely leaving it to feed. Afer weaning, the mother leaves and the pup must forage independently. Newly weaned pups are somewhat more gregarious than adults. Pups tend to stay in the reef shallows, entering into more diverse and deeper waters to forage as they age. Male aggression is somewhat common, as males compete for females for breeding purposes. Male aggression has resulted in a number of injuries and deaths to females, juveniles, and pups.

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). Research to identify prey species and their relative importance is currently underway using several methods: collection of potential prey items and blubber samples for ongoing fatty acid analyses; Crittercam recording of foraging behavior correlation of depth/location profiles with potential prey species habitat; and analysis of monk seal scat and spew samples for identifiable hard parts of prey.

Before human habitation of the Hawaiian Archipelago, the monk seal population may have measured in the tens of thousands as opposed to the hundreds of thousands or millions typical of some pinniped species. When population measurements were first taken in the 1950s, the population was already considered to be in a state of decline. In 1998, minimum population estimate for monk seals was 1,436 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 estimates for the MHI) (Forney et al., 2001). Taking into account the first year survival rates, NMFS Southwest Fisheries Science Center - Honolulu Laboratory estimated the species population size to be between 1,300 and 1,400 individuals (Laurs, 2000). Monk seals are found at six main reproductive sites in the NWHI: Kure Atoll, Midway Island, Pearl and Hermes Reef, Lisianski Island, Laysan Island and French Frigate Shoals. Smaller populations also occur on Necker Island, and Nihoa Island. NMFS researchers have also observed monk seals at Gardner Pinnacles and Maro Reef. Monk seals are also increasingly found in the MHI (including Niihau), where preliminary surveys have counted more than 50 individuals. 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.

Population trends for monk seals are determined by the highly variable dynamics of the six main reproductive subpopulations. At the species level, 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 Main Hawaiian Islands.

There was some evidence in the early 1990s that longline operations were adversely affecting the Hawaiian monk seals, as indicated by the sighting of a few animals with hooks and other non-natural injuries. In 1991, Amendment 3 established a permanent 50-mile Protected Species Zone around the NWHI that is closed to longline fishing. Since 1993, no interactions with Hawaiian monk seals in the pelagic longline fishery have been reported.

Sperm whales
Sperm whales have been protected from commercial harvest by the IWC since 1981, although the Japanese continued to harvest sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997). Sperm whales were listed as endangered under the ESA in 1973. They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the Marine Mammal Protection Act of 1972. Critical habitat has not been designated for sperm whales.

Female sperm whales take about nine years to become sexually mature (Kasuya 1991, as cited in Perry et al. 1999). Male sperm whales take between 9 and 20 years to become sexually mature, but will require another 10 years to become large enough to successfully compete for breeding rights (Kasuya 1991). Adult females give birth after about 15 months gestation and nurse their calves for two –3 years. The calving interval is estimated to be about four to six years (Kasuya 1991). The age distribution of the sperm whale population is unknown, but sperm whales are believed to live at least 60 years (Rice 1978). Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of mortality rate for juveniles and adults are now considered unreliable (IWC 1980, as cited in Perry et al. 1999). Sperm whales are known for their deep foraging dives (in excess of 3 km). They feed primarily on mesopelagic squid, but also consume octopus, other invertebrates, and fish (Tomilin 1967, Tarasevich1968, Berzin 1971). Perez (1990) estimated that their diet in the Bering Sea was 82% cephalopods (mostly squid) and 18% fish. Fish eaten in the North Pacific included salmon, lantern fishes, lancetfish, Pacific cod, pollock, saffron cod, rockfishes, sablefish, Atka mackerel, sculpins, lumpsuckers, lamprey, skates, and rattails (Tomilin 1967, Kawakami 1980, Rice 1986b). Sperm whales taken in the Gulf of Alaska in the 1960s had fed primarily on fish. Daily food consumption rates for sperm whales ranges from 2 -

4% of their total body weight (Lockyer 1976b, Kawakami 1980). Potential sources of natural mortality in sperm whales include killer whales and papilloma virus (Lambertson et al. 1987).

Sperm whales are likely the deepest and longest diving mammal. Typical foraging dives last 40 minutes and descend to about 400 meters followed by approximately eight minutes of resting at the surface (Gordon 1987; Papastavrou et al. 1989). However, dives of over two hours and as deep as 3,000 meters have been recorded (Clarke 1976; Watkins et al. 1985). Descent rates recorded from echo-sounders were approximately 1.7 meters/second and nearly vertical (Goold and Jones 1995). There are no data on diurnal differences in dive depths in sperm whales. However, like most diving vertebrates for which there is data (e.g. rorqual whales, fur seals, chinstrap penguins), sperm whales probably make relatively shallow dives at night when deep scattering layer organisms move toward the surface.

Sperm whales are distributed in all of the world's oceans. Several authors have recommended three or more stocks of sperm whales in the North Pacific for management purposes (Kasuya 1991, Bannister and Mitchell 1980). However, the IWC's Scientific Committee designated two sperm whale stocks in the North Pacific: a western and eastern stock (Donovan 1991). The line separating these stocks has been debated since their acceptance by the IWC's Scientific Committee. For stock assessment purposes, NMFS recognizes three discrete population "centers" of sperm whales: (1) Alaska, (2) California/Oregon/Washington, and (3) Hawaii.

A 1997 survey to investigate sperm whale stock structure and abundance in the eastern temperate North Pacific area did not detect a seasonal distribution pattern between the U S EEZ waters off California and areas farther west, out to Hawaii (Forney et al., 2000). A 1997 survey, which combined visual and acoustic line-transect methods, resulted in estimates of 24,000 (CV=0.46) sperm whales based on visual sightings, and 39,200 sperm whales (CV=0.60) based on acoustic detections and visual group size estimates (Forney et al., 2000). An analysis for the eastern tropical Pacific estimates abundance at 22,700 sperm whales (95% C. I. = 14,800-34,000; Forney et al., 2000).

Sperm whales have a strong preference for the 3,280-ft (1,000-m) depth contour and seaward. Berzin (1971) reported that they are restricted to waters deeper than 300 m (984 ft), while Watkins (1977) and Reeves and Whitehead (1997) reported that they are usually not found in waters less than 3,281 ft (1,000m) deep. While deep water is their typical habitat, sperm whales have been observed near Long Island, New York, in waters of 41-55 m (135-180 ft) (Scott and Sadove, 1997). When found relatively close to shore, sperm whales are usually associated with sharp increases in bottom depth where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke, 1956). They can dive to depths of at least 2000 m (6562 ft), and may remain submerged for an hour or more (Watkins et al., 1993). Sperm whales feed primarily on buoyant, relatively slow-moving squid (Clark et al., 1993), but may also eat a variety of fish, including salmon (*Oncorhynchus spp*.), rockfish (*Sebastes spp*.), and lingcod (*Ophiodon elongatus*) (Caldwell and Caldwell, 1983).

Sperm whales have been sighted in the Kauai Channel, the Alenuihaha Channel between Maui and the island of Hawaii, and off the island of Hawaii (Lee, 1993; Mobley, et al.1999, Forney et al., 2000). Additionally, the sounds of sperm whales have been recorded throughout the year off Oahu (Thompson and Friedl 1982). Twenty-one sperm whales were sighted during aerial surveys conducted in nearshore Hawaiian waters conducted from 1993 through 1998. Sperm whales sighted during the survey tended to be on the outer edge of a 50 - 70 km distance from the Hawaiian Islands, indicating that presence may increase with distance from shore (Mobley, pers. comm. 2000). However, from the results of these surveys, NMFS has calculated a minimum abundance of sperm whales within 46 km of Hawaii to be 43 individuals (Forney et al., 2000).

One interaction with a sperm whale was reported by observers between 1994 and 2002.

9.1.4.13 Biology and population status of other potentially affected marine mammals

Based on research, observer, and logbook data, the following marine mammals occur in the region and may be affected by the fisheries managed under the Pelagics FMP:

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*)

This section provides information on the biology and population status of other potentially affected marine mammals and is drawn from the 2001 FEIS' Chapter 3 (pp. 3-129 - 3-133).

Delphinids

The Pacific white-sided dolphin is found throughout the temperate North Pacific (Hill and DeMaster, 1999). Two stocks of this species are recognized, but the stock structure throughout the North Pacific is poorly defined. Population trends and status of the Central North Pacific stock of

Pacific white-sided dolphins relative to the optimum sustainable population are currently unknown (Hill and DeMaster, 1999).

The rough-toothed dolphin's distribution is worldwide in oceanic tropical and warm temperate waters (Miyazaki and Perrin, 1994). They have been sighted northeast of the Northern Mariana Islands during winter (Reeves *et al.*, 1999). Rough-toothed dolphins are also found in the waters off the Main Hawaiian islands (Shallenberger, 1981) and have been observed at least as far north as French Frigate Shoals in the Northwestern Hawaiian Islands (Nitta and Henderson, 1993). The stock structure for this species in the North Pacific is unknown (Forney *et al.*, 2000). The status of rough-toothed dolphins in Hawaii's waters relative to their optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney *et al.*, 2000).

Risso's dolphins are found in tropical to warm-temperate waters worldwide (Kruse *et al.*, 1999) but appear to be rare in the waters around Hawaii. There have been four reported strandings of Risso's dolphins on the Main Hawaiian Islands (Nitta, 1991). Risso's dolphins have also been sighted near Guam and the Northern Mariana Islands (Reeves *et al.*, 1999). Nothing is known about stock structure for this species in the North Pacific (Forney *et al.*, 2000). The status of Risso's dolphins in Hawaii's waters relative to their optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney *et al.*, 2000).

Bottlenose dolphins are widely distributed throughout the world in tropical and warm-temperate waters (Reeves *et al.*, 1999). The species is primarily coastal, but there are also populations in offshore waters. Bottlenose dolphins are common throughout the Hawaiian Islands (Shallenberger, 1981). Data suggest that the bottlenose dolphins in Hawaii belong to a separate stock from those in the eastern tropical Pacific (Scott and Chivers, 1990). The status of bottlenose dolphins in Hawaii's waters relative to their optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney *et al.*, 2000).

As its name implies, the pantropical spotted dolphin has a pantropical distribution in both coastal and oceanic waters (Perris and Hohn, 1994). Pantropical spotted dolphins are common in Hawaii, primarily on the lee sides of the islands and in the inter-island channels (Shallenberger, 1981). They are also considered common in American Samoa (Reeves *et al.*, 1999). Morphological differences and distribution patterns have been used to establish that the spotted dolphins around Hawaii belong to a stock that is distinct from those in the eastern tropical Pacific (Dizon *et al.*, 1994). The status of pantropical dolphins in Hawaii waters relative to their optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney *et al.*, 2000).

Spinner dolphins are the cetaceans most likely to be seen around oceanic islands throughout the Pacific and are also seen in pelagic areas far from land (Perrin and Gilpatrick, 1994). This species is common around American Samoa (Reeves *et al.* 1999). There is some suggestion of a large, relatively stable resident population surrounding the island of Hawaii (Norris *et al.*, 1994). Spinner dolphins are among the most abundant cetaceans in Hawaii's waters. However, the status of spinner dolphins in Hawaii's waters relative to their optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney *et al.*, 2000).

The striped dolphin occurs in tropical and warm temperate waters worldwide (Perrin *et al.*, 1994). Several sightings were made in winter to the north and west of the Northern Mariana Islands (Reeves *et al.*, 1999). In Hawaii, striped dolphins have been reported stranded 13 times between the years of 1936-1996 (Nitta, 1991), yet there have been only two at-sea sightings of this species (Shallenberger, 1981). Striped dolphin population estimates are available for the waters around Japan and in the eastern tropical Pacific, but it is not known whether any of these animals are part of the same population that occurs in Hawaii (Forney *et al.*, 2000). The status of striped dolphins in Hawaii's waters relative to their optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney *et al.*, 2000).

The pygmy killer whale has a circumglobal distribution in tropical and subtropical waters (Ross and Leatherwood, 1994). They have been observed several times off the lee shore of Oahu (Pryor *et al.*, 1965), and Nitta (1991) documented five strandings on Maui and the island of Hawaii. According to the MMPA stock assessment reports, there is a single Pacific management stock (Forney *et al.*, 2000). The status of pygmy killer whales in Hawaii waters relative to their optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney *et al.*, 2000).

False killer whales occur in tropical, subtropical and warm temperate seas worldwide (Stacey *et al.*, 1994). This species occurs around the Main Hawaiian Islands, but its presence around the Northwestern Hawaiian Islands has not yet been established (Nitta and Henderson, 1993). For the MMPA stock assessment reports, there is a single Pacific management stock (Forney *et al.*, 2000). The status of false killer whales in Hawaii waters relative to their optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney *et al.*, 2000).

The killer whale has a cosmopolitan distribution (Reeves *et al.* 1999). Observations from Japanese whaling or whale sighting vessels indicate large concentrations of these whales north of the Northern Mariana Islands and near Samoa (Reeves *et al.* 1999). Killer whales are rare in Hawaii's waters. There have been two reported sightings of killer whales, one off the Waianae coast of Oahu, and the other near Kauai (Shallenberger, 1981). Except in the northeastern Pacific, little is known about stock structure of killer whales in the North Pacific (Forney *et al.*, 2000). The status of killer whales in Hawaii's waters relative to their optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney *et al.*, 2000).

The melon-headed whale has a circumglobal, tropical to subtropical distribution (Perryman *et al.*, 1994). Large herds of this species are seen regularly in Hawaii's waters (Shallenberger, 1981). Strandings of melon-headed whales have been reported in Guam (Reeves *et al.* 1999). For the MMPA stock assessment reports, there is a single Pacific management stock (Forney *et al.*, 2000). The status of melon-headed whales in Hawaii's waters relative to their optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney *et al.*, 2000).

Whales

The short-finned pilot whale ranges throughout tropical and warm temperate waters in all the oceans, often in sizable herds (Reeves *et al.*, 1999). It is one of the most frequently observed cetaceans around Guam (Reeves *et al.*, 1999). Short-finned pilot whales are commonly observed around the Main Hawaiian Islands, and are probably present around the Northwestern Hawaiian Islands (Shallenberger, 1981). Stock structure of short-finned pilot whales has not been adequately studied in the North Pacific, except in the waters around Japan (Forney *et al.*, 2000). The status of short-finned whales in Hawaii's waters relative to their optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney *et al.*, 2000).

Bryde's whales have a pantropical distribution and are common in much of the tropical Pacific (Reeves *et al.*, 1999). Shallenberger (1981) reported a sighting of a Bryde's whale southeast of Nihoa in 1977. Available evidence provides no biological basis for defining separate stocks of Bryde's whales in the central North Pacific (Forney *et al.*, 2000). The status of Bryde's whales in Hawaii waters relative to their optimum sustainable populations is unknown, and there are insufficient data to evaluate trends in abundance (Forney *et al.*, 2000).

The Blainsville's beaked whale has a cosmopolitan distribution in tropical and temperate waters (Mead, 1989). Sixteen sightings of this species were reported from the Main Hawaiian Islands by Shallenberger (1981). Cuvier's beaked whale probably occurs in deep waters throughout much of the tropical and subtropical Pacific (Heyning, 1989). Strandings of this species have been reported in the Main and Northwestern Hawaiian Islands (Nitta, 1991; Shallenberger, 1981). There is no information on stock structure of the Blainsville's beaked whale or Cuvier's beaked whale. The status of Blainsville's beaked whales and Cuvier's beaked whales in Hawaii's waters relative to their optimum sustainable populations is unknown, and there are insufficient data to evaluate trends in abundance (Forney *et al.*, 2000).

The pygmy sperm whale is likely to occur all year in many parts of the tropical and subtropical Pacific (Caldwell and Caldwell, 1989). There have been at least nine reported strandings of this species in the Hawaiian Islands (Nitta, 1991). The dwarf sperm whale is rarely observed at sea in most areas , but is apparently abundant in some (Nagorsen, 1985). Its distribution, as inferred mainly from strandings, is worldwide in tropical and temperate waters. There have been two strandings of this species in the Hawaiian Islands (Nitta, 1991). The status of pygmy sperm whales and dwarf sperm whales in Hawaii's waters relative to their optimum sustainable populations is unknown, and there are insufficient data to evaluate trends in abundance (Forney *et al.*, 2000).

Pinnipeds

Northern fur seals and northern elephant seals commonly migrate into the northeastern portion of the historic Hawaii-based fishing zone (Bigg, 1990; Stewart and DeLong, 1995). Both species may occur in this region anytime of the year, but there are periods when the probability of their presence is greatest, especially for certain age and sex groups. Juvenile northern fur seals of both sexes are believed primarily to occur in the region during the fall, early winter and early summer (Bigg, 1990). Northern elephant seal adult females also migrate into the area twice a year, returning briefly to land to breed in the winter and molt in the spring (Stewart and Delong, 1995).

The eastern Pacific stock of the northern fur seal is classified as a strategic stock because it is designated as depleted under the MMPA (Hill and DeMaster, 1999). A review of elephant seal population dynamics through 1991 concluded that the status of this species could not be determined with certainty, but that these animals might be within their optimal sustainable population range (Barlow *et al.*, 1993).

9.1.4.14 Pelagics FMP fishery interactions with marine mammals

This section presents information on marine mammal interactions with the fisheries managed under the Pelagics FMP.

Hawaii-based Longline Fishery

Table 37. Observed marine mammal interactions with the Hawaii-based longline fishery 1994-2003 (numbers in parenthesis are the percent of total trips that were observed) Source: NMFS observer reports 1994-2002, PIRO web page Jan-June 2003

Species	1994-1999 total (3.3% to 5.3%)	2000 (10.4%)	2001 (22.5%)	2002 (24.6%)	Jan. - June 2003 18.4% to 21.4%
Humpback whale	0	0	1 released injured	1 released injured	0
Short-finned pilot whale	1 released alive	1 released alive 1 released dead	2 released injured	0	0
False killer whale	2 released alive	0	3 released injured	5 released injured	0
Sperm whale	1 released alive	0	0	0	0
Blainsville beaked whale	0	0	0	1 released dead	0
Unidentified whale	4 released alive	1 released alive	0	0	0
Risso’s dolphin	7 released alive	1 released alive	1 released injured	0	0
Spinner dolphin	1 released alive	1 released alive	0	0	0

Species	1994-1999 total (3.3% to 5.3%)	2000 (10.4%)	2001 (22.5%)	2002 (24.6%)	Jan. - June 2003 18.4% to 21.4%
Bottlenose dolphin	2 released alive	0	0	0	1 released dead
Common dolphin	0	1 released alive	0	0	0
Spotted dolphin	0	0	1 released dead	0	0
Unidentified cetacean	1 released, condition unknown	2 released alive	2 released injured	2 released injured	1 released injured
TOTAL	19	8	10	9	2

The above observed interactions for 2002 were recently extrapolated by NMFS' Southwest Fisheries Science Center as follows in Table 38.

American Samoa-based Longline Fishery

Federal logbooks for the American Samoa-based longline fishery from 1992 through 2001 indicate zero interactions with listed marine mammals. More recently, observers on 76 longline sets around American Samoa also recorded zero interactions with marine mammals.

Table 38. Extrapolated fleet-wide fishery interactions with marine mammals Source: Forney, 2003

Species	**Annual average 1995-1999**	**2000**	**2001**	**2002**
Observer coverage	4.50%	11.80%	22.70%	24.90%
Bottlenose dolphin	9	0	0	0
Risso's dolphin	24	8	4	0
Spinner dolphin	4	8	0	0
Spotted dolphin	0	0	4	0
False killer whale	9	8	4	12
Sperm whale	6	0	0	0
Humpback whale	0	0	4	4
Short-fin pilot whale	4	17	12	0

Beaked whale	0	0	0	4
Unid. cetacean	27	17	4	8
Total	83	58	32	28

Other FMP fisheries

Apart from the U.S. purse seine fishery in the Western and Central Pacific, all pelagic fisheries that operate within federal waters employ hooks and lines. These include trollers, which drag baited hooks or artificial lures behind a vessel; handliners, which fish in open water with baited hooks and longliners, which suspend 1000-3000 baited hooks from a mainline within the water-column. Nitta and Henderson (1993) provide details of marine mammal interactions with pelagic fisheries in Hawaii, from which the following has been summarized.

Troll fishermen fish in a variety of habitats and location, including on the open ocean, over seamounts, along the reef edge and around floating fish aggregating devices. Troll fishermen may look for signs of tuna schools such as seabirds diving on baitfish driven to the surface by skipjack and yellowfin tuna. Dolphin pods are another indicator of tuna schools, which like the seabirds will associate with tuna schools, waiting for the tuna to drive the baitfish to the surface (Rizutto 2001). Other pelagic fish-marine mammal interactions known to troll fishermen include short-fin pilot whales and oceanic white tip sharks, which scavenge on the prey remnants taken by the pilot whales (Rizutto, 2003). Commercial and recreational troll fishermen have reported both billfish and marlin to be taken by false killer whales (*Pseudorca crassidens*), with catches damaged or removed from the hook entirely. One troll fisherman reported that a false killer surfaced immediately astern of his boat holding a captured marlin crosswise in its jaws. Rough toothed dolphins and bottlenose dolphins have also been observed taking live bait.

Pelagic handline fishing in Hawaii can be divided between the daytime handline fishery or *palu-ahi* fishing, and the night time handline fishery or ika-shibi fishery. The palu-ahi fishery is so named as fishermen employ a bag of bait or palu, sunk and emptied underwater, to aggregate yellowfin and bigeye tunas. The fishery operates at traditional tuna "holes" or *koas*, locations known to aggregate tuna, over seamounts. Bottlenose (*Tusiops truncatus*) and rough-toothed dolphins (*Steno bredanensis*) have been observed taking both bait and catch from *palu-ahi* fishing, while bottlenose dolphins have been implicated in the loss of catch and bait in the *ika-shibi* fishery. There are no official data on interactions with small boat fisheries in Hawaii or other areas of the Western Pacific Region.

9.1.4.15 Biology and population status of potentially affected seabirds

Three species of albatross breed and forage in the North Pacific: the short-tailed albatross, the black-footed albatross and the Laysan albatross. NMFS observer data show that 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 is listed as endangered, however, the conservation status of the black-footed albatross is “vulnerable,” while the Laysan albatross is listed as a species of “least concern.” The short-tailed albatross is listed as “vulnerable” under the World Conservation Union (IUCN) (Croxall and Gales 1998), and as endangered under the U.S. ESA (65 FR 46643, July 31, 2000). The 2001 estimate of the worldwide population of short-tailed albatrosses was 1,362 individuals (USFWS 2001). There have been no reports of interactions between the endangered short-tailed albatross and the Hawaii-based longline fishery, but this situation could change in the future as the short-tailed albatross population is annually growing in size at approximately 7.8% (Hasegawa 1982, Cochrane and Starfield in prep).

The last published estimates of the number of breeding pairs of black-footed albatrosses and Laysan albatrosses were about 62,000 and 558,000 respectively (WPRFMC 2000). Ninety-six percent of black-footed albatross nesting sites and more than 99% of Laysan albatross nesting sites are in the Northwestern Hawaiian Islands (NWHI). As the number of juvenile (i.e., non-breeding) albatrosses may be five to six times the number of adult (i.e., breeding albatrosses) (Pradel 1996), the total world populations for black-footed and Laysan albatrosses are estimated to be 300,000 and 2.4 million, respectively (WPRFMC 2000).

Unpublished USFWS census data show that during the 1990s the number of breeding pairs of black-footed albatrosses in nesting colonies in the NWHI declined by about 1.3 percent. However, some nesting colonies experienced fluctuations. For instance, between 1987 and 1988, the number of active black-footed albatross nests at French Frigate Shoals decreased by 11.7% but then increased by 20.2% between 1997 and 2000. Counts of black-footed albatross breeding pairs on Laysan Island, which is the largest nesting colony for black-footed albatrosses and accounts for more than one-third of the world’s population of this species, indicate an increase of 4.2% in 1999, and then a decline of 17% in 2000.

The number of breeding pairs of Laysan albatrosses in nesting colonies in the NWHI has also fluctuated, with Laysan Island showing a 26% increase in breeding pairs between 1991 and 1996, followed by a 60% decline between 1996 and 1998 (USFWS unpub. data). Between 1991 and 1998, it is estimated that the number of Laysan albatross breeding pairs in the NWHI decreased by at least ten percent.

However, the most recent bird counts conducted by the Fish and Wildlife Service indicate that breeding pairs of black-footed albatrosses on Midway Island increased by 7.2% between 2001 and 2003. Breeding pairs of Laysan albatrosses on Midway were found to have increased by 53.9%. The cause for these increases is not clear, however the Fish and Wildlife Service believes that in general Midway is a safer place for the birds since many antennas and buildings that birds used to fly into have been recently removed in the Navy’s cleanup of the atoll (Honolulu Advertiser, January 9, 2004). Populations on other islands show varying trends, however in general numbers of breeding pairs of NWHI albatrosses show a stable or increasing trend.

The slow recovery of NWHI albatross nesting colonies to historical levels, and the fluctuations in the numbers of albatross breeding pairs may be related to fluctuations in overall ecosystem productivity (Polovina *et al.* 1994), as well as to the incidental catch of seabirds in longline fisheries. The average annual incidental catches of black-footed and Laysan albatrosses in the Hawaii longline fishery (1994-1999) represent about 0.46% and 0.05% of the total estimated populations of these species, respectively. This source of seabird mortality cannot account for all of the fluctuations in the number of NWHI breeding pairs described above. Although it is known that foreign longline vessels are operating in the foraging areas of the albatrosses close to the northern boundary of the U.S. EEZ around the NWHI (WPRFMC 2000), the number of seabirds killed by these vessels is unknown. Other anthropogenic sources of mortality occur at the NWHI seabird nesting colonies, such as at Midway Atoll where seabird deaths occur as a result of birds striking buildings, aircraft, vehicles, trees or high tension wires, or becoming entangled in recreational fishing gear. Further, albatross chicks also die each breeding season due to direct and indirect effects of plastic ingestion. And certainly, if breeding albatrosses are consuming plastic then this factor may also impact their foraging success and ability to maintain their overall reproductive fitness. The number of seabirds impacted by these causes, however, is largely unknown. Also unknown is the number of fledgling albatrosses killed by sharks and disease.

Recent evidence from population studies and modeling exercises suggests that the combination of domestic and foreign longline fisheries in the North Pacific have had a negative impact on the NWHI albatross populations (WPRFMC 2000). Although the emphasis of research to date has been on the impacts of fishing operations on the black-footed albatross population, the modeling exercises conducted at the Black-footed Albatross Population Biology Workshop can be applied to both black-footed and Laysan albatross populations. One finding of the workshop modeling exercises suggests that the sustained growth rate of an albatross population (without any fishing-related mortality) is in the range of zero to about four percent. The modeling exercises also showed that the growth rate of the population will be reduced by an equivalent percentage of the total number of birds killed in the longline fisheries each year. This estimated reduction in growth is a robust estimate in that it is not sensitive to the ratio of juveniles to adults lost, nor is it sensitive to whether the population was growing at zero or four percent. This means that if the total number of birds killed in the longline fisheries each year is of the order of one percent of the total population, then the growth rate of the population will be reduced by slightly more than one percent.

Given that albatrosses can live for at least 40 years and may skip one or two breeding seasons to molt (WPRFMC 2000), a thorough assessment of the impacts of a single mortality source, such as longline fishing by Hawaii-based vessels, requires long term monitoring of seabird population demographics. Juvenile seabirds are caught more often than adults in longline fisheries (Brothers 1991; Boggs 2001; Cousins 2001) and since albatrosses have long maturation periods (up to five years) during which juveniles do not return to the nesting colony, the impacts of the incidental catch of seabirds in longline fisheries on seabird populations may not be detected for several years. Moreover, several mortality sources at the breeding colonies, and the impacts of plastic ingestion on adult foraging success are unknown.

Therefore, to fully understand the impacts of longline fisheries on black-footed and Laysan albatross populations, modelers need to include age-specific survivorship and recruitment rates for both species. Again, due to the life history traits of these albatrosses, considerable time may lapse before the implementation of measures to reduce the incidental catch of seabirds in the Hawaii longline fishery results in measurable changes in the size and recruitment rates of NWHI albatross populations. Understanding the causes of these changes will be hampered by the fact that the Hawaii-based longline fleet is not the only fishery impacting the NWHI albatrosses, nor are fisheries the only possible causes for the observed fluctuation in breeding pair numbers. Consequently, long-term monitoring of NWHI breeding colonies coupled with international data sharing agreements is necessary to fully understand the impact of mitigation measures on albatross populations.

9.1.4.16 Overview of the incidental catch of seabirds in the Hawaii longline fishery

The NMFS, Southwest Fisheries Science Center, Honolulu Laboratory (NMFS, SWFSC Honolulu Laboratory) used data from NMFS observer reports and the NMFS Western Pacific Daily Longline Fishing Log to estimate the annual incidental catch of black-footed and Laysan albatrosses in the Hawaii longline fishery between 1994 - 1999, and 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 (WPRFMC 2000). In 1999, Dr. M. McCracken developed a new prediction model to estimate the number of black-footed and Laysan albatrosses incidentally caught by the Hawaii longline fishery during 1999, and then re-estimated takes for earlier years, 1994-1998 (Table 39). For each albatross species, a prediction model was developed that related the number of seabird interactions 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 incidentally caught on each unobserved trip on the basis of the predictor variables recorded in the logbooks for those trips. The total annual incidental catch of seabirds 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 incidental catch 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 incidental catches about the expected predicted values was used to construct approximate "prediction intervals" for seabird incidental catch. 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 incidental catch are given in Table 39. Estimates of incidental 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 is estimated that between 1994 and 1999, an average of 1,388 black-footed albatrosses and 1,175 Laysan albatrosses were killed in the Hawaii longline fishery each year (Table 39). These average annual incidental catches represent about 0.46% and 0.05% of the estimated worldwide black-footed and Laysan albatross populations, respectively.

Data collected by NMFS observers show that when Hawaii-based longline vessels targeted swordfish (*Xiphias gladius*) the incidental catch of seabirds was far higher than when vessels target tuna (Table 39). One reason for this is that vessels targeting swordfish were 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; WPRFMC 2000). The region of greatest interaction between seabirds and the historical swordfish longline fishery is a latitudinal band between 25° N. and 40° N. stretching from the international dateline to about 150° W. (NMFS unpub. data). 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.* in prep). 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 (Section 14.4.2). Hawaii longline vessels targeting swordfish set their lines where the fish were believed to be moving south through the fronts following squid, the primary prey of swordfish (Seki *et. al.* in prep.). Squid is also the primary prey item for the albatrosses (Harrison *et. al.* 1983). Hence, the albatrosses and the longline vessels targeting swordfish were often present at the same time in the same northern front of high biological productivity.

It is also possible that albatrosses nesting in the NWHI forage predominantly to the north and northeast of the Hawaiian Archipelago because ocean surface winds tend to seasonally diminish near the equator (Peixoto and Oort 1992). Because albatrosses are dependent upon these winds to dynamically soar over the ocean surface (Magnan 1925), it may be less energy efficient for these birds to forage at more southern latitudes. Bird counts made by the NOAA research vessel *Townsend Cromwell* in the tropical latitudes south of Hawaii confirm that albatrosses are rarely encountered south of 25° N. (C. Boggs pers. comm.). Further, satellite tagging of both breeding Laysan and black-footed albatrosses by Wake Forest University has shown that these birds consistently fly either north or northeast from the Hawaiian Islands when foraging (Anderson and Fernandez 1998).

A second reason that longline vessels targeting swordfish historically 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 historically consisted 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 was set at a shallow depth (5-60 m), and the line and baited hooks sank comparatively slowly. Consequently, albatrosses following behind a vessel targeting swordfish had a greater opportunity to dive on hooks and become caught. In addition, vessels targeting swordfish 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 usually 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.

In 2000 a formal consultation was conducted with the U.S. Fish and Wildlife Service under section 7 of the Endangered Species Act. This consultation examined the impacts of the historical (1994-1999) Hawaii longline fishery and concluded that the fishery was not likely to adversely affect endangered seabirds. However, the resultant Biological Opinion included several mandatory conservation measures. These included the requirement that vessel operators shallow-setting north of 23° N. must begin the setting process at least one hour after local sunset and end the setting process at least one hour prior to local sunrise. As described above, this element will be implemented under any alternative that would allow shallow-setting north of 23° N.

Table 39. Incidental catch of albatrosses in the Hawaii longline fishery by set type based on NMFS observer records from 1994-1998. (Mixed = swordfish and tuna.)

Targeted Fish During Set	Observed Bird Catch	Number of Observed Sets	Bird Catch/Set
Swordfish	300	488	0.615
Mixed	446	948	0.470
Tuna	16	1,252	0.012

Source: NMFS, SWFSC Honolulu Laboratory, unpubl. data.

9.1.4.17 Pelagics FMP fishery interactions with seabirds

The June 2001 implementation of regulations that prohibited shallow-set longline fishing significantly reduced fishery interactions with seabirds. Data presented in Table 40 are total fishery interactions (hookings and entanglements), these include both lethal and non-lethal interactions.

Table 40. Estimated fleet wide Hawaii-based longline fishery interactions with seabirds

Source: NMFS, SWFSC Honolulu Laboratory, McCracken 2000a. (94-99), PIRO report 200-2002.

Year	Black-footed albatross	Laysan albatross	Short-tailed albatross
1994	1,830	2,067	0
1995	1,134	844	0
1996	1,472	1,154	0
1997	1,305	985	0
1998	1,283	981	0
1999	1,301	1,019	0
2000	1,339	1,094	0
2001	258	252	0
2002	65	51	0

Fleet-wide estimates for 2003 are not yet available; observer information for the first half of 2003 is presented in Table 41.

Table 41. Observed seabird interactions with the Hawaii-based longline fishery, January - June, 2003 (observer coverage ranged from 18.4% to 21.4% during this time period) Source: PIRO website

Species	Number	Release condition
Black-footed albatross	22	dead
	1	injured
Laysan albatross	44	dead
Short-tailed albatross	0	NA

10.0 Environmental impacts of alternatives

NEPA requires federal agencies to consider the environmental impacts on the human environment. This section addresses the requirement to comprehensively and concisely consider the environmental impacts of each of the management alternatives discussed in Section 8 and of continued interest. For convenience, Table 42 summarizes the fishery management alternatives analyzed in detail here.

Table 42. Summary of Hawaii longline fishery management alternatives analyzed in detail

Alternative	Tuna Fishery?	Model Swordfish Fishery - with circle hooks and mackerel bait?	Dehooker, (and line cutter, dip net and bolt cutters) required?	Conservation measures?
Committee Alt 1	Yes, with no time/area closure	Yes, 1,060 sets annually	Yes	Yes
Committee Alt 2	Yes, with no time/area closure	Yes, 1,560 sets	Yes	Yes
Committee Alt 3	Yes, with recent time/area closure except for EEZ waters around Palmyra	Yes, 2,120 sets annually	Yes	Yes
Committee Alt 4 (Preferred)	Yes, with no time/area closure	Yes, 2,120 sets annually	Yes	Yes
Committee Alt 5	Yes, with no time/area closure	Yes, 3,179 sets annually	Yes	Yes
Committee Alt 6 (Current Fishery)	Yes, with recent time/area closure	No	Yes, except for dehooker	Yes
Alternative 7 (No Action)	Yes, with no time/area closure	Yes, no specific limits	Yes, except for dehooker	No

Information requirements for analyzing longline-turtle interactions are complicated for three reasons: first, the natural systems in which sea turtles and longline fisheries operate are complex, with wide variation in natural variability at seasonal, annual and decadal scales; second, human interventions into the natural environment affecting sea turtles is widely spread over time and space, with activities decades old still affecting sea turtle populations; and third, the available information from monitoring sea turtle populations is limited. Yet the Magnuson 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 Southwest Fisheries Science Center and the Pacific Islands Fisheries Science Center. 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 SEIS 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. (NOAA, 9/30/2002).

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 comparison of different methodologies (and results) in terms of inter-action estimates, post-hooking mortality, population models, transferred effects -- the substitution of foreign-caught swordfish and tuna for Hawaii-caught product, the long-term benefits of conservation projects as well as the inherent uncertainties regarding funding for, and the longevity of, the proposed conservation projects. In each case the SEIS presents a broad range of information with citations to the professional literature, where available, or to the scientific organization where the information originated.

Where possible, scientists involved in the preparation of material for this time-sensitive analysis have used sensitivity analysis (including Monte Carlo studies) to simulate variability in data where specific variance parameters are not available. 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). 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 sea turtles), this does not suggest that perfect information is required for any preferred alternative to proceed. In brief, it does suggest that caution be taken. This SEIS has used the best available information and made a broad presentation of it. The NEPA process of public review of this SEIS is a good opportunity for comment and challenge to this information, as well as for the provision of additional information.

Consideration of the no action alternative is required as part of the NEPA process since it provides a baseline for considering the action alternatives. In this case, with the current legal environment, determination of the no action alternative is difficult. There is substantial uncertainty about what course of action would take place should the alternative regulatory actions which are the subject to this SEIS not take place. Ultimately the Court is likely to be the source of resolution to that kind of ambiguity if the situation would occur. But for this SEIS, the no action alternative is best stated to the effect that to take no action would result, on April 1, 2004, in having no swordfish fishing prohibitions nor southern time-area closure for the longline fisheries managed under the Pelagics FMP. However, the no action alternative retains all the relevant regulations and other management measures that were not affected by the court order. Subsequent discussion of the regulatory environment (Section 9.1.4.1) delineates the regulations that would still be in effect and those vacated by the Court order.

The no action alternative in this SEIS is essentially the same as Alternative 2 in the FEIS. The analysis in the FEIS of Alternative 2 therefore substantially describes the no action consequences to the environment in this case.

The no action alternative would not occur intentionally. The Council and NMFS are committed to implementing a long-term rule. If for some unexpected reason a long-term rule is not implemented by April 1, 2004, several options would occur, one of which is the no action alternative as specified above. In that case, at least for an interim period, individual fishermen would have to weigh the potential costs of violation of the ESA should they take a turtle in the absence of an intact section 7 incidental take statement. The Council has also recommended an emergency rule (Section 6.0) for implementation by NMFS should this long-term action fail to be implemented by April 1, 2004. Similarly, both Secretarial and ESA regulations are potential outcomes.

10.1 Impacts on fishery participants

As Hawaii's major commercial fishery, the longline fleet also supports a substantial fishery supply sector (fuel, oil, bait, gear, etc.) as well as an auction house and numerous fish wholesaling and retailing operations. The Hawaii longline fishery, valued at $46.6 million in a 1998 baseline economic analysis, was estimated to have a total impact on Hawaii business sales of $113 million using an input-output model of the Hawaii commercial fishery (Sharma *et al.* 1999). This model calculates the interrelationship of industries producing inputs to the longline fishery, i.e., "backward" linkages. The total sales figure includes the direct effect of the ex-vessel sales and the indirect and induced income effects on other industries, i.e., associated businesses. Using this model, the personal and corporate income effect of the 1998 longline fishery was $50 million with up to 1,500 jobs directly associated with the fishery. State and local taxes are approximately $8 million. In addition there are "forward" linkages, i.e., the supply effect of Hawaii longline-caught fish on the seafood auction, wholesalers, retailers, etc. These measures are more difficult to measure but were estimated to represent an additional $8-16 million in value-added. Although not recently reassessed, it is likely the longline fishery's importance has dwindled slightly due to the loss of the swordfish sector. However, the conversion of some swordfish vessels to targeting tuna and other pelagic species has offset a portion of this decline.

Clearly low cost alternatives which allow higher levels of fishing effort without threatening sea turtle populations will have the greatest value to fishery participants and the general public. Beyond the amount of allowable fishing effort, the way in which this effort is distributed will also affect these values. For this reason, the Participation and Closure Options are discussed in detail below.

Under those Committee Alternatives with relatively low levels of model swordfishing, the distribution of a limited amount of allowable effort among a large number of vessels is likely to be unprofitable and inefficient as each vessel operator will have to undertake the capital investment to ensure that they have the appropriate gear on board (those which move back from California may already be geared up but Hawaii boats will need to refit their vessels for shallow-setting). Under alternatives with low levels of allowable effort, the return on investment for these vessels is likely to be low.

All alternatives except Committee Alternative 6 (current fishery), would permit shallow-set swordfish style fishing by vessels with a Western Pacific general longline permit. American Samoa longline vessels currently fish under a general permit, but a limited entry program for this fishery is currently nearing completion. American Samoa vessels could conceivably fish north of the equator and make shallow sets for swordfish. However, the American Samoa fleet targets primarily albacore tuna for the two canneries in Pago Pago. There is little to no market for fresh swordfish in Pago Pago, nor more importantly, easy access to markets elsewhere, unlike for the vessels that operate out of Hawaii. Two general longline permits have been issues to resident in Guam and in CNMI. Neither of these two permits are being used for active longline fishing in either location. Based on historical information for foreign longline vessels operating out of Guam, any longline fishing that might be conducted by U.S. vessels from the Mariana Islands would be deep sets for tuna. Vessels with a Western Pacific general longline permit may not land longline caught fish into Hawaii. Longline vessels with a general permit could conceivably fish using shallow sets to catch swordfish beyond the US EEZ around Hawaii and tranship to a Hawaii-based vessel with a receiving permit. However, there is no record of such an operation over the entire history of the Hawaii-based longline fishery.

Participation Option 1-Allow participation in the model swordfish-style fishery based on "first come first served." Depending on the amount of allowable effort, this option could result in a derby-style fishery where many participants gear up and fish in a competitive manner until the effort limit is reached. This could lead to safety problems if fishing occurs during hazardous weather or sea conditions, market effects if many vessels offload simultaneously, and inefficient (excess) investment if more boats gear up than are necessary. This option could be seen as avoiding issues of equity by providing an equal opportunity for all permit holders to participate in the swordfish-style fishery and it would be relatively easy to allocate available effort. However the necessary monitoring and closure of the fishery would be difficult as on any given day there are many vessels at sea - some of which are actively fishing and others of which are in transit. In addition, not every vessel has communication capabilities that are compatible with NMFS’ systems.

Participation Option 2 - Allow participation in the model swordfish-style fishery based on individual historical participation Basing participation on each vessel’s fishing history could be seen as equitable by many participants although there would likely be some dissension between those permit holders whose vessels have remained in Hawaii and those that have recently based their vessels in California to continue swordfishing. In addition, it would represent an uncompensated loss of access to the tuna sector which was not historically prohibited from participating in the swordfish fishery. This option could be difficult to implement as logbooks would have to be analyzed, decisions over which historical fishing to consider would have to be made, and trails of vessel and permit transfers would need to be traced. Costs to fishery participants would be a function of which vessels were allowed to participate and whether successful vessels were currently rigged for tuna-style or swordfish-style fishing. This option may result in efficiencies if there is no method for uninterested successful permit holders to transfer their allowable effort to those who do want to fish swordfish-style.

Participation Option 3 - Divide allowable effort equally among all boats. This option would allow each permit holder to fish an equal amount of effort (days, sets, hooks etc.). Although apparently fair, it is likely to result in inefficiencies if there is no method for uninterested permit holders to transfer their allowable effort to those who want to fish swordfish-style.

Participation Option 4 - Allow participation in the model swordfish-style fishery based on a lottery. Perceptions of equity are likely to be a function of who is eligible to participate in the lottery. Opening it to all permit holders might be seen as unfair to those who have historically fished swordfish-style (although the swordfish sector has never had its own limited entry program), while only allowing historical participants in would be likely to be seen unfavorably by tuna fishermen. The issue of unused effort could be addressed by opening a lottery to all (and only) those who express an interest. Assuming that fair notice is given to all permit holders, this may be seen as a reasonable compromise.

Participation Option 5 - Divide allowable effort equally among interested permit holders (preferred) Under this refined version of Participation Option 3, certificates for allowable sets would be evenly divided among permitted vessels belonging to interested permit holders (including those whose vessels are not currently registered to their permits) based on their positive response to a letter sent by NMFS. Permit holders could either fish their shares themselves, or trade, sell, or give them to other Hawaii longline limited access permit holders to use during that fishing year. The use of uniquely numbered physical certificates for each set will allow permit holders to transfer allowable effort among themselves with no intervention or recordkeeping by NMFS. This should result in increased efficiency as effort shares should be worth more to (and thus move toward) those who believe that they have a higher likelihood of shallow-setting profitably (e.g. experienced swordfish fishermen). Restricting effort shares to those who express interest will help to ensure that allowable effort is used. This option was endorsed by the Hawaii Longline Association.

Closure Option 1- When the swordfish fishery's incidental take statement or other limit is reached close the swordfish fishery ("hard limit"). This alternative would provide certainty to fishery participants and managers that the swordfish fishery would stop fishing when its average incidental take statement or other limit is reached. If the hard limit is set correctly, it could also avoid the reinitation of section 7 consultations due to excessive interactions.

Closure Option 2 - When swordfish fishery's incidental take statement or other limit is exceeded reinitiate consultation on the swordfish fishery. As compared to Closure Option 1, reinitiation of consultation would provide a less certain outcome in terms of continued swordfish fishing. In the past, reinitiation of consultations has resulted at times in fishery closures, however some fisheries have been allowed to continue fishing during the re-consultation period.

Closure Option 3 - When the swordfish fishery's new incidental take statement is reached for leatherback or loggerhead turtles, close the model swordfish fishery (preferred). Under this refinement of Closure Option 2, hard limits would be placed on the swordfish fishery for leatherback and loggerhead turtles (the species of concern in the shallow-set fishery) and the model swordfishery would be closed each calendar year when its new incidental take statement (concerning total interactions) for leatherback or loggerhead sea turtles is reached. Interactions and incidental take statements for green and ridley turtles would be combined with those for the tuna fishery and normal ESA procedures would apply to these species (as they would also apply to leatherbacks and loggerheads taken by the swordfish fishery). Updated information on year-to-date interactions will be available from fishery managers to inform participants as to the fishery's status regarding the established hard limits. This will allow vessel operators to avoid embarking on trips that are likely to be ended prematurely, as well implicitly providing notice of upcoming closures. Fishery participants would receive formal notice from NMFS at least one week in advance of any closure. Barring other new information, the fishery would automatically reopen on January 1 of the next year. Hard limits would not be used for olive ridley and green sea turtles. Although this option could also result in a derby-style fishery, it is unlikely as incidental take statements are calculated taking into consideration total anticipated fishing effort. Therefore the threat of the incidental take statement being exceeded is low and the incentive to race to the fish (turtles) is also low.

10.2 Impacts on target fish stocks and on non-target species

Conservation actions such as nesting beach management in the Southwest Pacific (Indonesia and the Melanesian Islands) will have no impacts on the target and non-target finfish species of the Hawaii longline fishery.

To provide a common reference point, NMFS scientists have modeled the anticipated impacts of the alternatives on fleet-wide catches of major species in relation to the 1994-1999 baseline. These data are presented in Table 43 for changes in swordfish, tunas and ex-vessel revenues.

Estimates of catches for the Hawaii longline fishery have been made by PIFSC using the Kobayashi/Polovina models (See Appendix H)The underlying predictive models are based on 1994 to 1999 data when the swordfish fishery was operating normally. The model is able to predict effects of time/area closures and varying effort by different fishing types. In 2003 this model was further revised by applying the interaction reduction rates associated with circle hooks and mackerel bait as discussed in Section 7.0. As expected, the change in swordfish catches under these alternatives is proportional to the volume of shallow-set longline effort. The restoration of half of the 1994-1999 average effort produces a swordfish catch roughly half that of the baseline. Tuna catches under the seven alternatives are inversely proportional to the amount of swordfish effort, with all but bigeye under alternative 6 (the current fishery) showing increases in catch, above the 1994-1999 baseline. This is due to only a percentage of the effort that was displaced into the tuna fishery post-1999 converting back to swordfish fishing, and tuna fishing effort levels in Committee Alternatives 1-6 remaining elevated above the 1994-1999 baseline.

Table 43. Comparison of impacts of the alternatives on the catches of the Hawaii-based longline fleet as compared to the 1994-1999 baseline. Source: NMFS PIFSC

Committee Alternative	Change in swordfish catches	Change in bigeye catches	Change in albacore catches	Change in yellowfin catches
1	-67.2%	19.2%	27.8%	18.2%
2	-56.6%	16.2%	23.5%	15.3%
3	-44.5%	11.3%	21.7%	18.2%
4 (preferred alternative)	-44.8%	12.8%	18.6%	12.1%
5	-22.4%	6.4%	9.3%	6.1%
6 (Current fishery, 2002 data)	-92.3%	0.0%	12.0%	29.4%
7 (No action, 1994-1999 data)	6.5 million pounds	5.2 million pounds	2.5 million pounds	1.7 million pounds

Reopening swordfish fishing may also lead to an overall increase in fishing effort by the Hawaii-based longline fishery, as vessels displaced to California by the 2001 regulations, may renter the fishery. However, fishing by all FMP longline vessels in the Pacific Ocean is still a fraction (<5%) of the overall level of longline fishing in the Pacific, and an even smaller fraction of the total mortality of Pacific pelagic stocks, which are caught in large volumes, not only by longliners but other fisheries as well, particularly the purse seine fishery.

With respect to Pacific swordfish catches, the Hawaii fishery, up to 1999, caught about 20% of the Pacific-wide swordfish total of around 15,300 mt, or in other words was responsible for about 20% of the fishing mortality on the swordfish stocks. The re-established fishery would be expected to catch about half of the historic average catch over the 1994-1999 period (6.7 million lb), equivalent to about 3.35 million lb or 1,500 mt. The stock assessment for North Pacific swordfish by Kleiber & Yokawa (2002), 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 longline fishing effort in the North Pacific.

As noted in Section 9.1.4.6 recent stock assessments for the four major commercial tunas taken in the Pacific Ocean (bigeye, yellowfin, albacore and skipjack) and swordfish indicate that these stocks are currently not overfished (Hampton et al. 2003, Hampton and Kleiber 2003, Labelle and Hampton 2003, Langley et al. 2003). Although the reopening of the swordfish fishery will likely increase tuna catches, particularly yellowfin tuna, the Hawaii longline catch of all four species are small percentages of the Pacific total catches (albacore-2%, yellowfin-0.2%, bigeye-2.5%, skipjack-0.3%), and a negligible fraction of the fishing mortality of these stocks.

The re-establishment of swordfish fishing will also likely mean increased marlin catches by the Hawaii-based longline fleet. Between 1994 to 1999, the Hawaii fleet caught an average of 970,000 lb (441 mt) of blue marlin and 875,000 lb (398 mt) of striped marlin. The average catch declined by just over 25% for blue marlin (717,000 lb, 326 mt) , and by about 50% (448,000 lb, 204 mt) for striped marline between 2000 and 2002. Dalzell (2003) reports that annual landings of blue and striped marlins in the Pacific amount to about 22,700 and 11,500 mt respectively. The pre-1999 Hawaii longline fishery thus contributed to about 2% of the Pacific blue marlin catch and 3.5% of the striped marlin catch. The re-establishment of the swordfish fishery at 50% of the pre-1999 levels of effort will thus likely have an negligible effect on the stocks of these species as a whole.

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. There is currently no Pacific-wide stock assessment of striped marlin. An assessment of striped marlin in the Eastern Pacific Ocean (EPO) by Hinton & Bayliff (2002) indicated that 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.

Sharks are the principal bycatch of the Hawaii-based longline fishery. The re-opening of swordfish fishing will likely mean an increase in shark catches by the Hawaii longline fleet. Pelagic sharks comprise about 50% of the composition of shallow swordfish longline sets, compared to 16% for tuna sets (Ito & Machado 2001; Ito pers comm.). The Hawaii longline fishery between 1994 and 1999 caught on average about 98,000 sharks, about 93% of which were blue sharks. Between 2000 and 2002, the average shark catch by the Hawaii fishery declined to about 60,000 sharks, about 84% of which were blue sharks. The decline in the proportion of blue sharks reflects pattern of fishing for tunas which tends to be concentrated south of Hawaii in warmer tropical waters, where blue sharks are less numerous (Nakano 1994).

Prior to 1999, about 50% of all sharks were retained, primarily for finning, while in the 2000-2002 period only 20% were retained for finning. Most of this retention was in 2000 before anti-finning regulations went into effect, and in 2001 and 2002 only 5% of all sharks were retained. Thus while shark catches will likely increase with the advent of swordfish fishing, only a small volume will be retained, with most released. Records collected by observers indicate that only about 14 percent of all sharks hooked incidentally in the Hawaii based longline fishing are brought to the side of the vessel dead (NMFS 2001). The most current stock assessment of blue shark in the Pacific was conducted by Kleiber et al (2001) using the Multifan-CL model suggests that with the most conservative estimate of stock size the MSY for this species is approximately twice the current level of fishing mortality.

Less is known about the stock status of other sharks taken by the Hawaii-based longline fishery, however, the diversification of fishing effort should result in a lower proportion of non-blue sharks in the catch, while the ban on finning and discarding of carcasses at sea, with the small market for shark flesh in Hawaii provides little incentive for retaining sharks.

In summary, given the healthy status of Pacific pelagic stocks and the small proportion of global Pacific fishing effort represented by the FMP longline fisheries for most species, it seems unlikely that any alternative will have a significant impact on fishery stocks. The potential for localized effects on catch rates in Hawaii-based small boat fisheries, however, can not be entirely discounted. Studies of interactions between small boat trollers and the longline vessels have not indicated any significant interactions (Skillman et al 1993). However recreational fishermen report that they are catching greater volumes of larger yellowfin and blue marlin since the curtailment of the swordfish fishery in 2001 (TenBruggencate, 2003). Alternatively, shallow set swordfish longline fishing has generally been conducted to the north of Hawaii at higher latitudes, beyond the EEZ. The re-establishment of swordfish fishing may actively divert fishing effort away from the Hawaii EEZ, thus minimizing any potential fishery interactions.

10.3 Impacts on protected species, including turtles, seabirds and mammals

The following sections discuss these impacts in detail.

10.4 Discussion of methodologies for assessing sea turtle interactions

The Hawaii-based longline fishery is the only FMP fishery for which detailed estimates of sea turtle interactions are available. This section presents a discussion on methodologies that have been used to date for making estimates of future (anticipated) and past interactions, as well as an overview of approaches to estimating post-hooking mortality rates. It discusses the relevant positive and negative aspects of each method.

10.4.1 Methodologies for predicting anticipated interactions

Estimates of anticipated average annual sea turtle interactions for the Hawaii longline fishery have been made by PIFSC using the Kobayashi/Polovina model (See Appendix H). Kobayashi and Polovina first modeled interactions between sea turtles and the fishery based on a suite of variables from observer data. The second Kobayashi and Polovina model integrated the first model with data from fishery logbooks. This integrated model was used to estimate historical interactions as well as to predict the likely number of interactions that were likely to result from restrictions on gear types, as well under a range of fishery time and area closures. The underlying predictive models are based on 1994 to 1999 data when the swordfish fishery was operating normally. The model is able to predict effects of time/area closures and varying effort by different fishing types. In 2003 this model was further revised by applying the interaction reduction rates associated with circle hooks and mackerel bait as discussed in Section 7.0 (See Appendix I)

10.4.2 Comparison of methodologies for estimating post-hooking mortalities

Two factors are considered in estimating the number of post-hooking mortalities, firstly the number of deeply and shallow hooked turtles, and secondly the mortality rate for each category of hooking. Differences in physiology, behavior and habitat exhibited by different turtle species may affect each of these factors. For example, loggerheads are more likely to be hooked in the mouth or swallow the bait, and thus may be deeply hooked, while leatherbacks are rarely hooked in the mouth and are therefore mostly externally hooked or entangled.

At this time, NMFS is operating under a policy on post-hooking mortalities developed by the Office of Protected Resources (OPR). An earlier version of this policy is documented in a January 4, 2001 memo to the NMFS Southeast Regional Office (Appendix J) in which NMFS' Office of Protected Resources (OPR) recommended that 50% of longline interactions with all species of turtles be classified as lethal, and 50% non-lethal. The OPR stated that this mortality rate was based on a review of several post hooking studies and input from veterinarians and scientists working in this field, and a risk-averse approach was taken.

NMFS' Office of Sustainable Fisheries and NMFS Southwest Fisheries Science Center's Honolulu Laboratory had a different view, and recognized the importance of a) distinguishing between lightly and deeply hooked turtles and b) using best estimates of turtle mortality rather than applying a precautionary buffer to the calculations, believing such a decision should be made at the individual fishery management level. However based largely on information from satellite- tagged loggerhead turtles, on January 30, 2001 NMFS' Office of Sustainable Fisheries modified the 50% mortality estimates discussed above in favor of NMFS' current mortality estimates of 27% and 42% respectively for lightly and deeply hooked turtles (Appendix K). This last approach was formally adopted by NMFS as its official policy in a February 16, 2001 decision memo and remains NMFS' policy at this time (Appendix L).

This policy has been criticized by Musick (Appendix M) as being based on a paucity of supporting data, especially with regard to leatherback post-interaction survival. Musick indicates that these figures are upwardly biased because satellite tag transmission failure within the first

30 days was assumed to be an indication of mortality, whereas experienced users of satellite tags have found that around 25% of tags may fail within the first 30 days. (Chaloupka's unpublished study discussed above found a transmission failure rate of 34%).

NMFS' OPR, with support from PIRO, is now organizing a workshop of experts to examine available information and expert opinions on appropriate post-hooking mortality rates for various species and types of interactions. It is anticipated that this workshop will yield a revised policy that takes into consideration all available information and expert recommendations.

The mortality numbers in Tables 44 - 49 were estimated by PIFSC based on the post-hooking mortality rates in NMFS' current policy. However, Table 53, uses a 5% post-hooking mortality rate, based on Chaloupka et al. (submitted for publication) and NMFS observer data for the Hawaii-based longline fishery. Chaloupka found a post hooking mortality rate of 8% for lightly hooked turtles. Combining Chalopuka's work with the observer data which indicates a zero percent mortality rate for lightly hooked turtles, yielded the conservative post-hooking mortality rate of 5% used in Table 53. This table also employs a delayed mortality factor of 29% for deeply hooked turtles, based on the 1997 study by Aguilar et al. (Appendix N). Not included in the estimation of mortalities for the shallow-set fishery is the expected but unquantified reduction in the ratio of deeply to lightly hooked sea turtles attributable to the use of 18/0 or larger circle hooks which are not easily swallowed.

Since the completion of the Draft SEIS for this action, NMFS has revised its policy on post-hooking mortality rates as summarized in Table 44. The revised policy is based on information from a panel of seventeen experts in the areas of biology, anatomy/physiology, veterinary medicine, satellite telemetry and longline gear deployment, as well as a comprehensive review of all of the information available on the issue. The revised rates were used by NMFS' Office of Protected Resources in the Biological Opinion prepared for this action (see Section 14.0).

Table 44. Criteria for assessing marine turtle post-interaction mortality after release from longline gear. Percentages are shown for hardshelled turtles, followed by percentages for leatherbacks (in parentheses).

Nature of Interaction	Released with hook and with line greater than or equal to half the length of the carapace	Release with hook and with line less than half the length of the carapace	Released with all gear removed
Hooked externally with or without entanglement	20 (30)	10 (15)	5 (10)
Hooked in lower jaw (not adnexa[1]) with or without entanglement	30 (40)	20 (30)	10 (15)
Hooked in cervical esophagus, glottis, jaw joint, soft palate, or adnexa (and the insertion point of the hook is visible when viewed through the mouth) with or without entanglement	45 (55)	35 (45)	25 (35)
Hooked in esophagus at or below level of the heart (includes all hooks where the insertion point of the hook is not visible when viewed through the mouth) with or without entanglement	60 (70)	50 (60)	n/a[2]
Entangled Only	Released Entangled 50 (60)		Fully Disentangled 1 (2)
Comatose/resuscitated	n/a[3]	70 (80)	60 (70)

[1] Subordinate part such as tongue, extraembryonic membranes

[2] Per veterinary recommendation hooks would not be removed if the insertion point of the hook is not visible when viewed through the open mouth.

[3] Assumes that a resuscitated turtle will always have the line cut to a length less than half the length of the carapace, even if the hook cannot be removed.

10.4.3 Comparison of methodologies for estimating past interactions

NMFS developed regression tree models evaluating the capability of a suite of factors to predict interactions between the Hawaii-based longline fishery and sea turtles (Skillman & Kleiber 1998). In essence, observer data was used to determine which factors recorded in logbooks from the Hawaii-based longline fishery demonstrated statistically significant relationships with turtle interactions. This model focuses on overall interactions with less emphasis on take by area and/or time.

In further model development, McCracken (2000) found that significant factors influencing interactions with loggerheads included month, latitude and sea surface temperature. Sea surface temperature was also significant for olive ridleys as latitude is for leatherbacks. The use of this model-based approach rather than simple extrapolations was necessitated by low levels of observer coverage (<5%) and the non-random placement of observers on longline vessels.
The (now invalidated) 2001 BiOp utilized McCracken's model-based predictor which also included both operational (logbook) and observer program data to estimate annual fleet-wide turtle interactions. This document re-estimated the 1994-1997 interactions, as well as providing new estimates for 1998 and 1999 (McCracken 2000). It also included a revision of these figures using the upper and lower bounds of McCracken's 95% prediction intervals to establish a range of estimated interactions for each species. The (also now invalidated) 2002 BiOp used data from July 2001 through 2002 to represent "the current fishery" as the regulations that were in effect during 2002 were implemented in July of 2001. McCracken's modeling approach was again used to estimate fleet-wide interactions. In this case, the point estimates (rather than the upper bounds of the prediction intervals) were specified as the anticipated fishery interaction numbers. The use of average annual take rates is problematic with four species of turtles, since there is a high probability that the average for any one species may be exceeded in a given year. This results in a situation where the fishery will be subject to section 7 consultations on an almost annual basis. A better approach would be to recognize that there will be year to year variation around the long-term average annual take rates, and that this may be exceeded for a given species from time to time. Using the upper bound of the 95% confidence limit would encompass this variability, while at the same time providing a trigger point for a formal section 7 consultation. As a precautionary measure, an informal consultation might be held in years where the take rate exceeds the long-term average.

10.5 Pelagics FMP fisheries impacts on sea turtles under the preferred alternative

Direct impacts on sea turtles

<u>Hawaii-based longline fishery</u>

The following assessment regards Hawaii's tuna (deep-set) and swordfish (shallow-set) pelagic longline fisheries as two separate fisheries. This is supported by analyses showing that these gear types have significantly different sea turtle interaction and mortality rates. Providing separate incidental take statements will allow early closure of fisheries that are having unanticipated interactions, but allow fishing to continue by better understood gear types.

Annual estimates of interactions between sea turtles and the Hawaii-based longline fishery under the Committee Alternatives are presented in Tables 45 to 53. Data on Committee Alternatives 1-5 were provided by NMFS' Pacific Islands Fisheries Science Center and apply recent estimates for the use of circle hooks with mackerel bait (92% decrease in hardshell turtle interactions, 67% decrease in leatherback interactions, 0% of hooked leatherbacks will ingest those hooks, and 27% of hooked loggerheads will ingest those hooks as reported in Watson et al., 2003) to updated interaction rates for Hawaii-based swordfish-style fishing that were estimated by the Kobayashi/Polovina model (see Appendix H for a general description of this model, also Appendix I for a description of the procedure and resultant data used for these estimates). These estimates may be refined by PIFSC as new data and analyses become available.

Not included in the estimation of mortalities for the shallow-set fishery under these alternatives is the expected, but unquantified reduction in the ratio of deeply to lightly hooked sea turtles attributable to the use of 18/0 circle hooks which are not easily swallowed. Also not included is the expected but unquantified reduction in post-hooking mortalities anticipated to occur due to the fact that circle hooks tend to lodge in the lower jaw rather than in the upper jaw (Bolten, 2002), which simplifies and reduces injuries caused by the hook removal. Hooking a turtle in the hard tissues of the jaw is believed to minimize the amount of injury and trauma to turtles, compared to hookings in the soft tissues of the gullet and digestive tract, which may pierce vital organs or create wounds which fester and increase the chances of the turtle dying following release.

Data for Committee Alternative 6 (the current fishery) were generated by NMFS' PIFSC and represent McCracken's fleet-wide estimates for 2002. The 2002 observer data used to generate the anticipated take of turtles under this alternative included 2 loggerheads taken during illegal shallow set longline fishing for swordfish, and thus may be positively biased. The inclusion of these interactions is the subject of ongoing discussions. In general, it has been seen as appropriate to include them in estimations of actual interactions. However, turtle catches resulting from illegal fishing are not included when making predictions of future interactions using proscribed gear or fishing practices. These predictions are generated to illustrate the efficacy of the regulatory measures and not their enforcement. As discussed in Section 8, Alternative 7 (no action) is anticipated to result in the short-term in a fishery in which there are no special restrictions on tuna or swordfish fishing. Data for this alternative represent Kobayashi's fleet-wide estimates for 1994-1998 (annual average) and are as presented in the 2001 FEIS under its Alternative 1 (this FEIS alternative did not include subsequent fishery management actions that including a 50-mile area around American Samoa that is now closed to large pelagic fishing vessels and new permit and reporting requirements for pelagic vessels fishing in EEZ waters around the Pacific Remote Island Areas - these measures were unrelated to turtle interactions and are not believed to be likely to affect turtle interactions or interaction rates).

With the exception of Alternative 7, turtle mortalities were estimated by NMFS' PIFSC using an average mortality ratio derived from observer data, and current NMFS policy which assumes that 27% of all lightly hooked turtles and 42% of all deeply hooked turtles will die. In this instance, the observed sample used to derive the average mortality ratio excluded turtles for which the condition (i.e. 'alive',' 'injured,' 'dead',' 'lightly hooked,' 'deeply hooked' or 'entangled') was unknown. This contrasts with mortality estimates in previous BiOps where turtles observed with unknown conditions were categorized as having a default condition (i.e. unknown hook location = deeply hooked, unknown alive or dead = dead). Using only turtles with known conditions to estimate the average mortality ratio does not ignore possible mortality of turtles excluded from the observed sample. Rather this procedure assigns those takes the average mortality from turtles with complete data. Current NMFS policy (see Appendix L) does not address the issue of missing data, and this estimation procedure is under review.

Mortality estimates for Committee Alternative 6 was drawn from McCracken's fleet- wide estimates for 2002 and Kobayashi's 1994-1999 (annual average) estimates respectively and employ NMFS' current post-hooking mortality policy. Data for Alternative 7 are drawn from the 2001 FEIS in which they were only calculated in an aggregated form.

In recognition of ongoing discussion concerning the need for improved mortality estimates (Section 10.4.2), Table 48 presents anticipated fishery impacts for Committee Alternative 4 (preferred alternative) using post-hooking mortality rates based on a combination of observer and research data with details following the table. These estimates are presented both as their calculated values and rounded upward to the nearest whole number. The use of a percent of an interaction does not appear to be feasible for fishery management. However, the presentation of actual values allows a more precise review of the relative impacts of the alternatives (e.g. both 0.9 and 0.001 would round up to one but they clearly represent very different potential impacts).

It is also clear that to the extent that a renewed Hawaii swordfish effort is relocated from current California swordfish effort, there would be no net increase in sea turtle interactions as this would be a relocation of existing effort rather than the entry of new effort. Such a scenario would in fact represent a decrease in interactions and mortalities as the preferred alternative requires operators of Hawaii-based vessels to use dehookers, circle hooks and mackerel bait (as well as continuing to use dip nets, line clippers and specific turtle handling techniques) while California-based vessel operators are not required to use these items and techniques. Given recent legal challenges to the California-based fishery, it is likely that at least some of the seventeen swordfish boats which transferred to California, but still hold Hawaii longline permits, are likely to return to Hawaii if they have an opportunity to fish for swordfish here. This potential for additional reductions in fishery impacts on sea turtles has not been quantified and is not included in the following tables.

Note: due to rounding, total interactions do not always appear to equal the sum of the interactions for deep and shallow-set fisheries.

Table 45. Committee Alternative 1 - 1,060 model swordfish sets annually, in conjunction with tuna fishing with no time/area closure. Source: PIFSC, 2003 *Predicting Sea Turtle Take, Mortality, and Pelagic Fish Catch Under the Five WPRFMC Management Scenarios for the Hawaii-based Longline Fishery (see Appendix G).*

Fishery Sector	Species	Total Interactions	Confidence Interval	Mortalities	Confidence Interval
Shallow-set	Leatherback	8	5-16	3	2-5
	Loggerhead	9	4-28	3	2-10
	Green	1	1-3	1	1-1
	Olive Ridley	3	1-9	1	1-4
Deep-set	Leatherback	20	11-32	10	6-17
	Loggerhead	5	1-10	4	1-7
	Green	7	2-15	5	2-10
	Olive Ridley	43	25-68	38	22-60
Total	Leatherback	28	15-47	13	7-21
	Loggerhead	13	5-38	7	2-17
	Green	8	3-17	5	2-10
	Olive Ridley	45	25-76	39	22-63

Table 46. Committee Alternative 2 - 1,560 model swordfish sets in conjunction with tuna fishing with no time/area closure. Source: PIFSC, Kobayashi 2003

Fishery Sector	Species	Total Interactions	Confidence Interval	Mortalities	Confidence Interval
Shallow-set	Leatherback	12	7-23	4	2-7
	Loggerhead	13	6-41	5	2-15
	Green	2	1-4	1	1-2
	Olive Ridley	4	2-12	2	1-5
Deep-set	Leatherback	19	10-32	10	5-16
	Loggerhead	5	1-10	3	1-7
	Green	6	2-14	4	2-9
	Olive Ridley	40	23-65	36	20-57
Total	Leatherback	31	17-54	13	7-22
	Loggerhead	17	7-50	8	3-21
	Green	8	3-18	5	2-10
	Olive Ridley	44	25-76	37	21-61

Table 47. Committee Alternative 3 - 2,120 model swordfish sets annually, in conjunction with tuna fishing with the recent time/area closure modified by opening EEZ waters around Palmyra Atoll. Source: PIFSC, Kobayashi, 2003

Fishery Sector	Species	Total Interactions	Confidence Interval	Mortalities	Confidence Interval
Shallow-set	Leatherback	16	10-31	5	3-9
	Loggerhead	17	8-55	6	3-20
	Green	2	1-5	1	1-2
	Olive Ridley	5	2-16	2	1-7
Deep-set	Leatherback	10	5-19	6	3-10
	Loggerhead	5	1-9	3	1-7
	Green	7	2-15	4	2-9
	Olive Ridley	39	23-62	34	20-55
Total	Leatherback	26	14-49	10	5-18
	Loggerhead	21	9-64	9	4-26
	Green	8	3-19	5	2-11
	Olive Ridley	44	25-78	36	21-61

Table 48. Committee Alternative 4 (preferred alternative)- 2,120 model swordfish sets annually, in conjunction with tuna fishing with no time/area closure. Source: PIFSC, Kobayashi, 2003

Fishery Sector	Species	Total Interactions	Confidence Interval	Mortalities	Confidence Interval
Shallow-set	Leatherback	16	10-31	5	3-9
	Loggerhead	17	8-55	6	3-20
	Green	2	1-5	1	1-2
	Olive Ridley	5	2-17	2	1-7
Deep-set	Leatherback	19	10-31	10	5-16
	Loggerhead	5	1-9	3	1-7
	Green	6	2-13	4	2-8
	Olive Ridley	38	22-60	33	19-53
Total	Leatherback	35	19-61	14	8-24
	Loggerhead	21	9-64	9	4-26
	Green	7	3-18	4	2-10
	Olive Ridley	42	24-77	35	20-59

Table 49. Committee Alternative 5 - 3,179 model swordfish sets annually, in conjunction with tuna fishing with no time/area closure. Source: PIFSC, Kobayashi 2003

Fishery Sector	Species	Total Interactions	Confidence Interval	Mortalities	Confidence Interval
Shallow-set	Leatherback	24	14-46	7	4-13
	Loggerhead	25	12-83	9	4-30
	Green	3	1-8	1	1-3
	Olive Ridley	8	3-25	3	2-10
Deep-set	Leatherback	18	9-30	9	5-15
	Loggerhead	4	1-8	3	1-6
	Green	5	2-11	4	1-7
	Olive Ridley	33	19-53	29	17-47
Total	Leatherback	42	23-75	16	9-28
	Loggerhead	29	12-91	12	5-35
	Green	7	3-18	4	2-9
	Olive Ridley	40	22-77	32	18-56

Table 50. Committee Alternative 6 (current fishery) - no model swordfish sets, in conjunction with tuna fishing with the recent time/area closure. Source PIFSC, McCracken 2003 *Estimation of Incidental Takes of Sea Turtles, Seabirds, and Marine Mammals in the Hawaii Longline Fishery, 2002*

Fishery Sector	Species	Total Interactions	Standard Error	Mortalities	Standard Error
Deep-set	Leatherback	6	8.3	2	NA
	Loggerhead	19	10.9	8	NA
	Green	3	7.9	3	NA
	Olive Ridley	31	12.7	29	NA

Table 51. Alternative 7 - no action, 1994-1999 FMP baseline.
Source: NMFS 2001 FEIS

Fishery Sector	Species	Total Interactions	Confidence Interval	Mortalities	Confidence Interval
Total	Leatherback	112	NA	9	NA
	Loggerhead	418	NA	87	NA
	Green	40	NA	5	NA
	Olive Ridley	146	NA	49	NA

The above impacts are summarized in Tables 52 and 53. For comparison purposes, the last row of each table presents data for the FMP baseline as presented in the (now invalidated) 2001 BiOp).

Table 52. Summary of total annual turtle interactions anticipated under the Committee Alternatives

Alternative	Leatherback	Loggerhead	Green	Olive Ridley
1 - 1,060 model swordfish sets, no time/area closure	28	13	8	45
2 - 1,560 model swordfish sets, no time/area closure	31	17	8	44
3 - 2,120 model swordfish sets, Palmyra EEZ open	26	21	8	44
4 - 2,120 model swordfish sets, no time/area closure (preferred alternative)	35	21	7	42
5 - 3,179 model swordfish sets, no time/area closure	42	29	7	40
6 - zero model swordfish sets, with southern time/area closure (current fishery)	6	19	3	31
7 - no action	112	418	40	146
FMP baseline interactions (1994-1998 annual average.)	112	418	40	146

Table 53. Summary of total annual turtle mortalities anticipated under the Committee Alternatives

Committee Alternative	Leatherback	Loggerhead	Green	Olive Ridley
1 - 1,060 model swordfish sets, no time/area closure	13	7	5	39
2 - 1,560 model swordfish sets, no time/area closure	13	8	5	37
3 - 2,120 model swordfish sets, Palmyra EEZ open	10	9	5	36
4 - 2,120 model swordfish sets, no time/area closure (preferred alternative)	14	9	4	35
5 - 3,179 model swordfish sets, no time/area closure	16	12	4	32
6 - zero model swordfish sets, with southern time/area closure (current fishery)	2	8	3	29
7 - no action	9	87	5	48
FMP Baseline (1994-1998 annual average)	9	87	5	48

Alternate mortality estimates for Committee Alternative 4 (preferred) are presented in Table 54. These are presented only for the purpose of allowing comparison of results using different research data and assumptions, as indicated in the footnotes to the table. They indicate another interpretation of the estimated post-hooking mortality rates under the preferred alternative.

Table 54. Committee Alternative 4 (preferred alternative) - 2,120 model swordfish sets annually, in conjunction with tuna fishing with no time/area closure, using post-hookng mortality rates based on observer and research data. Source: calculated by WPRFMC, see notes below for methodology

Fishery Sector	Species	Total Interactions	Immediate Mortalities	Delayed Mortalities of Lightly Hooked Turtles	Delayed Mortalities of Deeply Hooked Turtles	Total Mortalities
Shallow-set	Leatherback	16	1.88 [2] [8]	0.61 [1][9]	0.13 [1][10]	2.62[3]
	Loggerhead	17	0.22 [1][11]	0.36 [1][12]	2.71 [3][13]	3.29 [4]
	Green	2	0.19 [1][14]	0.09 [1][15]	0.89 [1][16]	1.17 [2]
	Olive Ridley	5	0	0.09 [2][17]	0.07 [1][18]	0.16 [1]
Deep-set	Leatherback	19	6.27 [7][1]	0.63 [1][2]	0	6.9 [7]
	Loggerhead	5	NA	NA	NA	4[3]
	Green	6	3[6]	0.15 [1][7]	0	3.15 [4]
	Olive Ridley	38	31.65 [32][4]	0.32 [1][5]	0	31.97 [32]
Total	Leatherback	35	8.15 [9]	1.24 [2]	0.13 [1]	9.52 [10]
	Loggerhead	21	NA	NA	NA	7.29 [8]
	Green	7	3	.41 [1]	0.89 [1]	3.31 [4]
	Olive Ridley	42	31.84 [32]	.24 [1]	0.07 [1]	33.14 [34]

Notes to calculations used in columns 4-7:

Figures in brackets [ ] represent estimates rounded up to nearest whole number. Actual (unrounded) numbers are presented to provide precise data on anticipated impacts.

Total interactions are as provided by NMFS in Table 54 above. Other totals are the sum of the deep and shallow-set fisheries calculations within this table.

Observer data is as presented in NMFS' (now invalidated) 2002 BiOp.

NA: these values could not be calculated due to the confounding factor that several observed interactions were on illegally shallow-set gear.

[1]Calculated as follows: 33% of observed interactions in the 1994-1999 tuna fishery were recorded by NMFS as immediate mortalities. 0.33 x 19 = 6.27 [7].

[2]Calculated as follows: 66% of observed interactions in the 1994-1999 tuna fishery were recorded by NMFS as lightly hooked or entangled. 0.66 x 19 = 12.54 [13] x 5% (0.05) delayed mortality factor = 0.627 [1].

[3] Calculated as follows: 75% of observed interactions for July 2001 through June 2002, a period in which only tuna-style longlining was permitted, are estimated to have died. This estimate is based on delayed mortality factors for lightly injured and deeply injured animals that have been criticized for being too high (see Appendix M) Furthermore, some of the observed interactions of loggerheads were made during shallow swordfish-style fishing sets. When attributed to tuna-style longline sets, these interactions overestimate the actual loggerhead mortality in the deep-set sector of the fishery.

[4]Calculated as follows: 83.3% of observed interactions in the 1994-1999 tuna fishery were recorded by NMFS as immediate mortalities. 0.833 x 38 = 31.654 [32].

[5]Calculated as follows: 16.6% of observed interactions in the 1994-1999 tuna fishery were recorded by NMFS as lightly hooked. 0.166 x 38 = 6.308 [7] x 5% (0.05) delayed mortality factor = 0.3154 [1].

[6]Calculated as follows: 50% of observed interactions in the 1994-1999 tuna fishery were recorded by NMFS as immediate mortalities. 0.5 x 6 = 3.

[7]Calculated as follows: 50% of observed interactions in the 1994-1999 tuna fishery were recorded by NMFS as lightly hooked. 0.5 x 6 = 3 x 5% (0.05) delayed mortality factor = 0.15 [1].

[8]Calculated as follows: 11.8% of observed interactions in the 1994-1999 swordfish fishery were recorded by NMFS as immediate mortalities. 0.118 x 16 = 1.888 [2].

[9]Calculated as follows: 76.4% of observed interactions in the 1994-1999 swordfish fishery were recorded by NMFS as lightly hooked or entangled. 0.764 x 16 = 12.224 [13] x 5% (0.05) delayed mortality factor = 0.6112 [1].

[10]Calculated as follows: 2.9% of observed interactions in the 1994-1999 swordfish fishery were recorded by NMFS as deeply hooked. 0.029 x 16 = 0.464 [1] x 29% (0.29) delayed mortality factor = 0.13456 [1].

[11]Calculated as follows: 1.3% of observed interactions in the 1994-1999 swordfish fishery were recorded by NMFS as immediate mortalities. 0.013 x 17 = 0.221 [1].

[12]Calculated as follows: 42% of observed interactions in the 1994-1999 swordfish fishery were recorded by NMFS as lightly injured. 0.42 x 17 = 7.14 [8] x 5% (0.05) delayed mortality factor = 0.357 [1].

[13]Calculated as follows: 55% of observed interactions in the 1994-1999 swordfish fishery were recorded by NMFS as deeply hooked. 0.55 x 17 = 9.35 [10] x 29% (0.29) delayed mortality factor = 2.7115 [3].

[14]Calculated as follows: 3.8% of observed interactions in the 1994-1999 swordfish fishery were recorded by NMFS as immediate mortalities. 0.038 x 5 = 0.19 [1].

[15]Calculated as follows: 34.6% of observed interactions in the 1994-1999 swordfish fishery were recorded by NMFS as lightly injured. 0.346 x 5 = 1.73 [2] x 5% (0.05) delayed mortality factor = 0.0865 [1].

[16]Calculated as follows: 61.5% of observed interactions in the 1994-1999 swordfish fishery were recorded by NMFS as deeply hooked. 0.615 x 5 = 3.075 [4] x 29% (0.29) delayed mortality factor = 0.89175 [1].

[17]Calculated as follows: 87.5% of observed interactions in the 1994-1999 swordfish fishery were recorded by NMFS as lightly injured. 0.875 x 2 = 1.75 [2] x 5% (0.05) delayed mortality factor = 0.0875 [1].

[18]Calculated as follows: 12.5% of observed interactions in the 1994-1999 swordfish fishery were recorded by NMFS as deeply hooked. 0.125 x 2 = 0.25 [1] x 29% (0.29) delayed mortality factor = 0.0725 [1].

The above mortality figures are conservative as they are derived by using methods which do not reflect the anticipated (but unquantified) reduction in the ratio of deeply to lightly hooked turtles expected to result as a result of requiring that circle hooks be used in the proposed model swordfish fishery.

As discussed in Section 7.0, estimates of leatherback and olive ridley interactions (and associated mortalities) in the above tables may be upwardly biased due to the mis-categorization of some past observed shallow-sets as deep-sets.

American Samoa-based longline fishery

Because NMFS does not have an observer program in place for the American-Samoa-based longline fishery, the only information available is from logbooks. For the American Samoa-based longline fishery, the federal logbooks from 1992 through 1999 indicate six interactions with sea turtles (i.e. hooking/entanglement). In 1992, one vessel interacted with a green turtle. In

1998, one vessel interacted with an unidentified sea turtle; it was released alive. In 1999, one vessel reported interactions with four sea turtles. Three turtles released alive were recorded as a hawksbill, a leatherback, and an olive ridley. One turtle, identified as a green, was reported to have died from its interaction with this vessel. None of the species' identification were validated by NMFS' Southwest Fisheries Science Center. NMFS cannot attest to the local knowledge of fishermen regarding the identity of various turtle species, particularly hard-shelled turtles. From 2000 through October 2002, there have been no reported interactions with sea turtles in this fishery (S. Pooley, NMFS, personal communication, October 2002). Based on logbooks from 1992 through 2001, it is apparent that this fishery takes sea turtles, but NMFS cannot quantitatively estimate the amount or extent of take of sea turtles by this fishery. Effort has greatly increased in this fishery in the last few years, but if a limited entry program is established as proposed in FMP Amendment 11, effort is unlikely to substantially increase in the future. Increases in effort are likely to result in potentially increased levels of incidental take of sea turtles; however on the 76 longline sets observed to date, there have been no observed interactions.

Other FMP longline fisheries

All alternatives, apart from Committee Alternative 6, would permit shallow set swordfish style fishing by vessels with a Western Pacific general longline permit. American Samoa longline vessels currently fish under a general permit, but a limited entry program for this fishery is currently nearing completion. American Samoa vessels could conceivably fish north of the equator and make shallow sets for swordfish. However, the American Samoa fleet targets primarily albacore tuna for the two canneries in Pago Pago. There is little to no market for fresh swordfish in Pago Pago, nor more importantly, easy access to markets elsewhere, unlike for the vessels that operate out of Hawaii. Two general longline permits have been issues to resident in Guam and in CNMI. Neither of these two permits are being used for active longline fishing in either location. Based on historical information for foreign longline vessels operating out of Guam, any longline fishing that might be conducted by U.S. vessels from the Mariana Islands would be deep sets for tuna. Of far greater concern is the likelihood that foreign vessels which tranship through Guam and CNMI (and American Samoa) are illegally fishing in US EEZ waters and potentially interacting with sea turtles. Such activities are likely as monitoring and enforcement levels are low in these areas. Vessels with a Western Pacific general longline permit may not land longline caught fish into Hawaii. Longline vessels with a general permit could conceivably fish using shallow sets to catch swordfish beyond the US EEZ around Hawaii and tranship to a Hawaii-based vessel with a receiving permit. However, there is no record of such an operation over the entire history of the Hawaii-based longline fishery.

Pelagics FMP troll fisheries

There have been no reported interactions with sea turtles in these fisheries. There is a chance, based on fishing methods including bait used and gear-type, that these fisheries do interact with sea turtles although the information is not reported. However, due to low effort and target-species selectivity of the gear, incidental take and mortality in these fisheries is likely minimal. Although the spatial distribution of trolling overlaps with the distribution of sea turtles there have been no reported interactions by vessel operators. In addition, sea turtles are not likely to interact with troll fishing gear because the gear is towed through the water faster than sea turtles may be traveling. Furthermore, sea turtles do not prey on the bait species used by the troll fisheries. A small potential exists that the fishing gear may incidentally hook or entangle a sea turtle when the gear is towed through the water. However, NMFS considers this type of an interaction extremely rare, and the lack of any reported interactions in this fishery may confirm this assessment, although, a lack of reported information does not necessarily equate to a lack of interactions. Therefore, incidental capture of sea turtles in these fisheries is expected to be rare and, due to the immediate retrieval of the gear, not likely to result in serious injury or mortality of the captured animal.

Pelagics FMP Pole-and-Line Fisheries

There have been no reported interactions with sea turtles in these fisheries. Although the distribution of the pole-and-line fishery overlaps with the distribution of sea turtles there is a very low likelihood of an interaction with a sea turtle because the turtle would need to be in the vicinity and the fisher would need to hook the animal or the animal would need to strike the hook. This type of an event is unlikely to occur because sea turtles are not likely to prey on the anchovy which is broadcast as bait and the activity of the fish feeding frenzy would deter turtles from remaining in the area.

Pelagics FMP Handline Fisheries

There have been no reported interactions between gear used in the handline fishery and sea turtles. Although there is the risk that sea turtles may become hooked or entangled in the fishing gear, any caught animal can be immediately dehooked or disentangled and released. Moreover, most turtles found in the area of the handline fisheries are not likely to prey on the baited hooks.

In addition to the above direct fishery impacts, the conservation and mitigation projects that are a part of all action alternatives are anticipated to beneficial impacts as indicated in Table 55. Conservation and mitigation actions, specifically sustained nesting beach management for turtles, have been shown worldwide to promote the long-term recovery of depleted turtle populations (Heppell 1997). This type of management initiative in Hawaii has led to a 30-year recovery of the Hawaiian green turtle (Balazs and Chaloupka in press) and, in the 1990s, to a more than10-year spectacular recovery of the olive ridley turtle in the Eastern Pacific. Moreover, simulation modeling of leatherback populations in the Eastern Pacific (Wetherall 1997) and Western Pacific (Milani Chaloupka, University of Queensland, pers. comm.) show the strong negative impact that egg harvests have on leatherback population recovery.

Of the five sea turtle species considered here, the population of Hawaii green sea turtles is increasing and olive ridley turtle nesting aggregation in the western Pacific appears to be somewhat stable or increasing slightly. In addition, there is no evidence that other factors such as fibropapillomatosis is affecting the Hawaiian green sea turtle recovery (Balazs & Chaloupka 2003). Cutaneous fibropapillomatosis is a major epizootic disease which affects a variety of sea turtles. The predominant lesions associated with this disease are a variety of tumors, namely fibromas, cutaneous papillomas and fibropapillomas. Because it has been reported primarily in green turtles, this disease has been designated green turtle fibropapillomatosis (GTFP) (George

1997) On the other hand, leatherback and loggerhead turtles are the species most often captured by the Hawaii-based longline fishery and are in general declining. For that reason, these species are the focus of the mitigation and conservation measures.

Nesting beach management includes protection of nesting females from being harmed or disturbed while digging nests and laying eggs and protection of the nests from human harvest and feral predation until the hatchlings emerge. Such activities are entirely consistent with the US Sea Turtle Recovery Plans, which includes the following among the de-listing criteria: “protect and manage turtles on nesting beaches, protect and manage nesting habitats, eliminate directed take of turtles and their eggs, and protect and manage populations in marine habitats” (Anon. 1998).

The use of conservation measures is also consistent with the objectives of international collaborative efforts to recover sea turtles. A recent international high level meeting co-sponsored by NMFS at the Rockefeller Foundation Bellagio Conference Center[4], was convened, among other primary objectives, to gain international acceptance of offsetting conservation measures such as those presented here. Meeting attendees included representatives from the US Department of State as well as renowned scientists with expertise in sea turtle biology, conservation and recovery. Attendees reviewed numerous papers, the majority of which spoke to the need for international conservation projects aimed at protecting nesting beaches to both offset fishery impacts and to successfully recover populations. Particularly relevant is Dutton and Squires' draft paper "Reconciling Fishing with Biodiversity: A Comprehensive Approach to the Recovery of Pacific Sea Turtles" (Appendix O) which concludes that "in order to reconcile continued fishing with sea turtle recovery, it will be necessary to adopt a comprehensive approach that goes beyond merely reducing fishery bycatch mortality of sea turtles...if fishing is to continue and sea turtle populations are to recover, some important building blocks of a comprehensive recovery strategy including offsets (such as nesting site and other habitat protection, community involvement in conservation, or financing of adoption of technology standards by developing countries fleets); technology standards to reduce bycatch of sea turtles; possibly performance standards; side payments to increase participation and compliance, to equitably distribute the burdens, and to finance offsets and adoption of technology standards in developing nations; and trade restrictions to provide positive economic incentives for responsible fishing and negative economic incentives to deter destructive fishing practices, and also to plug trade leakages." The meeting's draft report contains a similar recommendation to ‘promote a broad set of sea turtle conservation initiatives to offset all sources of fisheries related turtle mortality.’

Cited as positive examples were US Pacific coast fishermen who have adopted a nesting beach to protect nesting females and their eggs, and pelagic longline fishermen who are working with a conservation group to adopt a leatherback nesting beach in Baja California, Mexico. Fishermen

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4 Conservation and Sustainable Management of Sea Turtles in the Pacific Ocean, Rockerfeller Foundation Study and Conference Center, Bellagio , Italy, November 17-22, 2003.

are providing funding to allow this conservation group, working in conjunction with Mexican authorities and local communities, to provide security for eggs and nesting females from poachers and animal predators and to protect and improve nesting habitat, thereby increasing the success and survivor rate of egg laying and hatchlings.

Besides being consistent with previous actions the inclusion of conservation measures as part of this document's preferred alternative is consistent with the provisions of the Endangered Species Act in terms of providing beneficial measures to mitigate adverse effects of the action. Section 7 of the ESA requires federal agencies to consult with NMFS (or the FWS as appropriate) prior to undertaking any action that may affect listed species or their designated critical habitat. When the action is expected to have significant adverse effects on the listed species or habitat, the action agency and applicant may agree to include in the proposed action conservation measures that mitigate for such adverse effects, allowing the relevant Service to reach a "no jeopardy" conclusion in its Biological Opinion.

Under the conservation measures, the Council will continue to collaborate with NMFS to develop and fund contracts with relevant NGO's such as World Wildlife Fund - Indonesia (WWF-Indo), Village Development Trust (VDT) of Papua New Guinea, or the Sea Turtle Association of Japan. These conservation measures have come directly from these NGOs currently working at relevant sites conducting research and population monitoring activities. It is their contention that with additional funding and program support, additional conservation benefits can be attained. These projects are new, but cost estimates are dependent on preexisting programs. See Section 8.2 for a complete description of these projects and Appendix P for specific proposals that have been submitted to date for these measures.

It is important to note that numbers do not always tell the whole story in the world of conservation projects. Conduction of projects can and do often have high spin-off value in regards to raising awareness level, education, and providing multiplier effects that generate other worthwhile actions including the establishment of valuable and collaborative working relationships. The number of turtles theoretically saved should be viewed in context with the establishment of positive, but unquantifiable, working relationships, which are essential toward integrated management efforts to achieve recovery of shared international sea turtle resources.

The conservation and mitigation measures described here will provide benefits in both the immediate and long-term (Table 55). Those measures which directly conserve adults or juvenile turtles are considered to provide both immediate and long-term conservation benefits to the population, whereas those which direct efforts toward habitat, nest and/or egg protection are considered to have long-term population benefits. Calculations are based on conservative assumptions made by NMFS based on available data that indicate that up to 1,000 eggs may be needed to produce 1 adult turtle, leatherback nests average 85 eggs per nest, and loggerhead nests average 125 eggs per nest (Appendix Q).

Table 55. Impacts of conservation and mitigation measures included in all action alternatives

Measure	Value	Benefit
Leatherback turtles		
Irian Jaya, War-mon Beach Nest protection, poaching reduction	90-100% beach protection ~ 1,000 nests = ~ 85,000 eggs = ~ 85 adults, AND an additional ~ 10 nesting turtles	Immediate and long-term benefits
Irian Jaya Coastal Foraging Grounds Reduce and/or eliminate harvest/ harpooning of turtles	~ 100 leatherback adult turtles	Immediate and long-term benefits
PNG Kamiali community Nest protection	90% additional beach protection ~ 1,000 to 1,500 nests = ~ 85,000 to 127,500 eggs = ~ 85 to 127 adults	Long-term benefits
Loggerhead turtles		
Baja, Mexico Halibut Gillnet fishery Fishermen workshops and place observers on boats	~ 300 Japanese loggerhead juveniles	Immediate and long-term benefits
Japan Nesting Beaches Nest and hatchling protection	~ 53 nests = ~ 6,625 eggs = ~ 6.6 adults Plus valuable cooperative working relationships	Long-term benefits

10.6 Population impacts under the preferred alternative

10.6.1 Discussion of methodologies for assessing population impacts

In the early 1990s NMFS initiated the development of a turtle population simulation model (TURTSIM) (Wetherall 1997) to analyse impacts on sea turtle populations through interactions with the Hawaii-based longline fishery. One simulation computed the equilibrium state of a population under a given set of biological parameters for any given incidental take, and a second simulation analyzed the annual dynamics of specific turtle populations affected by human activities over time with specified life history parameters.

The TURTSIM model predicted very low mortality rates for interactions between the Hawaii-based longline fleet and leatherback or loggerhead turtles and there was no discernable change in the population trajectories if the fishery was increased fivefold or remained at the same level. These conclusions are similar to those reached by Chaloupka (see below). These predictions were based on observer records of turtle mortalities, which are very rare. Wetherall noted the limitations of working without complete data on other sources of mortality, e.g. direct harvest of eggs and nesting females etc. Although the TURTSIM model was used by NMFS in the 1998 BiOp, it was subsequently abandoned and efforts were put into a suite of models created under contract by Dr. Milani Chaloupka.

In the interim, a conceptual model based on a life history approach was used in the 2001 and 2002 BiOps. This approach examines the demography of sea turtles and uses this information to qualitatively assess whether a given action would jeopardize the ongoing existence of sea turtle populations.

As compared to conceptual models, mathematical population models are transparent because they are easily documented with the equations and computer code presented for review. While there may be assumptions inherent in the construction of mathematical models, these can be easily tested for their influence on the sensitivity of the model. Conceptual models lack the same degree of transparency unless all steps are taken to show how decisions are arrived at are thoroughly documented (including providing data sources, model parameterization information and numerical output). Moreover, the potential for subjective decision making is greater with conceptual models since the modeling exercise relies to a much greater degree on personal judgement, and cannot be subjected to sensitivity analysis.

Although not yet utilized in its BiOps, NMFS has conducted several internal reviews of the Chaloupka model to date. A summary report of the May 6-7, 2003 Workshop on the Use of Population Models in Conservation of Sea Turtles under review by NMFS and expected to be released shortly.

An independent review by the Centre for Environment, Fisheries and Aquaculture Science (Appendix R) found that the Chaloupka model appeared to be the best model currently available for species recovery and fishery management. The TURTSIM model which was reviewed in the same document, appeared suitable for the specific purpose of examining the influence of various anthropogenic factors on the eastern Pacific leatherback population, but the model would have to be extensively reworked if it was to be applied to western Pacific leatherback populations.

An independent review by Taylor of the Southwest Fisheries Science Center's La Jolla Laboratory's Protected Resources Division (Appendix S) was critical of the Chaloupaka model, concluding that it was opaque, complex and an inappropriate tool for management decision regarding the effects of the longline fishery. However, this conclusion was not supported by S. Hepell who provided an independent review to NMFS (Appendix T). Hepell noted the weaknesses of the data available to modelers, but concluded the model itself has the potential to serve as a key component in a suite of analytical tools to assess the viability of sea turtle populations.

10.7 Assessment of impacts under the preferred alternative

The Chaloupka model has been used by the Council and the Hawaii Longline Association to assess the impacts of the Hawaii-based longline fishery under the preferred alternative (Appendix U). That evaluation indicated there would be no detectable marginal impact on stock abundance of Hawaiian green turtles and Pacific olive ridley turtles from the preferred alternative. In addition, the anticipated interactions and mortalities of Japanese loggerhead turtles under the preferred alternative would have no detectable impact on stock abundance. The marginal effect of the anticipated interactions and mortalities for the western Pacific leatherback stock(s) was evaluated against the expected steady-state stock abundance assuming no exposure to any other anthropogenic hazards, and there was no detectable marginal effect due to the loss of 25 or 30 adult leatherbacks per annum on the western Pacific leatherback stock under the preferred alternative. In conclusion, the model found that the preferred alternative would have no discernable effect on any of the stocks of sea turtles which interact with FMP fisheries. As stated above, this model focuses only on the impact of fishery interactions, not included are the beneficial impacts of the proposed conservation measures. Please note that this memo references slightly different estimates of anticipated interactions and mortalities than those presented here. This was due to the late discovery of a calculation error (now corrected). Dr. Chaloupka has confirmed that the difference between the values presented in his memo and the corrected values presented here is too small to have any detectable impact (M. Chaloupka pers. com to Tony Beeching Oct. 9, 2003). No quantitative evaluations of the rejected alternatives have been conducted to date, however those alternatives with lower anticipated interaction levels would be expected to have equally negligible effect, while those with higher interaction levels would have increased effects.

A criticism of the original Chaloupka model was that it simulates a complex system of biological and ecological relationships of which there is limited real knowledge and thus must rely on many assumptions which, especially when using model output with confidence limits, may convey a false sense of precision. Recommendations have been to use a range of input assumptions, rather than relying on a single “best guess” assumption, and to avoid basing conclusions or inferences on the statistical properties of the stochastic model output. The following analysis thus considers a range of scenarios with different input assumptions to help dispel this false sense.

The approach used here was to use two variants of the model for each species: 1) the model as supplied by the contractor after substantial review, contribution from an expert workshop, and minor alterations; and 2) a more conservative version assuming lower population sizes, and much greater fishery impacts. The model versions were altered to better reflect observed declines in numbers of nesting turtles, and by increasing the mortality attributed to fisheries, as described below. The intent of the alteration was to consider “safer guess” or more pessimistic scenarios with the perspective that turtle populations are rapidly approaching extinction with fisheries contributing substantially to the decline (Spotilla et al., 1996; 2000). This viewpoint is not reflected well in the original model, or universally accepted by turtle experts (Pritchard, 1996). The use of two model versions: 1) a larger population model (very similar to the original Chaloupka model); and 2) a small population model with greater fishing mortality (F) incorporates a range of expert opinion on the status of turtle populations in relation to fishery impacts.

The leatherback model simulates the population dynamics of turtles in Malaysia (Terengganu, metapopulation A) and in Indonesia and the rest of the western Pacific (metapopulation B). In both versions of the western Pacific leatherback model, Malaysian nesting ends by 2000, and the model effectively represents metapopulation B nesters, including well documented nesters in Indonesia (Jamursba Medi) plus poorly documented nesters in nearby Papua New Guinea, the Solomon Islands, and other western Pacific Islands. The Loggerhead model simulates the North Pacific Population nesting in Japan. In each model version the decline of turtle populations results from the onset of competing anthropogenic sources of turtle mortality at various life stages. In the model versions explored here the variable causes of turtle mortality are primarily egg harvesting, coastal fishing, longline fishing, or loss of nesting habitat. Other sources of mortality are included in the models from start to finish without trend (i.e. beach washover, egg predation) or were not explored here (i.e. temperature effects were excluded in these simulations)[5]. In both the larger and small population model versions for both species the populations rebound if all anthropogenic impacts cease, suggesting that these populations can be saved. However, in all the models, if the cumulative effects continue, the simulated populations go extinct.

In this analysis, the models are used to illustrate possible effects of a restored Hawaii-based swordfish fishery operating at the historical rate with traditional gear, the effects of operating at 50% of the historical rate using gear that reduces loggerhead and leatherback take by 92 and 67% (respectively), and the effects of the proposed conservation measures (Table 57). Effects are illustrated as percentage decreases or increases in the numbers of future nesters one turtle generation in the future (*circa* 2020 for leatherbacks and 2040 for loggerheads). Model output for rejected alternatives is not available, however alternatives with lower levels of swordfishing can be inferred to have reduced impacts compared to those presented for the preferred alternative, while those with higher levels of swordfishing can be expected to have higher impacts.

Leatherback turtle population models

The "best guess" larger population model for western Pacific leatherback turtles (Chaloupka 2002a, b) simulates the virtual disappearance of Malaysian (metapopulation A) nesting by the year 2000 as has been observed (Liew, 2002). This model simulates a decline in metapopulation B nesters (from Indonesia, Papua New Guinea, and other locations) from a peak of nearly 8,000 in the early 1980s to around 2,500 in the early 2000s (Figure 4). All the models assume density dependence, with simulated female turtles increasing their re-migration rate as egg harvesting reduces the number of young turtles. The number of nesters oscillates whenever a major change

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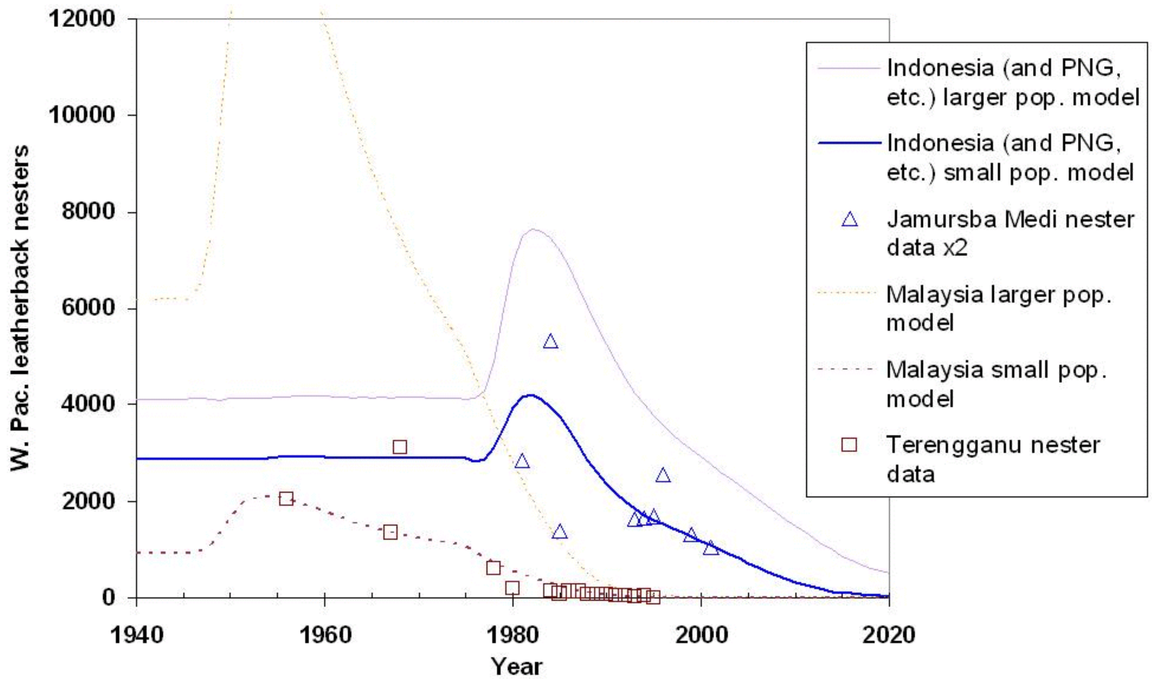
[5]Temperature effects on nesting beaches may have contributed greatly to population declines, particularly for the virtually extinct Malaysian leatherback population (Chaloupka 2002b). For the other populations (leatherback metapopulation B and loggerheads) temperature effects are uncertain, and in the scenarios explored here the population declines were assumed to be due to other causes.

Figure 4. Larger population and small population (with greater F) versions of the western Pacific leatherback turtle metapopulation model compared with observed data.

in egg harvest is simulated, with nesters increasing with increased harvest as there are fewer recruits, and then decreasing as recruitment increases due to increased nesting. Simulated peaks



in Malaysian nesters in the 1950's and Indonesia and etc. (metapopulation B) nesters in the 1980s (Figure 4) are the density-dependent response to initiation of major egg harvesting.

Each model includes 2 nester trajectories: Malaysia (metapopulation A); and Indonesia, Papua New Guinea (PNG) and other western Pacific nesters (metapopulation B). The small population model with greater fishing mortality (F) was adjusted to match the observed nester data from Malaysia (Terangganu data from Chan and Liew 1996), and Indonesia (data for Jamursba Medi Indonesia from Hitipeuw and Maturbongs 2002). It was assumed that metapopulation B nesters amount to about twice the observed number of nesters at Jamursba Medi Beach.

The "safer guess" small population model for leatherbacks assumes that less of the population decline is due to egg harvest, and more of the decline is due to fishing. Adjusting egg harvests, fishing mortality, and population size was an iterative process conducted to achieve a reasonable match to the observed nester trends (Chan and Liew, 1996; Hitipeuw and Maturbongs, 2002) while producing a model with increased fishing mortality and smaller population size (Figure 4). The simulated peaks in Malaysian nesters in the 1950's and Indonesian nesters in the 1980s are again the density-dependent response to egg harvesting. Since the Malaysia nesters are gone, metapopulation B effectively represents all western Pacific nesters. Poorly documented nesting occurs at seldom-observed beaches in Papua New Guinea, the Solomon Islands, and elsewhere in the Western Pacific (NMFS 1998-leatherback recovery plan; Hitipeuw and Maturbongs, 2002; Philip, 2002). It was assumed that the metapopulation B trend is about double the observed time series at Jamursba Medi Beach in Papua (formerly Irian Jaya) Indonesia. For the small population leatherback model, simulated total western Pacific nesting declines from a peak of about 4,000 nesters in the early 1980s to a little over 1,000 nesters *circa* the year 2000 (Figure 4). This seems very reasonable considering that recent nesters at Jamursba Medi in Indonesia (i.e. 450-600, Hitipeuw and Maturbongs 2002) and along the Morobe coast of Papua New Guinea (250, Philip 2002) alone total 700-850 nesters. The small population model simulates a population about half as numerous as the larger population model in the late 1990's, and less than 1/3 as numerous as the larger population model at the initiation date for the preferred alternative (ca. 2004-5). Both models predict the disappearance of nesters within a few decades - by about 2040 with the larger population model and by about 2030 with the small population model.

Loggerhead turtle population models

The larger population model for North Pacific loggerhead turtles (Chaloupka 2002c, d) shows the least decline in nesters among all of the models considered here (Figure 5). The simulation shows nesters starting at a historical level of around 4,000 then oscillating with 30-year period (ca. 1 loggerhead generation) as a density dependent response to the onset of egg harvesting in mid-century.

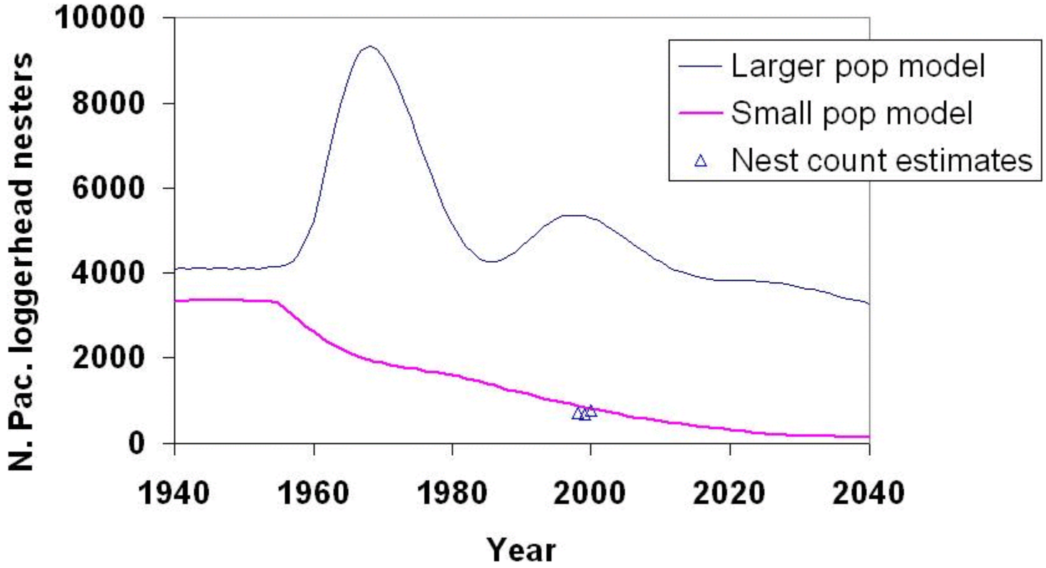


Figure 5. Larger population and small population (with greater F) versions of the North Pacific loggerhead turtle population model.

The larger population model shows density dependent occilations triggered by egg harvesting. The small population model with greater fishing mortality (F) replaces egg harvest with beach loss, and includes higher levels of mortality from longline and coastal fishing. These parameters were adjusted to match observed nest count data from Suganuma (2002). Similar 30-year oscillations are evident in real nesting trends recorded at Kamouda (Gamoda, Figure 6; NMFS 2002 BiOp; Suganuma 2002), a nesting site in Japan that has been monitored continuously since 1954. The periodicity of the cycle suggests an upturn in nesting should be anticipated, and more recent data on a handful of nesting sites show increased nesting (Figure 7, Sea Turtle Association of Japan website http://www4.osk.3web.ne.jp/~umigame/E/ETop.html). In keeping with a

precautionary approach, neither of the loggerhead models incorporates this recent increase in nesting. The larger population model simulates about 5,000 nesters in the year 2000, as nesting reaches the peak of a cycle, and then nesting declines to about 3,300 nesters a generation after the preferred alternative. Nesting continues to slowly decline, and is projected to cease in the year 2255.

The "safer guess" small population model for loggerheads re-examines the anthropogenic impacts, placing greater emphasis on nesting habitat loss and fishing mortality than the larger population model, and assuming a smaller initial population size. Adjusting egg harvests, beach loss, fishing mortality, and population size was an iterative process conducted to create a declining nester trajectory (Figure 6) that intersects with recent nester estimates based on nest count data (Suganuma 2002, Table 56) Nest counts were divided by a ratio of 3.4 nests per nester (Wetherall and Balazs, 1991) to provide estimates of 663-761 nesters in 1998-2000. Only a small amount of nesting occurs outside of Japan. The longest continuous time series of nest counts from Kamouda (Gamoda, Figure 6) suggests that nest counts in the late 1950's and early 1960's were 2-3 times higher than in the late 1980's. The iterative adjustment of model parameters produced a nester trajectory that declines from about 3,300 nesters in 1955 to about 800 nesters in the year 2000 (Figure 5). The small population model for loggerheads simulates a population about 20% smaller than the larger population model in the 1940s, and 86% smaller at the initiation date for the preferred alternative (ca. 2004-5). Although the larger simulated population persists for several more centuries, the small simulated population ceases nesting in about 2065.

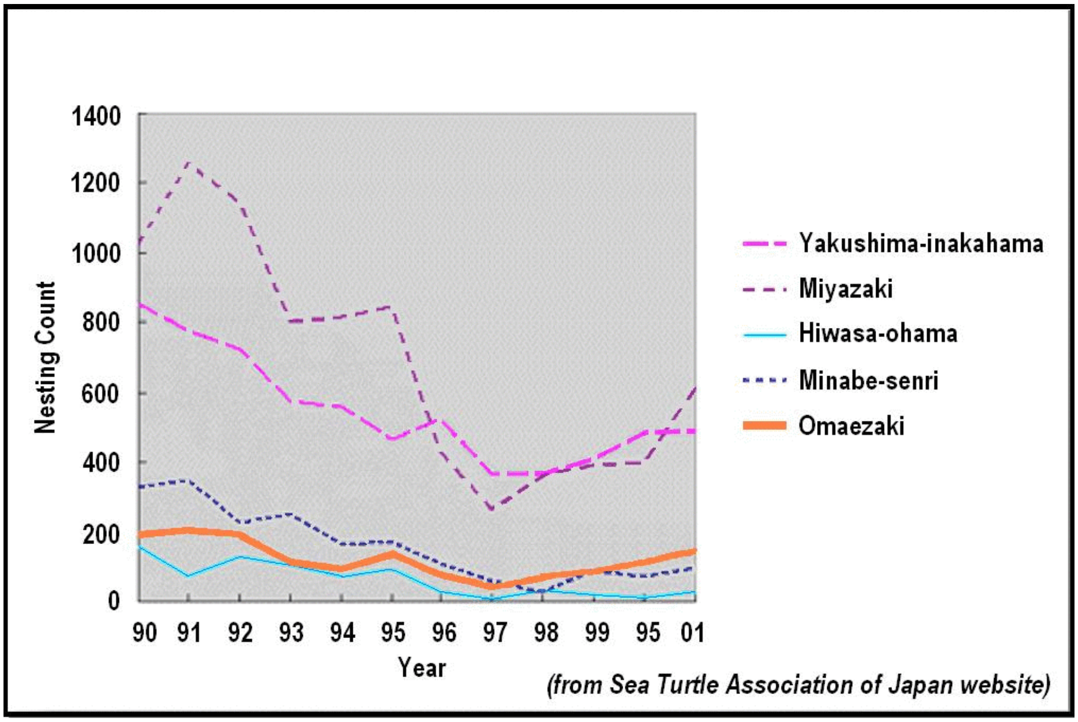


Figure 6. Loggerhead nest count data from beaches in Japan, with the longest continuous series showing a thirty year cycle similar to that simulated for nesters in the larger population model (NMFS 2002 BiOp).

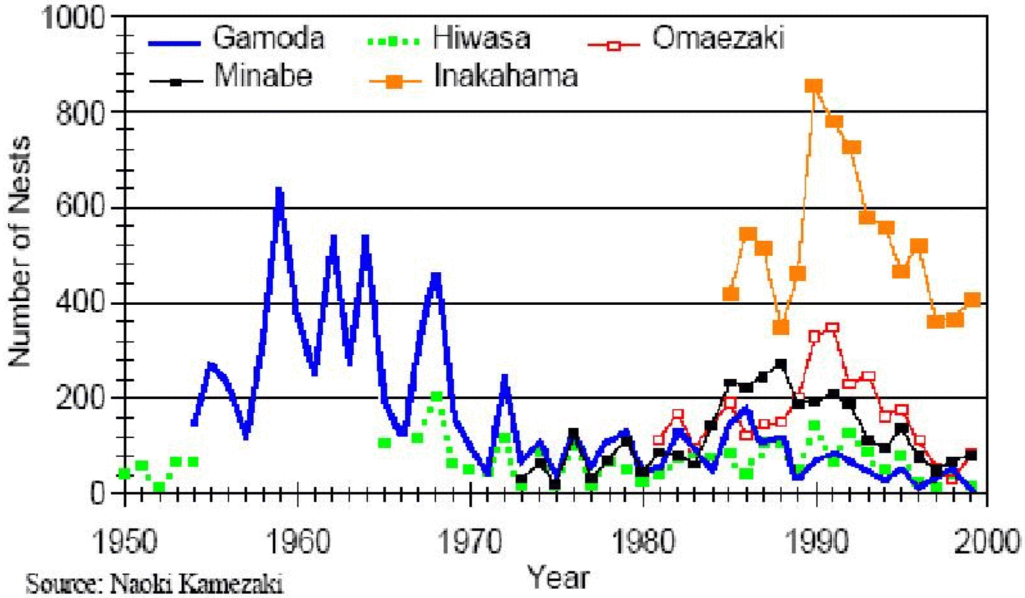


Figure 7. Updated loggerhead nest count data from beaches in Japan, with most of the beaches showing an upward trend in numbers of nests over the last several years (http://www4.osk.3web.ne.jp/~umigame/E/ETop.html).

Table 56. Total loggerhead nest counts for all of Japan from Sugnauma (2002) and derived estimates of the number of loggerhead nesters.

Nesting Season	No. of Nests (Suganuma 2002)	Estimated No. of Nesters based on 3.4 nests/nester (Wetherall and Balazs, 1991)
1998	2,479	729
1999	2,255	663
2000	2,589	761

Egg harvest and beach loss impacts

The Chaloupka model for leatherback turtles provides example egg harvests of 90% for the Malaysian (Terangganu) metapopulation and 75% for the rest of the western Pacific. These values for egg harvest are used in the larger population (best guess) model for western Pacific leatherback turtles. The destruction of nesting habitat is left at default values in all versions of the leatherback turtle models. The default model parameters and impacts that were not modified or discussed here are described in model documentation (Chaloupka 2002a, b). Leatherback egg harvesting was simulated to end in Malaysia in 2000 when turtles stopped nesting there. The World Wildlife Fund (WWF) has initiated work to reduce egg harvesting in Indonesia (Hitipeuw and Maturbongs 2002) but has not been able to maintain a presence on site in all years, and so the model assumes egg harvests are continuing. The National Marine Fisheries Service and the Western Pacific Regional Fisheries Management Council have initiated activities to support and extend WWF nest protection activities in Indonesia, Papua New Guinea, and other Western Pacific nesting sites (WPRFMC Emergency Rule Package October 2003). Egg harvesting could be largely controlled, as has been successfully achieved at many Atlantic nesting beaches (Reichart and Fretey 1993, Girondot 1996, Dutton et al. 1996) and at Playa Grande (Spotilla et al. 2000).

The small population model for leatherbacks assumes that less of the population decline is due to egg harvest, and more of the decline is due to fishing mortality. Simulated fishing mortality was increased (below) and egg harvest reduced so that the simulated nester decline rate matched the observed rate, and population size was adjusted so that simulated nesters matched the observed number (Figure 4). Egg harvests were set at 80% for Malaysia and 50% for the rest of the western Pacific nesting population.

North Pacific loggerhead turtles may be less subject to egg harvest than western Pacific leatherbacks. The Chaloupka model documentation on North Pacific loggerheads presents an example using 90% egg harvest, but notes that real information on egg harvest is lacking. A lower level of egg harvesting (75%) was assumed in both loggerhead models used in this EIS. In the larger population model a continuous egg harvest of 75% is initiated in the default start year (1945). This perturbation is responsible for the simulated 30-year oscillations in nesters that bear a resemblance to the observed trend at Kamouda (Figure 6). These oscillations dampen over time (Figure 5).

According to Suganuma (2002) egg harvesting was a traditional practice that is no longer occurring in Japan, where nesting is now impacted mostly by the impairment of beach habitat. Sea walls have been constructed that block nester access to beaches, nestling access to the water, and which cause nesting sites to be eroded. Buildings and roads built near beaches have also resulted in artifical lighting and other disturbances to nesters. For the safer guess, small population model it was assumed that traditional egg harvesting at 75% began in 1800 (the start date for all of the simulations) and was reduced by 80% in 1965. The Chaloupka model parameter for beach loss was modified to have a start and end date, and beach loss was set to start when egg harvest was reduced in 1965. The level of beach loss was increased 5-fold to cause the same egg survival probability as was previously caused by egg harvest. The small population simulation (Figure 5) does not show density dependent oscillations in recent years like those in the larger population model because the initial perturbation occurs in 1800. The change in 1965 does not cause a new perturbation because the reduced egg harvest is supplanted by beach loss.

Fishery impacts

Information is scant on the numbers of sea turtles taken by Pacific Fisheries other than the U.S. longline fishery. A questionnaire-based survey of fishery research and training vessels fishing with tuna longline, bottom trawl, drift nets and other gear was conducted in the late 1980's (Nishemura and Nakahigashi 1990). Responses to the questions were received from 41 vessels reporting turtles sighted, captured, location, whether the turtles were alive or dead, and few other details. The results of the questionaire were not broken down by gear type. The question about catches requested numbers caught "in recent years" which could mean over several years rather than per year. Despite problems with the methodology this study is among the very few available that gives any information on other fisheries and it is quoted whenever the subject is addressed.

Based on the survey, and unspecified data from longline logbooks and from research vessels of the Kagoshima Fisheries University, Nishemura and Nakahigashi (1990) estimated a longline capture rate of 0.1 turtles (all species) per 1,000 longline hooks, and a Pacific-wide longline catch of 40,000 turtles (all species) per year. The turtles were not distributed uniformly, which could result in problems extrapolating to the entire Pacific. Thus, the authors refined their calculations to represent only the area surveyed (20 S to 50 N, Western Pacific and South China Sea only) resulting in an estimated 21,200 captures per year. Mortality was estimated at 42% (0.042 deaths per 1,000 hooks, 16,800 deaths Pacific-wide, and 12,300 deaths west of 140 W). Many turtles sighted or captured (19%) were not identified to species. Based on other studies (McCracken 2000, OFP 2001) the species most frequently caught on longlines in tropical waters is the olive ridley, which was seldom (<2%) identified by survey respondents. The survey information indicates that about 36% of turtles sighted or captured were loggerheads, 19% were greens, and 14% were leatherbacks. These data were not provided by gear type, but about a third of the loggerheads were reported in the "East China" sea which is described as primarily a bottom trawl fishing ground. About a third of the responding vessels fished bottom trawls and half fished tuna longlines. The reported longline fishing depth of 0-50 meters does not describe typical tuna longline, and together with the high number of loggerheads and low number of olive ridleys the capture data are more similar to shallow, high latitude, swordfish-style longline fishing than to tropical tuna longline fishing. Is not possible to accurately estimate the species of turtles taken or the take rate for tuna-style longline gear from the data in this paper.

Fishery observer data on the turtle bycatch by international longline fisheries in the southwestern Pacific (OFP 2001) indicates very few loggerhead turtles captured, with most captures being olive ridleys and greens, along with some leatherbacks. Despite a predominance of observer coverage at high latitudes, most of the turtle captures (0.039 turtles/1,000 hooks) occurred in equatorial waters (10° N - 10° S) at about 40% of the rate estimated by Nishemura and Nakahigashi (1990). The rate was an order of magnitude less at higher latitudes (10-35 S, 0.003 turtles/1,000 hooks) and almost two orders of magnitude less at the highest latitudes (>35° S, 0.00067/1,000 hooks).   Assuming an average mortality rate of about 40% for all species combined[6] the mortality rates for captures in the OFP report would be 0.016 deaths/1,000 hooks, 0.0012 deaths/1,000 hooks (10°-35° S) and 0.00027 deaths /1,000 hooks from low to high latitudes, respectively. Gear depth was the most important factor affecting turtle bycatch in the OFP report, with more turtles caught on the shallower hooks closer to floats. This depth effect may explain why the survey estimates (Nishemura and Nakahigashi 1990) based on shallow-fishing longliners were so high.

The Chaloupka models were parameterized to incorporate the available information and the impressions of model workshop participants regarding fishing impacts on sea turtle populations (Chaloupka 2002b; 2002d). Three major fisheries are included in the models, high seas drift-gillnet fishing, coastal fishing (including trawling and other coastal fisheries such as the Kei Islands harpoon fishery), and longline fishing. The model versions used in this EIS frequently retain the default Chaloupka model parameters for the capture and mortality of turtles in fisheries other than the Hawaii-based longline fishery, especially in the case of the larger population models. Revisions were made to more precisely match Hawaii-based fishing mortality. All model revisions were designed to match mortality estimates, rather than capture estimates, because the models assign no effect to non-fatal captures.

The default values for fishing intensity and the resulting impacts in terms of turtle mortalities were used in the larger population model for leatherback sea turtles (Figure 4). The intensity of each major fishery (drift net, coastal, longline) is a constant in each model except for start date and duration, and the ability to reduce fishing intensity once in each simulated series. The latter is an added function of the models (details avalable from Chris Boggs, NMFS PIFSC, Honolulu Hawaii). Except at these times fishing intensity stays the same. The intensity is analogous to the fraction of the turtle population that is vulnerable to the fishery, so although it may not change, the resulting turtle mortality is proportional to the abundance of each age-class impacted by the fishery. As the population number and age structure change, the numbers of mortalities change. In the larger population model for leatherbacks, simulated mortalities due to drift net impacts declined from about 400 to about 200 per year in the 1980s as the simulated population declined. The last year of the fishery was 1991, after which the United Nations banned this mode of fishing on the high seas. Impacts from the Hawaii-based longline fishery reflect the midpoint of a fishery observer data series from 1994 (incomplete year) through 1999, and the approximate midpoint of this series (1997, rounded up) is an interesting date for comparing Hawaii impacts with other cumulative impacts.   Hawaii longline fishery impacts averaged 41 leatherbacks mortalities per year[7]. Simulated coastal fishing impacts vary from about 820 mortalities in 1985

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[6]Based on the ratio of take to estimated mortality for the old, pre-2000, shallow- and deep-fishing Hawaii fishery (March 29 2001 BiOp Table IV-15) with post-release mortality estimated according to NMFS policy.

[7]Take estimated as 112 leatherbacks/year (1994-99) for the historical Hawaii-based fishery (March 29 2001 BiOp Table IV-7) with mortality assumed to be 36.6% = 41 leatherbacks (from estimates in March 29 2001 BiOp Table IV-15).

to 370 mortalities (9 times the Hawaii impact) in 1997 according to the larger population model. Simulated non-Hawaii longline impacts vary from 230 mortalities in 1985 to117 mortalities (about 3 times the Hawaii impact) in 1997. This seems a bit low for the relative impact of all international longline fishing, as addressed in the small population model (below). All non-Hawaii fishing combined is simulated to have about 12 times the impact as Hawaii fishing. The impact of all three major fisheries (drift net, coastal, and non-Hawaii longline) when all three were active in the mid-1980s is simulated to be about 1,300 leatherback deaths per year with the larger population model.

The small population model with greater F increases the intensity of longline fishing 5-fold, although the impact in terms of the number of mortalities is not increased this much because the population is reduced and there are fewer turtles available to be caught. The total international longline fishing effort impacting the western Pacific nesting leatherback population[8] amounts to about 28 times the effort of the Hawaii-based fleet in the same period. Studies have shown that leatherbacks are taken by longline fishing at similar rates at both low and high latitudes (McCracken 2000, OFP 2001)[9] so it seems reasonable to extrapolate Hawaii mortalities over this larger fishery. Take by the old (pre-2000, shallow- and deep-set) Hawaii longline fishery amounted to an average of 112 leatherbacks per year (March 29 BiOp Table IV-7) caught on 15.5 million hooks (Ito and Machado 2001 H-01-07). One could simply extrapolate this take by a factor of 28 times to estimate international longline impacts. However, most of the longline fishing effort throughout the Pacific uses deep set, tuna-style fishing methods. The overall Hawaii take rate of 112/15,500,000 = 0.0072 leatherbacks per 1,000 hooks is about 2.9 times the take rate by Hawaii deep-set tuna-style fishing gear[10]. Therefore, a better factor for extrapolation would be 28/2.9 or about 9.7 times the Hawaii take. On this basis the international longline fleets might be causing the deaths of about 9.7 x 41 = 398 leatherback turtles per year. The small population model with greater F for leatherbacks simulates about 780 non-Hawaii longline deaths in 1985 and about 410 in 1997, or about 10 times the mortality caused by the Hawaii-based longline fishery. The model increases the intensity of coastal fishing by a factor of 2.25 which is just enough to keep the mortality due to coastal fishing at the same level as in the larger population model. Combined, international fishing is simulated to result in the deaths of 19 times more leatherbacks than the old Hawaii-based fishery in 1997. The impact of all three

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[8] Approximately 440 million hooks for longline fishing effort in the Pacific (SPC online database) excluding the SE Pacific (South of the equator and east of 140 W) which is mostly frequented by turtles from the eastern Pacific nesting population.

[9] There appears to be a band of reduced interaction with loggerheads in middle latitudes, between 15 and 25 N, at least in the central North Pacific, but interaction rates below and above this range appear similar.

[10] The Based on data in the March 29 2001 BiOp, 6 leatherbacks were caught by deep-set tuna-style fishing (Table IV-13) on 1440 observed sets (p. 106) averaging 1,690 hooks per set (Table IV-12) at a rate of 6/(1440*1690) = 0.0025/1,000 hooks. The overall rate (deep- and shallow-set combined) of 112 leatherbacks/15,500,000 hooks = 0.0072/1,000 hooks is 2.88 times the deep-set rate.

major fisheries (drift gillnet, coastal, and non-Hawaii longline) when all three were active in the mid-1980s is simulated to be about 1,800 leatherback deaths per year with the small population model.

The simulated annual fishery mortality of 1,800 leatherbacks in the small population model is in the neighborhood of the estimated 1,500 females per year killed by trawl, longline, and drift gillnet fisheries per year cited by Spotilla (2000). Much higher unpublished estimates of longline bycatch have been presented, suggesting that about 3,800 leatherbacks and 7,000 loggerheads are hooked by about a third of the Pacific longline effort per year (Rebecca Lewison, Duke University, personal communication February 2003). Assuming 37% mortality (see footnotes 2 and 6) these estimates suggest about 1,400 leatherback and 2,600 loggerhead deaths per year caused by a third of Pacific longline effort. The Lewiston estimates use data and methods that are not yet available for review, and have not been utilized in this analysis. If total fishing mortality really is substantially greater than has been simulated in the models used here, matching revised small population models to observed nester trends would require reducing other sources of anthropogenic mortality to compensate. This would cause simulated effects of the non-Hawaii fisheries to be greater relative to egg harvest and beach loss, but would not substantially alter the simulated effects of the preferred alternative. The preferred alternative would represent a much smaller fraction of the total fishery impact, but would remain similar in relation to the sum of all anthropogenic impacts.

Incorporating conservation measure into the preferred alternative assumes a certain degree of risk in terms of maintaining the continuity of such efforts in order to offset the impacts of the Hawaii longline fishery. Two criteria are used by the NMFS Office of Protected Resources in evaluating
conservation measures with respect to improving the population baseline:1) the certainty that measures will be implemented, and 2) the certainty of the measures being effective. The general formula for evaluating effectiveness is "exposure, response and risk" of the species and/or stock that will be subjected to the conservation measures. These criteria will ultimately determine how much difference conservation measures will make in a consultation. To meet these criteria, the Council has been guided by advice from its Turtle Advisory Committee on developing conservation measures (WPRFMC 2003b). The projects selected are with established conservation programs run by government and/or conservation NGOs, in locations where there has been considerable consultation and collaboration with local communities.represent a collaboration between the Council, the Pacific Islands Regional Office and NMFS' Southwest Fisheries Science Center (SWFSC), regional and local governments around the Pacific rim, conservation and wildlife groups internationally, and the fishing industry both nationally and internationally.

Roles in these conservation projects are evolving as the new Pacific Islands Region becomes established and the Council's efforts are developed. The SWFSC – which has a strong history of collaboration with the international sea turtle conservation community -- has been the technical monitor for the projects that were implemented in 2003 and is expected to continue to do so with assistance from the PIFSC and PIRO, which also serves as grants monitor. Funding for the projects comes from a variety of sources, some from NMFS base funds and some as part of cooperative agreements between NMFS and the Council based on Congressional appropriations for sea turtle research in the Pacific. PIRO focuses on the US flag states in the Pacific while the SWFSC and the Council are focusing on international projects. The roles of NGOs and the fishing industry will also develop as these projects progress into a fully formed program of sea turtle conservation in critical areas throughout the Pacific.

The highest loggerhead bycatch rates in the central Pacific are above 25° N, with only a few longline captures recorded below this latitude (McCracken 2000, OFP 2001). The old (pre-2000, shallow- and deep-fishing) Hawaii-based mortality of 155 loggerheads/year[11] caught on 15.5 million hooks averages 0.01 loggerhead deaths per 1,000 hooks for longline fishing (all styles combined) at higher latitudes. This rate is much higher than the OFP rate for all species (2001), lower than Nishemura and Nakahigashi (1990) would indicate, and is the best estimate available for specifically for loggerheads. Applied to international longline fishing effort above 25 N averaging 65.5 million hooks per year in the 1990's (SPC online database) estimated longline mortality for this region is about 655 loggerheads per year. Only 2 loggerheads have been documented as captured in tropical Pacific waters by longline gear. The OFP (2001) reports 1 in the equatorial zone out of 2143 observed sets (approximately 4.3 million hooks) and the NMFS Hawaii longline observer program reports 1 captured in the 1st quarter of 2002 out of 6.8 million observed hooks. The average mortality rate indicated by these data, assuming 37% mortality of captured loggerheads, would be 2*0.37/1,000 = 0.00067 per 1,000 hooks. Applied to international longline fishing effort in the North Pacific below 25 N averaging 252 million hooks per year in the 1990's (SPC online database) estimated longline mortality for this region is about 15 loggerheads per year, for an estimated total of 670/year (655 + 15) in the entire North Pacific.

To match the estimated deaths due to non-Hawaii longline fishing the larger population model for North Pacific loggerhead sea turtles sets longline fishing intensity slightly (17%) higher than the Chaloupka default value. The model simulates 710 longline deaths in 1985 declining to 670 in 1997, about 4.3 times the Hawaii-based longline mortality. The default is used for coastal fishing with simulated mortalities of 510 turtles in 1985 and 410 in 1997, about 2.6 times the 155 loggerhead deaths estimated for the Hawaii-based longline fishery in the late 1990's. The default value for drift gillnet fishing was increased about 4-fold to simulate about 940 deaths in 1985 and about 800 deaths in 1991, matching observer-based estimates of loggerhead mortality in the North Pacific drift net fishery (Wetherall, 1997). All together simulated non-Hawaii fishery deaths of 1,080 loggerheads amount to about 7 times the Hawaii mortality in 1997. The impact of all three major fisheries (drift net, coastal, and non-Hawaii longline) when all three were active in the mid-1980s is simulated to be about 1,080 loggerhead deaths per year with the larger population model.

[11]Take estimated as 418 loggerheads/year (1994-99) for the historical Hawaii-based fishery (March 29 2001 BiOp Table IV-8) with mortality assumed to be 37.1% = 155 loggerheads/year (from estimates in March 29 2001 BiOp Table IV-15)

Fishing intensity is increased by a factor of 3.1 for drift gillnet fishing 6.4 for coastal fishing and 7.3 for non-Hawaii longline fishing in the small population model for loggerheads, but the resulting number of fishery deaths does not change as radically because of the smaller population size. Drift gillnet deaths remain about the same as in the larger population model. Simulated coastal fishery deaths are about 810 in 1985 and 560 in 1997, or 3.6 times the impact of the Hawaii-based fishery, and simulated international longline deaths are about 1,760 in 1985 and 1,170 in 1997, or 7.5 times the Hawaii impact. Together all non-Hawaii fishery impacts total about 11 times the Hawaii impact. The impact of all three major fisheries (drift net, coastal, and non-Hawaii longline) when all three were active in the mid-1980s is simulated to be about 3,510 loggerhead deaths per year with the small population model.

Simulated effects of restored fishing and conservation measures
The simulated effect on the numbers of future nesters is illustrated for the two species and two models (Table 57) The effect of restored swordfish fishing at the historical level of fishing effort with traditional gear assumes that fishing effort will remain constant, take will decline in proportion to the simulated decline of the population, and that the fishery will operate continually from 2004 onwards. Multiple simulations (10 batch runs of 500 simulations per batch) were conducted for each scenario and average values were reported. Tests of the statistical significance were not conducted because the stochastic or random variation in the models may be somewhat arbitrary, and variance measures or deviations from the mean could provide a false sense of model precision. The simulated negative effects of a fully restored fishery are small but not negligible, ranging as high as about 8% for both loggerheads and leatherbacks in the small population model, and averaging about 6% for leatherbacks in the larger population model.

The effect of swordfish fishing restored to 50% of the historical level using circle hooks with mackerel-type bait assumes that the effect of the historical fishery is reduced by 50% and again by 92% and 67% for loggerheads and leatherbacks (respectively). The resulting estimated effects of the proposed swordfish fishery restoration are very small (0.1%-1.4%, Table 57). These results suggest that the effects of the preferred alternative are probably too small to ever be detected, given the inter-annual variation typical of observed nester abundance (Chan and Liew, 1996; Hitipeuw and Maturbongs, 2002; Suganuma, 2002).

The simulation of the leatherback conservation measures (Table 57) assumes that 2,250 nests will be saved in 2004: 1,000 at War Mon in Papua, and 1,250 (mean of 1,000 and 1,500) in Kamiali. This number of nests represents about 14% of the nests harvested in the larger population model and about 63% of the nests harvested in the small population model with greater F. This simulation also assumes that turtles saved in the Kei Islands will be a mixture of adults and subadults based on the size distribution reported by Suarez and Starbird (1996). A total of 110 adult and subadult turtles (100 from the Kei Islands fishery and 10 adult females at nesting beaches) were simulated as saved by reducing coastal fishing intensity in the models. The simulation assumes a constant conservation effort over the following years, such that the same proportion of nests and turtles are saved, rather than a fixed number.

The simulation of loggerhead conservation measures (also Table 57) saves 53 nests (6.625 eggs) and about 300 juvenile turtles in 2004, and again assumes this conservation effort will continue at a constant level, saving the same proportion of nests and turtles as the population size changes. The effect on the numbers of nesters after a generation is given as a percentage compared to the number that are simulated without the action after a generation. These percentages do not represent changes from the current status of the nester population. So although the conservation measures all show greater positive effects than the negative effects simulated for the Hawaii-based fishery, they do not indicate an increase in nesters over the current number. Nesting continues to decline with the conservation measures at a lower rate than it would otherwise, reducing the risk of extinction. More comprehensive conservation measures, including protection of all nesting beaches and the widespread use of environmentally responsible fishing technologies, are required to save the populations.

Table 57. Population simulation model effects on next generation nesters under two scenarios

	Old style swordfish fishery 100% restored	Model swordfish fishery (2120 sets/yr with circle hooks and mackerel-type bait)	Conservation measures
Larger population model			
Leatherbacks in 2020	6.3% decrease	1.0% decrease	118.0% increase
Loggerheads in 2040	0.6% decrease	0.1% decrease	0.8% increase
Smaller population model			
Leatherbacks in 2020	8.3% decrease	1.4% decrease	536.8% increase
Loggerheads in 2040	7.7% decrease	0.7% decrease	42.6% increase

The effects of the fishery and of the conservation measures were simulated separately in contrast to no action, and not as a combined action. However, the simulated positive effects of the conservation measures range from 8 to 380 times the magnitude of the simulated negative effects of the proposed swordfish fishery (in the preferred alternative). The simulation results suggest that the conservation measures, if conducted reliably and consistently, could potentially go far beyond compensating for the negative effects of the Hawaii-based fishery. In contrast to the simulated fishery effects, for leatherbacks in both models and for loggerheads in the small population model the simulated effects of the conservation measures are on the same order or larger than the inter-annual variation typical of observed nester abundance (Chan and Liew, 1996; Hitipeuw and Maturbongs, 2002; Suganuma, 2002). In other words, unlike the fishery effects which simulation suggests could be too small to detect in the noise of the real world, the simulated conservation measures could make a detectable difference in future nester trends by slowing the decline towards extinction and providing valuable time to launch additional conservation efforts.

Indirect Impacts on Sea Turtles
This section provides an overview of indirect impacts that may occur under all alternatives to the extent that they would restrict swordfish harvests or enable the transfer of environmentally responsible fishing technologies. These are termed transferred effects and may include markets, fishing grounds, and technology transfers. A further discussion of transferred effects is found in the discussion of the cumulative impacts of the alternatives (Section 10.11).

Markets
With the exception of the renumbering of figures and tables, this entire section is excerpted from an unpublished September 2003 draft report by Paul Bartram and John Kaneko for the Pelagic Fisheries Research Program. The focus of this report is the market transfer effects of the closure of the Hawaii-based swordfish fishery that is willing to be regulated to protect sea turtles, without concurrently prohibiting the domestic consumption of swordfish from unregulated fisheries. Relief from these negative market transfer effects under the alternatives is anticipated to be in direct proportion to the extent to which domestic swordfish demand is met by the FMP fisheries using gear which reduces and mitigates fishery interactions with sea turtles.

> An immediate consequence of the closure of the Hawaii swordfish fishery was the relocation of swordfish boats to California, and a transfer of fishing effort to the eastern pacific. Claims, such as those by NMFS (March 2001 BiOp), that this movement of effort from one part of the Pacific to another has saved turtles, by reducing takes is clearly simplistic. Turtle takes have not been reduced, the action has merely transferred the turtle takes eastwards. With the possibility of a reopening of the Hawaii-based swordfish fishery, some claim that this will result in new turtle takes. It is however clear that the returning boats will transfer their effort back to their old fishing grounds and the overall impact on turtles will not change.
>
> Regulation of the Hawaii longline fishery stemming from the Biological Opinion issued by NMFS in March 2001 (NMFS, 2001) has cut off the supply of fresh swordfish and greatly restricted the supply of fresh tuna during the southern seasonal area closure. U.S. buyers have substituted fresh imports to replace the Hawaii products no longer available (Redmayne, 2001).
>
> The market-driven transferred effects on sea turtle takes and fish bycatch resulting from regulation of the Hawaii longline fishery can be quantified by comparing bycatch per unit of target pelagic fish catch in the Hawaii longline fishery with competing sources of the same products. This section contains tables that express the differential costs of pelagic longline fishing in terms of sea turtle bycatch and non-target fish discards when one mt of imported fresh tuna or imported fresh swordfish replaces one mt of Hawaii longline products no longer available due to fishery regulation. The tables are patterned after the methodology of Hall (Norris et al., 2002). For the purposes of this analysis, all sea turtle takes are treated as having an equal impact on the affected population. In reality, a take from a severely depleted population, such as eastern Pacific leatherbacks, would be worse than a take from a healthier population, such as

Atlantic leatherbacks. However, no such adjustment or weighting is made in the present study.

This section presents analyses of market-transferred effects on bycatch that likely occurred (a) when U.S. fresh fish marketers and consumers replaced Hawaii longline swordfish no longer available with foreign imports; and (b) when U.S. fresh fish marketers and consumers replace the seasonal shortfall in Hawaii longline tuna production (during the April-May area "southern area" closure) with foreign imports

Seafood marketers who are knowledgeable about Hawaii longline products and recent substitutes were interviewed to identify the countries that fill niches no longer supplied by the Hawaii longline fishery. Most of these interviews were conducted at the 2003 Boston International Seafood Show.

The U.S. is the world's largest swordfish market (Ward and Elscot, 2000) and any shortfall in domestic production is likely to be filled by imports. The U.S. fresh swordfish supply is becoming increasingly dependent on imported products (Figure 8). Fresh swordfish imports to the U.S. market increased in the mid-1990's and made a large increase between 1996 and 1997. From 1997 to 2000 there was a steady increase. Between 1999 and 2000 imports increased by 31,013 kg, however between 2000 and 2001, imports increased by 355,745 kg reaching a total of 8,982,601 kg in 2001 (NMFS, 2002a). Unfortunately total domestic swordfish production data for 2001 are not available at this time for comparison.

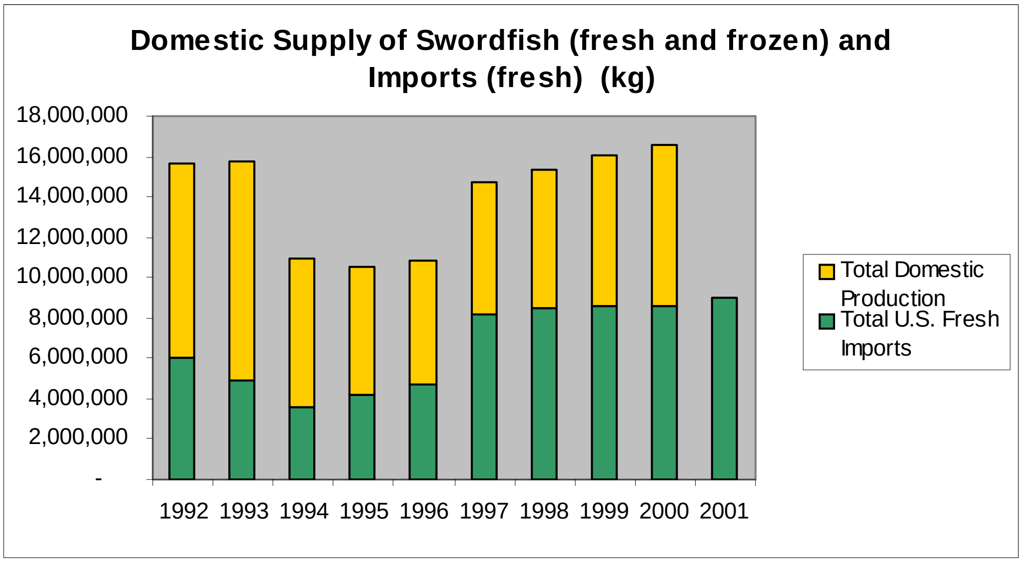

Figure 8. Domestic (fresh and frozen) and imported fresh swordfish supply to the US market between 1992 and 2001. Data source: NMFS, 2002a; Data for domestic supply not available for 2001

NMFS' regulatory actions restricting U.S. swordfish longline fleets in Hawaii and the North Atlantic Ocean have drastically reduced domestic fresh swordfish production. The total domestic production in 2001 is expected to be less than 3,000 mt, down from 7,900 mt in 2000 (Redmayne, 2001). Imports of fresh swordfish have nearly doubled since 1996 (NMFS, 2002a) indicating that the U.S. market is increasingly reliant on imported swordfish (Redmayne, 2001).

"Reasonable and prudent measures" in the NMFS Biological Opinion prohibited all shallow, "swordfish-style" longline fishing in the North Pacific by U.S. vessels (NMFS, 2001). Before this restriction halted swordfish production by the Hawaii longline fishery, most of the catch was shipped fresh by airfreight to the U.S. mainland (URS Corp., 2001).

The U.S. market for higher priced fresh swordfish is distinct from the market for frozen swordfish. Hawaii longline-caught fresh swordfish represented a considerable portion of the total domestic swordfish production in the US. The total domestic production of fresh and frozen swordfish and Hawaii's fresh swordfish production are compared in Figure 9. Hawaii swordfish represented between 37.3% and 47.8% of the total domestic production between 1997 and 2000. Hawaii production in 2001 is estimated to have fallen to 300,000 kg or about 10% of the year 2000 swordfish catch. Product from the other domestic swordfish fisheries is also expected to have dropped, increasing the market demand for imported product.

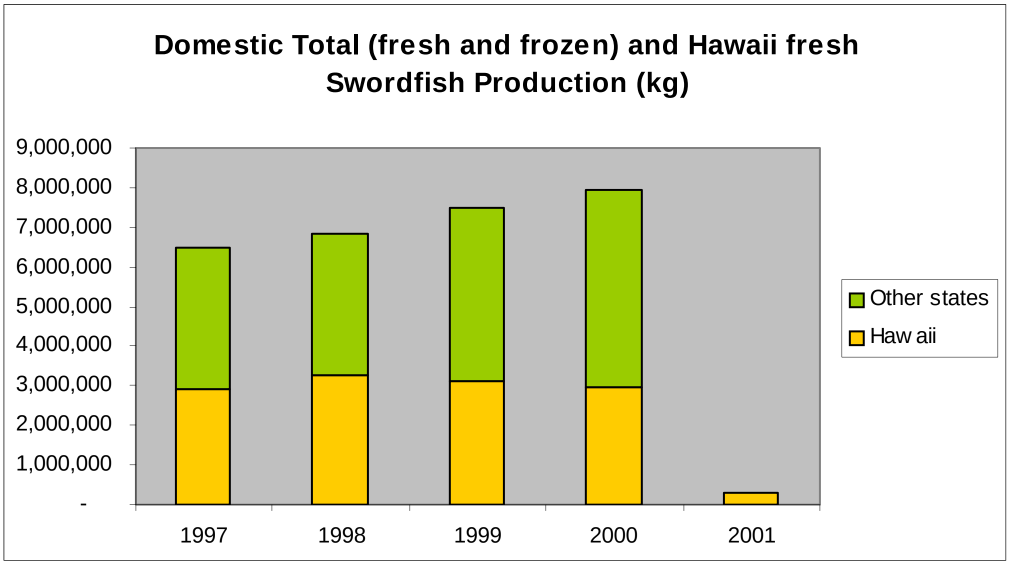

Figure 9. Domestic total (fresh and frozen) and Hawaii fresh swordfish production between 1997 and 2001. (2001 data available only for Hawaii). Data source: NMFS, 2001; 2002a and 2002b

The top ten countries supplying fresh swordfish to the U.S. market between 1999 and 2001 were Australia, Brazil, Canada, Chile, Costa Rica, Mexico, Uruguay, Ecuador, South Africa and Trinidad Tobago (Figure 10).

Several U.S. fresh fish marketers who were formerly major dealers in Hawaii longline swordfish products were interviewed for this study: Tom Kraft (Norpac Fisheries Export, Honolulu, HI), Saul Phillips (Export Inc., New Jersey), (Tim Malley, Stavis Seafoods, Inc., Boston). Interviews were conducted during the period March 11-13, 2003, at the Boston International Seafood Show. During wide-ranging discussions about the Hawaii swordfish fishery – past, present and future – the marketers were asked which foreign suppliers of the many fresh swordfish exporting countries had taken over the specific Hawaii share of the market following the Hawaii swordfish fishery closure. They identified the primary sources of fresh swordfish replacing Hawaii longline products as eastern Pacific suppliers -- California (relocated Hawaii swordfish longline boats), Mexico, Panama, Costa Rica -- plus South Africa. Some informants believe that increased supply of swordfish from Mexico and Panama may have been related to an El Nino weather pattern that prevailed in 2001-2002. (S. Phillips, pers. comm. to P. Bartram, March 13, 2003).

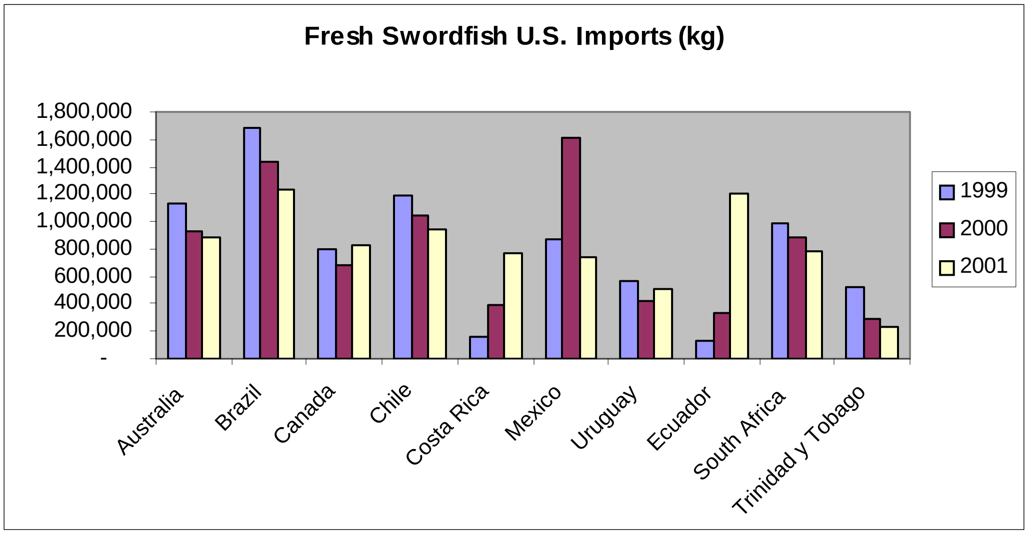

Figure 10. Top ten countries exporting fresh swordfish to the US (1999-2001).
Data source: NMFS, 2002a

Available information indicates that the sea turtle take rate in the latter longline fisheries is at least three times higher than in the Hawaii shallow-set swordfish-style longline fishery. Incidental catch of sea turtles by longline fleets that land swordfish in the eastern Pacific is very high when compared with the oceanic Pacific longline fisheries but similar to levels of sea turtle interactions from the Brazilian South Atlantic longline fishery. The most likely explanation may be a higher bycatch per unit effort of sea turtles in longline fisheries close to important nesting beaches compared to the open ocean (Segura and Arauz, 1995).

Table 58. Market-transferred effects on sea turtle bycatch when swordfish from eastern Pacific shallow-set longline fisheries is substituted for Hawaii shallow-set longline swordfish.

Area and Longline fishery	Sea turtle takes / mt target fish catch	mt target fish catch/ sea turtle take.
Eastern Pacific – high	14.5	0.07
Eastern Pacific -- low	0.45	2.2
Hawaii Shallow-set swordfish-style	0.15	6.6
Transferred effect on sea turtle bycatch -- high (of substituting eastern Pacific swordfish for Hawaii longline product).		97 X more sea turtle takes/ mt target fish catch
Transferred effect on sea turtle bycatch-- low (of substituting eastern Pacific swordfish for Hawaii longline product).		3 X more sea turtle takes / mt

Leatherback turtles from the eastern Pacific population are particularly at risk of incidental capture of longline fisheries operating in the vicinity of the Galapagos Islands. Morreale et al. (1996) and Eckert and Sarti (1997) have demonstrated the existence of a corridor for leatherbacks of the central American region and southern Mexico on their southward post-nesting migration toward South America. Turtles that have been satellite tracked head toward the Galapagos Islands, where they taper into higher concentrations, perhaps in a feeding migration, before dispersing again toward South American waters (Morreale et al., 1996). The clustering of many individuals along this migratory corridor greatly increases the vulnerability of eastern Pacific leatherback turtles to incidental capture in longline fisheries, especially because of the prevalence of shallow-set fishing practices off Mexico and central America (Bartram and Kaneko, pers. comm.).

Table 59. Market-transferred effects on sea turtle bycatch when swordfish from eastern Australia shallow-set longline fishery is substituted for Hawaii shallow-set longline swordfish.

Area and Longline fishery	Sea turtle takes / mt target fish catch	mt target fish catch/ sea turtle take.
Eastern Australia	0.07	14.2
Hawaii Shallow-set swordfish-style	0.15	6.6
Transferred effect on sea turtle bycatch -- (of substituting eastern Australia swordfish for Hawaii longline product).		2 X less sea turtle takes/ mt target fish catch

Table 60. Market-transferred effects on sea turtle bycatch when swordfish from Atlantic shallow-set longline fisheries is substituted for Hawaii shallow-set longline swordfish.

Area and Longline fishery	Loggerhead turtle takes / mt target fish catch	mt target fish catch/ loggerhead sea turtle take.
Brazil	23.2	0.04
Hawaii Shallow-set swordfish-style	0.15	6.6
Transferred effect on sea turtle bycatch – Brazil (of substituting Brazil swordfish for Hawaii longline product).		155 X more loggerhead turtle takes/ mt target fish catch

As the above data demonstrates, unilateral restrictions on Hawaii-based tuna and swordfish effort is unlikely to result in ocean-wide take reduction and may in fact increase total takes through market-driven transfer effects. This result is also supported by a more recent study conducted for the Council which utilized data from NMFS' Fisheries Statistics and Economics division. This study (still in draft) found that since the essential closure of the Hawaii-based swordfish fishery in early 2001, the reduction in Hawaii swordfish landings has been mirrored by an upward trend in US fresh swordfish imports from Ecuador, Costa Rica, and Panama (Sarmiento, 2004). As NMFS has previously found in its FEIS, a net reduction in takes and meaningful sea turtle conservation can only occur when effective reduction measures are transferred widely in domestic and foreign longline fisheries. Such transfers would include the widespread use of circle hooks and mackerel-like bait for fleets which make shallow sets for swordfish, the use of dehooking devices, and effective extension and education for longline fishermen in the best practices for releasing turtles caught or entangled in longlines.

Fishing grounds

No specific studies have been completed on this topic, but it is theorized (and reported anecdotally) that as Hawaii-based longline vessels have vacated their prime swordfishing grounds north of Hawaii, foreign fishing vessels have moved in to fish those areas using shallow-set longline gear. Moreover, vessels that previously fished and were based in Hawaii relocated to California, fishing in the Eastern Pacific Ocean. It is likely, therefore, that no additional sea turtles are being protected as a result of the domestic prohibition of this gear type, and the preferred alternative to re-open the swordfish fishery on the condition that mitigation methods and devices be used, may allow the longliners which moved to California to re-enter the Hawaii fishery, resulting in a net saving of turtlesthus reducing the area's overall fishery impact on sea turtles. Whether this will reduce worldwide impacts without the successful transfer of new fishing technologies and mechanisms to enforce compliance in foreign fleets is unclear.

Technology transfers

Beyond what can be accomplished through the regulation or prohibition of domestic fisheries, the adoption of mitigation methods and devices by foreign fishing fleets that continue to interact with sea turtles is a vital step in reducing impacts on these species. The preferred alternative's development and model of cost-effective mitigation methods and devices will provide the opportunity for domestic and foreign fishery managers to constructively address sea turtle conservation on an international basis. This importance of the development and transfer of successful technologies was also recognized by NMFS in its recent Biological Opinion on PIFSC's Section 10 permit #1303 that authorized a limited experimental swordfish-style fishery to test and refine the use of a number of promising technologies including the use of "stealth gear" (gear which is not readily visible to turtles) and daytime deep-setting for swordfish to mitigate fishery interactions as expressed in the following excerpt from that Biological Opinion (NMFS 2001b).

"However, the negative population effects of the loss of adult female leatherbacks are expected to be offset by the reductions in fishery mortality expected in the years following the experiment. As discussed in the Effects of the Action section, NMFS anticipates that the successful techniques to reduce or avoid turtle interactions will be adopted (or required) in domestic longline fisheries shortly after the experiments conclude. NMFS also anticipates that foreign longline fleets will adopt these methods as well. Adoption of these methods in both domestic and foreign longline fleets will result in Pacific-wide, if not worldwide, reductions in longline fisheries mortality of leatherbacks."

Seabirds

The elimination of the swordfish fishery led to a marked reduction on the takes and mortalities of seabirds, particularly blackfoot and Laysan albatrosses. Changes to the southern area closure had very little effect on further reduction of seabird takes as seabirds are not common in this area. All alternatives considered here maintain current requirements and include the additional requirement that vessels shallow-setting north of 23°N employ blue-dyed bait and complete the setting process during the hours of darkness. Based on data from Garcia and Associates (McNamara et al., 1999) and NMFS (Boggs, 2001), it is estimated that the use of just one of the current mitigation measures reduces interactions by 83 to 98 percent. The use of night setting alone has been found to reduce interactions with black-footed albatrosses by 95 percent and interactions with Laysan albatrosses by 40 percent. 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. The use of 18/0 or larger circle hooks which are at least 2" in diameter and thus 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.

Marine mammals

All pelagic fisheries in the Western Pacific Region under Council jurisdiction are classified as Category III under Section 118 of the Marine Mammal Protection Act (MMPA) of 1972 meaning that annual mortality and serious injury of a stock by a the fishery is less than or equal to 1 percent of the potential biological removal (PBR) level for that stock. The PBR is the maximum number of animals not including natural mortalities from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. Marine mammal interactions with the Hawaii-based longline fishery are rare events that are difficult to predict. To the extent that alternatives would increase total fishing effort, impacts on marine mammals also have the potential to increase. As described in Section 14.0, NMFS and the Council are exploring ways to reduce and mitigate fishery impacts on marine mammals.

10.8 Impacts on ocean, coastal, essential fish habitat and habitat areas of particular concern

None of the alternatives are anticipated to lead to substantial physical, chemical, or biological alterations to the habitat, or result in loss of, or injury to, managed species or their prey. Longline fishing consists of suspending a series of steel hooks from nylon lines within the epi-pelagic zone of the high seas and US EEZ. Given the inert nature of the materials used and the suspension of longlines beyond any demersal substrates in shallow or coastal waters, no alternatives considered here would have any substantial impact on the physical and chemical properties of the water column. For these reasons they will not adversely affect ocean or coastal habitat, essential fish habitat, or habitat areas of particular concern.

10.9 Impacts on biodiversity and ecosystem function

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. It is therefore anticipated that none of alternatives considered here would negatively affect biodiversity or ecosystem functions. Moreover, the reopening of the swordfish fishery under the preferred alternative, albeit at 50% of the 1994-1999 levels of fishing effort would diversify the depth range and geographic range of the fishery. Alternatives that would require the use of circle hooks with mackerel-type bait to reduce and mitigate sea turtle interactions, as well the conservation programs for sea turtles that are part of all alternatives, will minimize fishery impacts on sea turtles while promoting the restoration of turtle populations, hence actively promoting biodiversity. The anticipated successful transfer of mitigation technologies to other fishing nations will increase the positive impacts of these requirements.

10.10 Impacts on public health and safety

Due to the fact that none of the alternatives considered would require fishing in ways significantly outside of historical patterns, public health and safety will be negatively affected. However, alternatives that would require the use of circle hooks and dehookers may increase safety for crew members. Just as circle hooks are less likely to snag sea turtles, so would they be less likely to snag crew members. Dehookers would likely be used to release sharks as well as sea turtles, thus reducing the risk associated with bringing a live shark on board a fishing vessel. There is the possibility that fishermen might be tempted to make a trip during a period of particularly inclement weather, if the number of loggerhead or leatherback turtle interactions is approaching the hard limit to take advantage of swordfish fishing opportunities before the fishery closes. However, the Hawaii longline fishery operates year round in a variety of weather conditions, with only the advent of a hurricane confining fishermen to port.

10.11 Cumulative impacts of the alternatives on the environment

The range of alternatives considered here is based on previous patterns of fishing effort observed in the Hawaii-based longline fishery and does not include significantly new methods of fishing or new areas previously not fished by the Hawaii fishery. No matter which alternative is implemented, cumulative impacts on target and non-target species would be unaffected.

Cumulative effects would occur when direct and indirect effects of the alternatives combine with effects of factors exogenous to Pelagics FMP-managed fisheries to produce a net effect different from the separate effects or the exogenous factors. These net effects can be beneficial or adverse. Principles of cumulative effects analyses identified by the Council on Environmental Quality include the following:

1. Cumulative effects are caused by the aggregate of past, present, and reasonably foreseeable future actions.

2. Cumulative effects are the total effect, including both direct and indirect effects, on a given resource, ecosystem, and human community of all actions taken, no matter who (Federal, other government, or private) has taken the actions.

3. Cumulative effects must be analyzed in terms of the specific resource, ecosystem, and human community being affected.

4. It is not practical to analyze the cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful. In addition, there must be a relationship or “nexus” between the direct and indirect effects of the alternatives being evaluated and external effects.

5. Cumulative effects on a given resource, ecosystem, and human community are rarely aligned with political or administrative boundaries.

6. Cumulative effects may result from the accumulation of similar effects or the synergistic interaction of different effects.

7. Cumulative effects may last for many years beyond the life of the action that caused the effects.

8. Each affected resource, ecosystem, and human community must be analyzed in terms of its capacity to accommodate additional effects, based on its own time and space parameters.

10.11.1 Cumulative impacts on sea turtles

Five major exogenous factors were identified as having the potential to contribute to cumulative effects on sea turtles:

- Fluctuations in the ocean environment
- Incidental take in other fisheries
- Impacts on nesting and marine environments, including directed takes
- Current and future regulatory regimes, including transferred effects

Fluctuations in the ocean environment

Ocean climate fluctuations that change the habitat quality or the prey availability of sea turtles have the potential to affect their short or long-term distribution and abundance. Changes in oceanographic conditions may also alter rates of incidental takes of sea turtles in commercial fisheries. For example, sea turtles are known to follow temperature and chlorophyll fronts that may also be areas where fisheries are concentrated, and the concurrence of fishing effort and foraging animals may have resulted in increased interactions (NMFS, 2000). The magnitude of potential effects is uncertain but this factor could contribute significantly to cumulative effects on sea turtles.

Incidental takes of sea turtles in other fisheries

The incidental mortality of all species of marine turtles in commercial fishing operations has long been recognized as a serious threat to the stability of those populations (NMFS and FWS, 1998a, 1998b, 1998c, 1998d, 1998e,1998f; National Research Council, 1990). Often the effect of fishery mortality has a higher impact on population stability than many other sources of mortality (e.g., extensive egg harvest, nesting habitat destruction) because fisheries impact larger size/age classes of sea turtles. The effect of mortality in this size/age class is particularly damaging, as these turtles have some of the highest value to the population in terms of reproductive potential (Crouse *et al.,* 1987; Crowder *et al.,* 1994). Larger turtles not yet mature have survived many years of selective pressures but have not yet begun to support the population by reproducing themselves. Thus, while anthropogenic mortality may occur at many size/age classes in marine turtle population, it has been demonstrated that a relatively small anthropogenic mortality at these larger size/age classes will drive a population to extinction - despite almost complete protection of eggs and nesting females on the nesting beaches (Crouse *et al.*, 1987).

The survival of the affected sea turtle species will largely depend on their ability to retain sufficient abundances that enable populations to persist in the face of chance events operating at several levels (demographic variation, environmental variation, genetic variation) that affect the likelihood of extinction. The same traits that make long-lived species with delayed sexual maturity, such as sea turtles, so vulnerable to reduced survival rates also make their populations slow to recover once depleted (NMFS, 2000b). A population remains viable when it maintains sufficient genetic variation for evolutionary adaptation to a changing environment. It has been recommended that effective population sizes of at least hundreds of individuals be maintained to preserve evolutionarily important amounts of genetic variation (Lande and Barrowclough, 1987).

Population maintenance and recovery are highly sensitive to changes in the survival rates of the age classes which have a higher reproductive value (i.e., large juveniles and adults) than early life stages (i.e., eggs and hatchlings). Juvenile and adult survival rates should be sufficiently high to ensure enough juveniles survive to and through their reproductive years to maintain stable populations. Even seemingly small numbers of takes, especially of certain life stages, may have negative effects on population viability and the prospects for recovery (NMFS, 2000b).

One of the hallmarks of a fishery-impacted population decline is that the rate of decline can be quite fast. An example of this is the eastern Pacific nesting populations of leatherback sea turtles. As noted earlier, these populations dropped more than 80 percent in 15 years (Sarti *et al.*, 1996; Spotila *et al.*, 2000), a decline that was caused primarily by incidental mortality by coastal and high seas gillnet fishing off S. America and in the N. Pacific (Eckert and Sarti, 1997). In contrast, the destruction of the leatherback population in Terengannu, Malaysia took more than 50 years for which over harvest of eggs was primarily credited with the decline (Chan and Liew, 1996).

Another issue which must be considered when evaluating the interaction of fisheries with sea turtles is that sea turtle distribution is not homogeneous. Sea turtle distribution is often patchy, both temporally and geographically. The factors which lead to such patchiness are not entirely defined, though as noted earlier in this volume there are a few characteristics that can be important in governing turtle distribution (e.g., temperature, food availability, available refugia, etc.). Thus, it is often impossible to estimate total fishery interaction based on fishing effort alone or fleet distribution alone. As more information on sea turtle habitat preference becomes available it should be easier to anticipate fishery turtle interaction rates.

Because of the highly migratory nature of sea turtle populations, there is significant overlap of sea turtle stocks between the western and eastern Pacific. This is particularly true of loggerheads and leatherbacks, and, with respect to the Hawaii fishing area, also for olive ridleys.

An additional source of mortality for loggerhead and leatherback turtles, besides the various international sources considered in the CA/OR BO, is the Japanese swordfish-directed longline fishery in the northwest Pacific. This fishery generates a higher incidental mortality of loggerhead and leatherback sea turtles than the Hawaii-based longline fishery. This reasoning is based upon fishery characteristics, as the Japanese swordfish fleet deploys gear that is similar to that used by the Hawaii-based swordfish fleet but that exerts roughly four times more effort in the North Pacific Transition Zone and adjacent subtropical frontal zone. Additionally, interaction rates for loggerhead turtles may be even higher in the Japanese fishery because of the closer proximity to nesting grounds in Japan. Using the assumptions of Cousins *et al.* (2000) that the "mixed" target sector of the Hawaii-based longline fishery is most similar to the Japanese swordfish longline fishery in gear, first approximations of leatherback and loggerhead incidental take and mortality were estimated by applying the interaction rates for these species in Hawaii's "mixed" longline sector to the 25 million hooks of annual fishing effort in the Japanese swordfish-directed longline fishery. This calculation produces crude estimates of 1,350 takes, with 115 mortalities, of leatherback turtles per year and 3,950 takes, with 688 mortalities, of loggerhead turtles in the Japanese swordfish fishery.

Impacts of Asian tuna-directed longline fisheries are more difficult to define. It is assumed that cumulative sea turtle takes are greater for the Asian fleets simply because they account for an estimated 95.5% of all longline fishing effort in the Pacific. Most of the tuna-directed effort by these fleets is conducted at tropical latitudes, so the interaction rates would probably be highest for olive ridley turtles, moderate for green turtles and low for hawksbill, leatherback and loggerhead turtles.

The Hawaii recreational shoreline fishery is a source of mortality specifically for green turtles. Of the 299 documented turtle strandings in the main Hawaiian Islands during 1999, 15 percent, or 43 animals, had recreational fishing hooks in them. The most serious aspect of green turtle interactions with recreational shore fishers is entanglement in monofilament fishing line. The line may get wrapped around the turtle's flipper and restrict its movements and ultimately may even sever the appendage. Twenty of the 43 documented turtle strandings related to recreational fishing were dead when recovered. The remaining 23 turtles were entangled in monofilament line (NMFS, 2000a). Anecdotal information from recreational fishers suggests that the rate of interaction with shoreline fishing gear is much higher than the NMFS-documented strandings.

Impacts on sea turtle nesting and marine environments, including directed takes
The Recovery Plans for Pacific sea turtles (NMFS and FWS, 1998a, 1998b, 1998c, 1998d, 1998e, 1998f) describe over 26 non-fishery related impacts to sea turtles and evaluate their impact to each population by region. These impacts are separated into "nesting environment" and "marine environment." The following is a summary of those impacts:

Nesting environment

- Directed Take - directed take refers to the intentional killing of sea turtles or their eggs for food or other domestic or commercial purposes. For most regions of the Pacific and most species such directed take is illegal as the killing of reproductive females and their eggs is counterproductive to population stability. However, enforcement is often difficult. As a general rule, egg take is more prevalent in most regions than the killing of reproductive females.

- Increased Human Presence - refers to the increase presence of humans near or on nesting beaches. Problems include increased recreational use, construction of permanent or temporary structures on the beaches, litter or refuse, and general harassment of nesting turtles or their hatchlings.

- Coastal Construction - because of the value of coastal lands, and because such areas are often easiest to build on, sea turtle nesting beaches are frequent subjects of private and commercial construction. Construction results in the destruction of the nesting beach through direct impact (sand harvesting, etc.) or through collateral effects such as light pollution (sea turtles require dark beaches to nest), increased human harassment and increased egg or turtle harvesting.

- Nest predation - egg and hatchling loss due to non-human predation is a serious problem in some areas. Often such problems are exacerbated in areas of high human occupancy because feral animals (e.g., dogs, pigs, cats, rats) are frequently the culprits. In some cases increased natural predators (e.g. racoons, coati-mundis) can be a problem, but usually this only occurs where introduced terrestrial ecosystems have displaced the beach ecosystem.

- Beach erosion - the effects of storms, a sea level rise or seasonal changes can affect beaches, and thereby degrade nesting habitat.

- Artificial lighting - as noted under human presence, artificial lighting can be a problem at nesting beaches. Adult and hatchling sea turtles use the presence of a lighter horizon to find the sea when returning from a nesting beach. Artificial light can disorient turtles or prevent them from nesting.

- Beach Mining - refers to the extraction of sand from nesting beaches to be used in construction (in concrete). The effect of removing sand from beaches is often increased erosion leading to destruction of the beach.

- Vehicular Driving on Beaches - crushes turtle eggs and destroys nesting habitat by causing compaction and rutting; makes it difficult or impossible for hatchlings to negotiate their way to the water.

- Exotic Vegetation - non-native species of vegetation can interfere with nesting beaches by affecting incubation temperatures (which impacts hatch success as well as hatchling sex ratios, which are thermally regulated), as well as by creating thick root masses which foul nests or by interfering with sand flow dynamics (beaches often need annual erosion and replenishment to clean the beach and remove residual organics that are left after incubation).

- Beach Cleaning - a process common to resort areas where mechanical rakes are used to remove accumulated debris, often damages nests in the process.

- Beach Replenishment - the replacement of sand onto a beach after it has been eroded away is called beach replenishment. However, such action can bury nests already deposited, or more significantly the replacement sand can be of the incorrect quality and can result in poor hatch success or even interfere with the turtle's ability to dig a nest cavity.

Marine Environment

- Direct take - refers to the direct harvest of turtles for domestic or commercial purposes (e.g. food, jewelry, leather or other products)

- Natural Disasters - such as large storms, hurricanes etc. can kill sea turtle turtles, particularly those foraging in shallow coastal habitats. More long term natural phenomena such as *El Niño* can also impact turtle populations, particularly those which are already stressed by other problems.

- Disease and parasites - can impact turtle populations, particularly once turtle populations have been reduced so severely that such natural stresses have larger impacts than would normally be the case in healthy populations. Often turtles that have been compromised by other problems will secondarily exhibit high parasite loads that exacerbate the poor health conditions of the turtle. Finally disease epidemics can impact turtle populations. For example, the fibropapillomas epidemic has been severe on green turtles living around the islands of Hawaii, and threatens their recovery.

- Algae, Seagrasses and Reef Degradation - is a form of marine habitat damage which clearly impact turtle populations by limiting food or refugia.

- Environmental Contaminants - such as oil or other chemical contaminants are particularly high in coastal areas with larger human populations and can harm turtles as well as their habitats. Less well known are chemical contaminants on the high seas but they are a source of mortality to sea turtles.

- Debris (Entanglement and Ingestion) - provide a potentially serious, but impossible-to-quantify source of mortality in sea turtle populations. For example, ghost fishing gear (abandoned or discarded) can kill turtles submerged for extended periods by entanglement. Particularly insidious is gear that may entangle turtles until the gear becomes so weighted that it sinks and once the turtles have decomposed, it rises to surface waters to entangle turtles again. There are numerous reports of abandoned gear with large numbers of dead turtles and other species entangled in the gear. Equally unquantified and potentially serious is debris that turtles may consume and cause death. All pelagic sea turtles will eat jellyfish (and for leatherbacks this is all they eat), and they often confuse plastics with this prey. The effect can be to kill the turtle through an intestinal blockage, or there may be physiological impacts as has been suggested for turtles who consume latex balloons (Lutz, 1989; Lutz and Alfaro-Schulman, 1991). Finally, many pelagic turtles (particularly hatchlings) are surface grazers who will consume anything found floating at the surface. This can include a large number of anthropogenic contaminants such as plastic beads used in plastic fabrication and oil or tar balls.

- Predation - is considered a natural source of mortality; however, it must be considered a threat when turtle populations become reduced. Pelagic turtles probably represent only an occasional food source for predators such as sharks and *Orca*, and thus predator population size may be decoupled (predator population size is not linked to prey population size) from sea turtle population size. Thus, when turtle populations are reduced the effect of predation has a greater impact than would be seen when turtles are numerous.

- Boat Collisions - can be a threat to turtle populations primarily in coastal environments when boat traffic and turtle densities are high.

- Marina and Dock development - can act as an indirect threat to turtles through the destruction of habitat, elevated contaminant levels (caused by increased boat traffic) and increased risk of boat strikes.

- Dredging - represents a risk to sea turtle coastal habitats.

- Dynamite fishing - threatens primarily coastal turtle populations by incidental killing of turtles and habitat destruction.

- Oil Exploration and Development - is considered threatening to turtle populations because of possible contamination of habitats, increased boat traffic and pre-drilling seismic exploration. This latter activity can kill turtles or damage their hearing.

- Power Plant Entrapment - occurs in some coastal areas that use ocean water for cooling. Turtles swim into the sea water intakes and are sometimes drowned.

- Construction Blasting - can kill or injure turtles in the immediate area, as well as degrade important habitats.

Current and future regulatory regimes, including transferred effects

Sea turtle species which are accidentally caught in Pelagics FMP-managed fisheries are protected under the Endangered Species Act. NMFS’ CA/OR BO (NMFS, 2000c) concludes that the CA/OR drift gillnet fishery is likely to jeopardize leatherback and loggerhead turtles and proposes to restrict the fishery to reduce the fishery’s take of these species.

A fishery management plan is currently being prepared for U.S. fisheries for highly migratory species in the Pacific. The California-based longline fishery will be managed under this plan. As necessary, this plan may also include restrictions on fishing methods in order to reduce or avoid impacts to sea turtles (NMFS, 2001a). When it enters into force, the Inter-American Convention for the Conservation and Protection of Sea Turtles is expected to promote conservation of sea turtles in the convention area (NMFS, 2001a). The regulatory factor contributes significantly to cumulative effects estimated for sea turtles. At this time, NMFS is under a federal Court injunction not to issue any more High Seas Compliance Act permits for longline vessels fishing outside of the west coast EEZ. This issue remains unresolved.

The direct impacts on sea turtles estimated for the alternatives described here are discussed in Section 10.5 of this document. Although discussed to a limited degree, one of the most significant aspects of the impacts of current and future regulatory regimes is that of transferred effects which are further detailed here as they may be viewed as a cumulative impact of some current and potential fishery management regimes. Transferred effects are indirect effects that may occur outside of the managed area as a result of management actions within the managed area. Adverse transferred effects may occur as a result of management actions intended to reduce adverse impacts on protected or managed species in a discrete fishery, but actually promote and increase the adverse impacts on other populations of the integrated resource system. Transferred effects may affect the ultimate balance of environmental impacts, unintentionally driving the system in the opposite direction from the intent of the management measures when taken and evaluated in isolation. Beneficial transferred effects may also occur. For example, gear innovations and management approaches demonstrated to be effective in one fishery, might be transferred to another fishery and help to promote appropriate management of that resource.
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Management alternatives that maintain or modify current reductions in the production of swordfish by the Hawaii-based longline fishery will continue to have adverse transferred market effects. These result as the swordfish production and supply system adjusts to the reduction in Hawaii swordfish landings. The U.S. mainland is the principal market for Hawaii swordfish. The adverse transferred effects related to the restriction of Hawaii swordfish production are a potential result of shifts of domestic fishing effort as vessels redirect effort to less restricted fishing grounds. Adverse transferred effects can also result as the market shifts from a declining domestic supply to an increased reliance on imported swordfish supplies from areas with unknown protected species monitoring and management efforts.

Beneficial transferred effects might occur should displaced Hawaii-based longliners relocate to better managed fisheries with lower rates of anticipated adverse impacts on protected species. Beneficial transferred effects might occur should swordfish be imported to replace Hawaii swordfish in the market from countries or fisheries that have lower adverse impacts. However, beneficial transferred effects are not likely as there are few (if any) fisheries that meet this criteria.

The U.S. mainland market, particularly in the North Atlantic region, is a major consumer of fresh and frozen swordfish. Swordfish supplied to the higher-priced fresh sector of the market can come from several sources. Domestic suppliers include the North Atlantic and Hawaii fisheries. Countries exporting fresh swordfish to the U.S. market are fishing North Atlantic, South Atlantic, South Pacific and Mediterranean swordfish stocks.

When North Atlantic swordfish management caused a reduction in the supply from the U.S. fishery, there was a supply response from swordfish producers outside of the management area (Thunberg and Seale, 1992). Part of the response in the late 1980s was a redirection of fishing effort to Hawaii that resulted in the rapid expansion of the North Pacific domestic longline fishery for fresh swordfish. In this case, management action in the Atlantic fishery transferred adverse effects to Pacific sea turtle populations as the displaced fishing effort relocated to the western Pacific. Most of the swordfish production in Hawaii was shipped by air cargo to the North Atlantic states.

Management actions that prohibit or restrict shallow-setting may drive more of the historic fleet to redirect effort on swordfish populations outside of the managed area. Additional vessels may relocate and fish in other domestic fisheries or move outside of the country to fisheries that do not share the same management requirements (limited entry, catch reporting, observer coverage, gear and area restrictions and concerns for adverse impacts on protected and non-targeted species) with the western Pacific fisheries managed under the Pelagics FMP. Overly restrictive regulations in Hawaii that severely constrain the ability of vessel owners to realize returns are likely to lead to these vessels relocating to less regulated areas. In response to the current regulations, some vessels previously active in Hawaii have relocated to the California-based longline fishery which is not yet subject to specific constraints on swordfish fishing (shallow-setting).

Any void in domestic fresh swordfish supply is more likely to be filled by exporting countries. The U.S. imported fresh swordfish from many different countries with the top six countries in 1999 being Brazil, Chile, South Africa, Australia, Mexico and Uruguay (NMFS, http://www.st.nmfs.gov/st1/trade/tradeprdctentry.html). A myriad of market-driven transferred effects occur on target, non-target and protected species. Comprehensive coverage of the full scope of transferred effects on protected species is hampered by the relative lack of accurate fisheries statistics, observer coverage and measures provided for protected species by international fleets. The Hawaii pelagic fisheries managed under the Pelagics FMP are a notable exception in that the fishery has observer coverage and fishery statistics are available. However, it is important to attempt to gain an appreciation for the potential magnitude of market-driven adverse transferred effects where possible. Although fisheries data from some of the important exporting countries may be limited, what is available offers a glimpse of the potential significance of the transferred effects of product substitution. The following sections consider the possible impacts on sea turtles associated with replacing Hawaii swordfish with fish from just a few of the leading fisheries exporting fresh swordfish to the U.S. market.

Uruguay

Based on observer records of 99 longline sets made between 1994 and 1995, the Uruguay swordfish longline fishery in the southern Atlantic may take 5.36 leatherbacks per 10,000 hooks and 10.72 loggerheads per 10,000 hooks (Weidner *et al.*, 1999). Mortality estimates are not available. Swordfish CPUE is estimated to be from 13.3 mt to 20.0 mt swordfish per 10,000 hooks. Using this information, there may be from 0.26 to 0.40 leatherbacks taken per mt of swordfish produced. There may be as many as 0.53 to 0.80 loggerhead turtles taken per mt of swordfish produced.

By comparison, the historical (1994-1998) Hawaii-based longline fishery was estimated to result in 0.10 leatherback takes per 10,000 hooks and 0.36 loggerhead takes per 10,000 hooks (NMFS, 2000). The CPUE during the 1999 directed swordfish fishery in Hawaii was estimated to be 14.6 swordfish per 1,000 hooks with an average weight of swordfish of 57.2 kg (WPRFMC, 2000). This converts to an estimate of 8.3 mt of swordfish per 10,000 hooks. Using this information, each mt of Hawaii-caught swordfish may be associated with 0.012 leatherback takes and 0.043 loggerhead takes.

The potential difference in magnitude of the adverse transferred effects can be calculated by dividing the estimated number of sea turtle takes per mt of Uruguay swordfish with the number of estimated turtle takes per mt of Hawaii swordfish (Table 61). The adverse transferred effect on sea turtles associated with each mt of Hawaii swordfish replaced by swordfish from Uruguay might be expected to result in 21 to 33 times more leatherback takes per mt of swordfish. Each mt of Uruguay swordfish may be associated with 12 to 18 times more loggerhead turtle takes than predicted for swordfish from the Hawaii-based longline fishery.

Table 61. Comparison of Adverse Impacts of the Uruguay and Hawaii Swordfish Fisheries on Sea Turtles.

Fishery	Leatherback Turtles		Loggerhead Turtles	
	Takes per mt swordfish	mt swordfish per take	Takes per mt swordfish	mt swordfish per take
Uruguay	0.26-0.4 takes	3.85-2.5 mt	0.53-0.80 takes	1.89-1.25 mt
Hawaii	0.012 takes	83.33 mt	0.043 takes	23.25 mt
Relative difference in rate	Uruguay 21.6x greater adverse impact per mt swordfish		Uruguay 12.3x greater adverse impact per mt swordfish	

To put this into perspective, each 100 mt of Hawaii-caught swordfish is predicted to result in the take of 1.2 leatherback takes. Substitution by imported swordfish from Uruguay would be expected to result in 26 leatherback takes (Figure 11) Similarly, for the same 100 mt of swordfish substituted into the market, Hawaii swordfish would be associated with 4.3 loggerhead takes and be exchanged for 53 loggerhead takes caused in the production of Uruguay swordfish.

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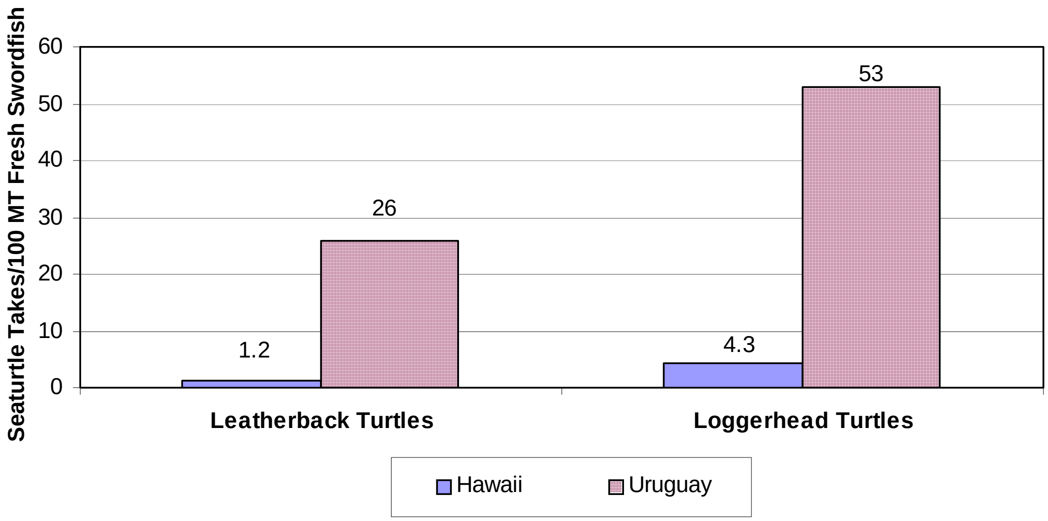


Figure 11. Potential Magnitude of Market Driven Transferred Effects on Sea Turtles Resulting from Substituting Swordfish Imported from Uruguay for Hawaii-caught Swordfish in the U.S. Market

Brazil
The best current evidence from Brazil's swordfish fishery in the southern Atlantic is based on extremely low numbers of observed trips. Observer data do not distinguish sea turtle takes by species. However, the limited observer data available indicate that longliners operating in Brazil may take as many as 116 sea turtles resulting in 16 mortalities per 10,000 hooks (Weidner and Arocha, 1999). The CPUE for the Brazilian longline fishery is estimated to be five metric tons swordfish per 10,000 hooks (Weidner and Arocha, 1999). Using these values it is estimated that the Brazilian swordfish longline fishery may take as many as 23.2 sea turtles and result in 3.2 sea turtle mortalities per mt of swordfish produced.

By comparison, the historical (1994-1998) Hawaii-based longline fishery was estimated to result in 0.596 sea turtle takes and 0.028 sea turtle mortalities per 10,000 hooks based on observer data between 1994 and 1999 (NMFS, 2000). Using the CPUE of 8.3 mt swordfish per 10,000 hooks, it is estimated that the Hawaii swordfish fishery may have resulted in 0.071 sea turtle takes per mt of swordfish produced and 0.0033 sea turtle mortalities per mt of swordfish.

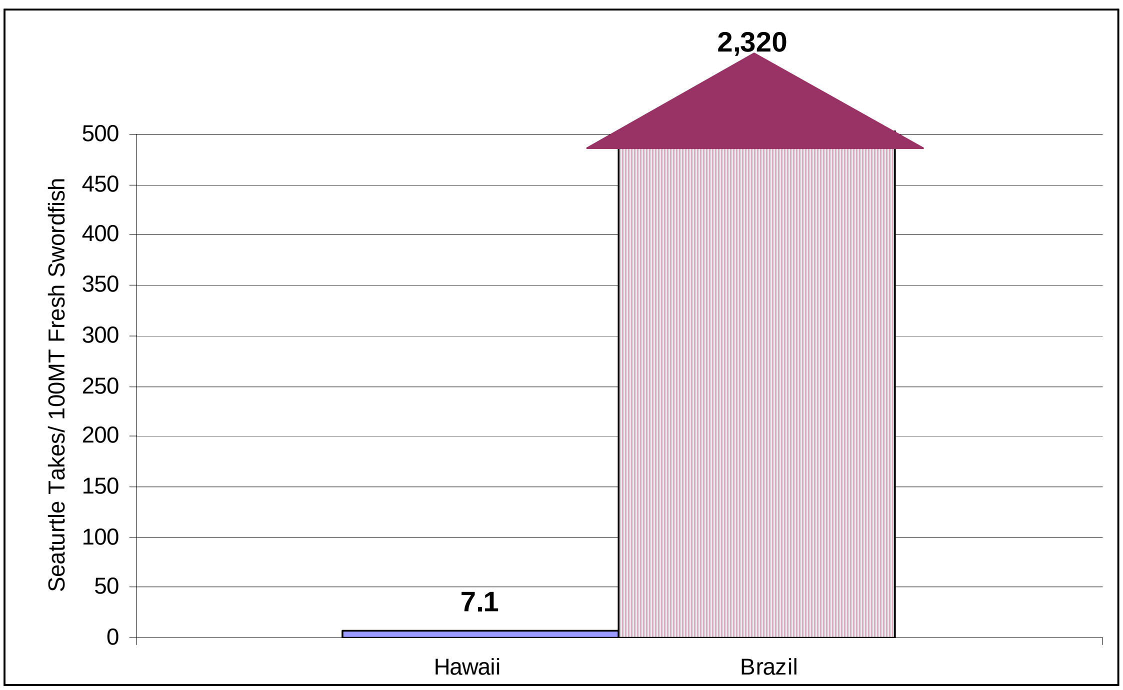
The magnitude of adverse transferred effects on sea turtles associated with each mt of Hawaii swordfish displaced from the market that is substituted with fish from Brazil may be as high as 325 times more sea turtle takes and over 950 times more sea turtle mortalities per mt of swordfish (Table 62). Clearly, the substitution of each mt of Hawaii-caught swordfish by swordfish from Brazil's fishery could represent an unintentional and yet significant adverse impact on sea turtles.

Table 62. Comparison of Adverse Impacts of the Brazil and Hawaii Swordfish Fisheries on Sea Turtles.

Fishery	Sea Turtle Takes		Sea Turtle Mortalities	
	Takes per mt swordfish	mt swordfish per take	Mortalities per mt swordfish	mt swordfish per mortality
Brazil	23.2 takes	0.043 mt	3.2 mortalities	0.31 mt
Hawaii	0.071takes	14.08 mt	0.0033 takes	303 mt
Relative difference in rate	Brazil 326x greater adverse impact per mt swordfish		Brazil 969x greater adverse impact per mt swordfish	

Each 100 mt of Hawaii-caught swordfish is predicted to result in 7.1 sea turtle takes and if replaced with swordfish from Brazil, could increase the adverse impacts on sea turtles to 2,320 takes for the same amount of swordfish sold in the U.S. market (Figure 12).

Figure 12. Potential Magnitude of Market Driven Transferred Effects on Sea Turtles Resulting from Substituting Swordfish Imported from Brazil for Hawaii-caught Swordfish in the U.S. Market.



Chile

The magnitude of the Chilean swordfish fishery in the eastern Pacific impacts on sea turtles in the eastern Pacific is unknown and fisheries data are limited. However, the potential significance of adverse impacts on sea turtles may be great as described in detail above. With a large commercial and artisinal swordfish fishery in Chile using longline and driftnet gear, the adverse impacts on sea turtles may be significant. Evidence exists that links sea turtles (including leatherbacks and loggerheads) caught in Chile, with nesting populations of turtles in Mexico and Costa Rica. Although estimates of the numbers of sea turtle takes and mortalities per mt of swordfish produced could not be made with the limited data available, the potential for significant adverse transferred market effects exists and may result from substituting Hawaii-caught swordfish with fish from Chile.

Mexico

The potential transferred market effects arising from the substitution of Hawaii swordfish with fish caught in Mexico may also be significant. Fisheries data including information on incidental takes and mortalities of sea turtles related to the swordfish fishery are not available. Mexico's swordfish fishery in the eastern Pacific by domestic or foreign vessels (potentially including displaced Hawaii-based longliners) represents another significant source of adverse transferred effects on sea turtles. The swordfish fishery in Mexico deserves close scrutiny in that adverse transferred effects on sea turtles may occur as a result of management alternatives applied in the Western Pacific Region. Alternatives that result in the displacement or relocation of Hawaii-based fishing vessels to fishing grounds in the eastern Pacific off Mexico may unintentionally compound adverse impacts on those sea turtle populations. The market substitution of swordfish caught by Mexican vessels for swordfish produced in the Hawaii-based fishery may carry with it a significant adverse impact on sea turtles greatly exceeding the impacts of the Hawaii fishery.

These are some of the market-driven transferred effects that could be the unintentional result of management efforts to mitigate the adverse effects of the Hawaii-based longline fishery directed on swordfish. The transferred effects must be given consideration in determining the ultimate cumulative effect of management action. Although the adverse transferred effects may impact sea turtle populations distinct from those caught in the Western Pacific Region, they can be significant in the global effort to recover and sustain sea turtle populations. Each fishery has its own unique degree of impacts that can be used to compare different sources of the same species of fish on a ton for ton basis. Again, the Hawaii-based fishery and the Western Pacific Region should not be viewed and managed in isolation. The interconnectedness and adaptive nature of the market and supply along with the mobility of the fishing effort are critical considerations. The ecosystem and precautionary management principles require that market-driven transferred effects be understood and anticipated.

As with the swordfish supply and market, reduced production of tuna and associated species by the Hawaii-based longline fishery can have adverse transferred effects that would occur in two ways. Hawaii-based vessels could relocate to other areas to fish, or fish from those areas caught by other fleets could be imported to substitute for Hawaii production decreases. Adverse transferred effects could offset the beneficial effects that were intended by displacing longline fishing effort from the Hawaii fishery. The significance of the transferred effects is greatly dependent on where and how new longline fishing effort is conducted as well as the transferred effects associated with the source of the tuna replacing Hawaii production.

There is a high probability that the existing Hawaii-based longline fishing effort would be relocated to pelagic fishery resources outside of the Western Pacific Region management area, where markets have not developed for non-target species that are valuable in the Hawaii market. This may result in increased amounts of economic discards by the displaced Hawaii fleet that currently have a high level of retention because of the Hawaii market demand for a wide range of pelagic species. Fish imported to replace reduced Hawaii production would likely come from producing areas and fleets that currently discard all pelagic catches except tuna and billfish and may also have greater adverse impacts on protected species.

Longline fishing fleets operating in the western Pacific are a likely source of fresh tuna that may replace any reduction in supply of Hawaii caught fresh tuna (bigeye, yellowfin, albacore) in the U.S. market. These would probably include Chinese, Taiwanese and Japanese vessels operating in Micronesia. These vessels deploy longline gear similar to the Hawaii-based tuna fleet, though a sector of the Taiwanese and Chinese longline fleets make relatively shallow sets (five to ten hooks between floats) at night (SPC, 2000). A provisional estimate of sea turtle takes is 0.27 takes per 10,000 hooks from fleets operating from 10° N. to 10° S. (SPC, March 2001, unpub. data), which is similar to a rate of 0.20 takes per 10,000 hooks fleets operating in the Federated States of Micronesia (Bailey *et al.*, 1996). Both rates are aggregated over all gear configurations, and the shallow setting method suggests that the rate of sea turtle takes may actually be higher as seen in the Hawaii-based longline fishery. While species identification in the western Pacific longline fisheries is not well documented, given the tropical area of the fishery the take rates would probably be highest for olive ridley and green turtles and lowest for hawksbill, leatherback and loggerhead turtles.

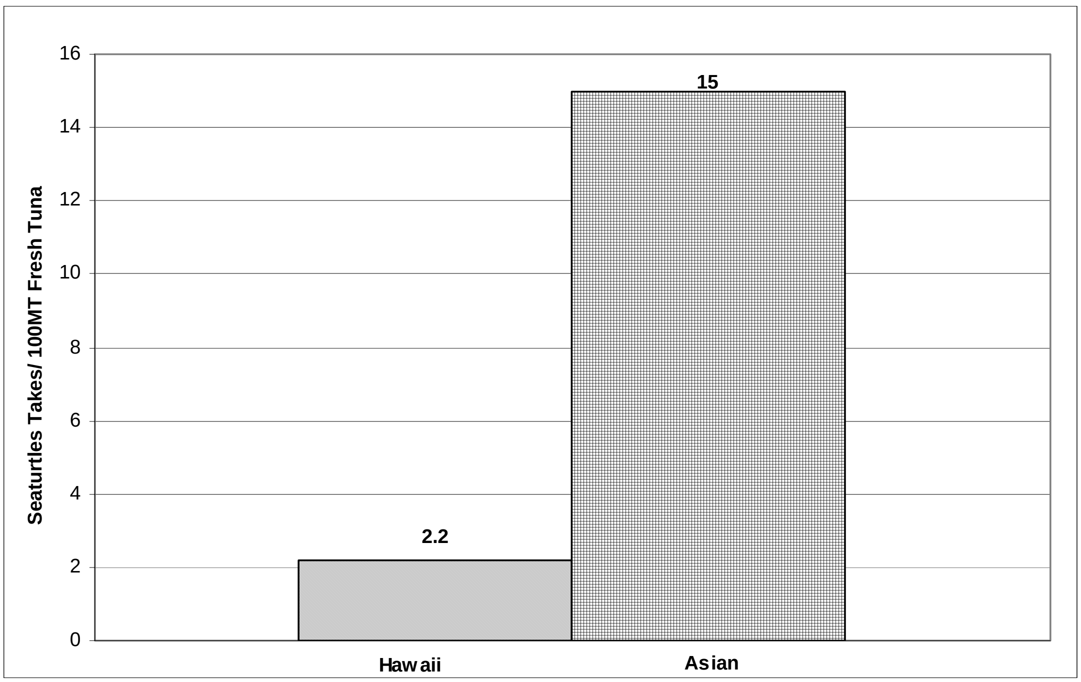
The tuna catch rate (bigeye, yellowfin, albacore) for these fleets is approximately 1.79 mt per 10,000 hooks (SPC, 2001, unpub. data). Using these estimates (Table 63), tuna caught by the fleets operating in the western Pacific would be expected to result in 0.15 sea turtle takes per mt of tuna. By comparison, the combined tuna catch rate in Hawaii tuna longline fishery is estimated at 2.58 mt tuna per 10,000 hooks. The Hawaii tuna style longline trips are estimated to result in 0.0097 sea turtle takes/set (NMFS, 2001a). The average tuna set is 1,690 hooks. The Hawaii tuna fishery is estimated to result in 0.057 sea turtle takes per 10,000 hooks. Using these estimates, the Hawaii tuna longline fishery would result in 0.0222 sea turtle takes per mt of tuna. Substitution of imported tuna caught by Taiwan, Chinese or Japanese vessels operating in Micronesia for Hawaii tuna in the U.S. market would be expected to result in 6.75 times more sea turtle takes per mt.

Table 63. Comparison of Adverse Impacts of the Asian (Taiwan, China, Japan) and Hawaii Tuna Fisheries on Sea Turtles.

Fishery	Sea Turtle Takes	
	Takes per mt tuna	mt tuna per take
Asian tuna longline fleets in western Pacific	0.150 takes	6.66 mt
Hawaii	0.0222 takes	45.04 mt
Relative difference in rate	Asian fleets 6.75x greater adverse impact per mt tuna	

Hawaii tuna-style longlining is predicted to result in 2.22 sea turtle takes for each 100 mt of tuna (Figure 13) By contrast, each 100 mt of tuna (bigeye, yellowfin and albacore) caught by Taiwan, China and Japan tuna longliners operating in the western Pacific is estimated to result in 15 sea turtle takes.

Figure 13. Potential Magnitude of Transferred Effects on Sea Turtles Resulting from Substituting Imported Tuna from Taiwanese, Chinese and Japanese Longline Fleets Operating in the Western Pacific for Hawaii-caught Tuna in the U.S. Market.



Another example of an adverse transferred market effect would be if a reduced domestic supply of fresh tuna caused a shift in some consumer demand to bottomfish and reef fish species, most of which are fully or over-exploited around the main Hawaiian Islands (NMFS SWFSC-HL, 2000a).

Summary of cumulative impacts of the alternatives on sea turtles
Fishery impacts are not limited to the Hawaii-based longline fishery alone. Historically a number of high seas and coastal fisheries as well as coastal management problems (including nesting beaches) have had direct bearing on the endangered status of Pacific sea turtles. Contemporarily, incidental take in the Hawaii-based longline fishery is small when seen in terms of all fisheries and other sources of mortality in the Pacific, but is likely still large enough to impose a significant threat to the stability of at least leatherback and loggerhead turtles.

All action alternatives would continue to displace some or all of the historical Hawaii-based swordfish longline fishing effort. Some or all of the displaced effort may continue to relocate to the California and Mexico-based longline fishery. Both leatherback and loggerhead sea turtles are commonly found in the eastern Pacific. Take rates are expected to be high because leatherback turtles aggregate in Monterey Bay during the summer and begin to migrate offshore beyond the EEZ in September. The California-based longline fishery is not observed, the current level of incidental take of sea turtles is unknown but may increase as a result of increased effort. Shifting swordfish longline fishing effort to the eastern Pacific would not increase the likelihood of survival or recovery of the sea turtle species (NMFS, 2001a).

All alternatives have the potential to add to already significant effects on sea turtles because of the importance of even small numbers of mortalities of leatherback and loggerhead species. The alternatives could also have a significant positive impact on cumulative effects if sea turtle takes by Pacific-wide longline fisheries are reduced throughout the range of the populations of the threatened or endangered species. This would be facilitated by the implementation of alternatives which include a model swordfish fishery which would be used to model the practicality and efficacy of new technologies to reduce and mitigate sea turtle interactions, such as the use of circle hooks with mackerel-type bait and dehookers. The economical use of these measures in a commercial fishery will provide a powerful tool for fishery managers and other government representatives to influence the activities of other fishing nations.

Significant cumulative impacts on sea turtles requiring mitigation
To reverse the trend of decline in leatherback and loggerhead sea turtles will take a multilateral approach in both fisheries and coastal resource management. Acting to remove Hawaii-based longline fishery mortality alone will not reverse these species declines. This is recognized in the action alternatives analyzed here as they all include a suite of conservation measures designed to protect and recover sea turtle populations in foreign waters and beaches. Further progress was made at a November 2003 international high level meeting co-sponsored by NMFS at the Rockefeller Foundation Bellagio Conference Center[12].

10.11.2 Cumulative impacts on seabirds

[12] Conservation and Sustainable Management of Sea Turtles in the Pacific Ocean, Rockerfeller Foundation Study and Conference Center, Bellagio , Italy, November 17-22, 2003.

Two of the most important historical factors influencing albatross populations in the North Pacific were (a) severe declines caused by feather hunters and egg collecting in the late 19th and early 20th centuries (McDermond and Morgan, 1993); and (b) the Asian high seas drift net fishery. North Pacific populations of black-footed, Laysan and short-tailed albatross have not yet recovered from the directed harvests of a century ago. High seas driftnet fishing was widely practiced by Japanese, Korean and Taiwanese fleets through the 1980s until the end of 1992. Driftnet fisheries in the temperate North Pacific had major impacts on Laysan and black-footed albatross through entanglement of birds in fishing gear. Although these fisheries were responsible for the deaths of hundreds of thousands of seabirds (Johnson *et al.*, 1993), they also provided a food supplement to black-footed albatross and, to a lesser extent Laysan albatross, which scavenged considerable amounts of squid and fish directly from driftnets and offal discarded from vessels during processing of the catch (Gould *et al.*, 1998). At the end of 1992, large-scale pelagic high seas driftnet fisheries conducted by Asian fleets ceased in accord with the United Nations' moratorium on this fishing method.

Seven other major exogenous factors were identified as having the potential to contribute to cumulative effects on essential fish habitat and the marine environment:

- Fluctuations in the ocean environment
- Extermination for construction of infrastructure
- Loss of nesting habitat
- Marine debris and waste disposal
- Air strikes
- Incidental take in fisheries
- Current and future regulatory regimes

Fluctuations in the ocean environment

A climatic shift that occurred in the central North Pacific in the late 1980s produced an ecosystem shift in the NWHI to a lower carrying capacity, with a 30-50 percent decline in productivity. The recruitment and survival of several marine resources, including seabirds, was negatively affected (Polovina *et al.*, 1994). Future ocean climate shifts are likely to cause changes in seabird abundance and this factor contributes significantly to cumulative effects on seabirds.

Extermination

Ten of thousands of albatross were exterminated from Midway Atoll to construct an aircraft runway for the Department of the Navy. It is possible that short-tailed albatross on the island could have been killed during this process. The U.S. government transferred Midway Atoll from the Navy to the Department of the Interior in 1996 and Midway Atoll is presently managed as a National Wildlife Refuge where seabird nesting habitat is protected (FWS, 2000) and breeding colonies are increasing. If large-scale extermination occurs in the future at other important nesting habitats in the Pacific-range of albatross, this factor could contribute significantly to cumulative effects on seabirds

Loss of nesting habitat

Loss of habitat now represents the greatest threat to short-tailed albatross (McDermond and Morgan, 1993) and, to a lesser extent, black-footed and Laysan albatross. Current population enhancement efforts in Japan are concentrated on attracting breeding short-tailed albatross to an alternate, well-vegetated colony site on Torishima, which is less likely to be affected by volcanic eruptions, mud slides, or erosion than other nesting colony sites in Japan (FWS, 2000). As long as habitat continues to limit albatross population recovery, it will be of great significance to cumulative effects on seabirds.

Marine debris and waste disposal

Drift and trawl nets accumulate in the Northwestern Hawaiian Islands and entangle protected species, including albatross. A multi-agency state and federal effort is underway to remove derelict nets from several locations in the NWHI. The ingestion of marine debris (primarily plastic) by albatross chicks may result in dehydration and starvation, intestinal blockage, internal injury or exposure to dangerous toxins (Cousins, 1998). As long as net fisheries lose gear in the North Pacific and marine debris accumulates near albatross nesting sites, however, the potential for entanglement will remain (FWS, 2000) and this factor will contribute significantly to cumulative effects on seabirds

Air strikes

Since acquiring the airfield at Midway Atoll NWR from the Department of Defense in July 1997, FWS has implemented several precautions to reduce and document seabird collisions with airplanes, especially during the albatross nesting season from November through June. The FWS has documented that 135 seabirds, not including any short-tailed albatross, have collided with aircraft and died. A female short-tailed albatross has seasonally resided close to the end of the runway since 1989. The limited airplane service to Tern Islet, French Frigate Shoals in the Hawaiian Islands NWR injured and killed a small number of seabirds, but never short-tailed albatross (FWS, 2000). This airstrip is currently closed but air strikes could be of potential significance to cumulative effects on seabirds if it reopens.

Incidental takes of seabirds in other fisheries

Asian longline fleets operate in North Pacific areas that overlap the known range of the short-tailed albatross (FWS, 2000). Most Asian longline vessels fish primarily for tuna, so they probably have much lower albatross take rates than swordfish longline fisheries. Unfortunately, they do not report longline interactions with seabirds. Collectively, these 3,000+ vessels no doubt have a significant effect on North Pacific albatross. Cousins *et al.* (2000) made a rough first approximation of the potential numbers of albatross killed in North and Central Pacific pelagic longline fisheries, based on the ratio of swordfish and seabirds incidentally hooked in the Hawaii-based longline fishery. Applying different average catch rates of Laysan and black-footed albatross from different sectors of the historical Hawaii-based longline fishery to Japan's swordfish-directed longline fishery in the North Pacific and to North Pacific longline fishing by Japanese, Taiwanese and Korean vessels which target tuna, Cousins *et al.* (2000) speculated that Asian pelagic longline fisheries operating in the North Pacific may accidentally catch 30,000 birds per year.

Seabird interaction problems in the North and Central Pacific are mild compared with those in Alaska's demersal longline fishery and in pelagic longline fisheries in the South Pacific and Southern Ocean (Cousins *et al.*, 2000) where the species and sheer numbers of birds involved are much greater. Pelagic longline fisheries kill far fewer albatross than did driftnet fisheries although they do not provide as much supplemental food. North Pacific fisheries which target squid, the primary prey item of albatross, may affect food availability but how this affects seabird populations is unknown. The balance of positive and negative impacts of longline fisheries on black-footed and Laysan albatross populations is unknown, complex and probably in a continual state of flux (Gould *et al.*, 1998).

The US Fish and Wildlife service has previously authorized a recreational rod and reel fishery at Midway Atoll National Wildlife Refuge. About eight Laysan albatross were entangled in lines and one bird was hooked by a lure in the recreational fishery at Midway. No mortality was associated with these interactions. No injuries were reported for black-footed albatross as a result of the recreational fishery. Short-tailed albatross have been most frequently observed at Midway between October and April, although none were observed at sea during 1999 and 2000. The recreational fishery is now defunct but occurred primarily between April and October, so there was some overlap between the presence of short-tailed albatross and recreational fishing activities at Midway (FWS, 2000). Based on the low allowable take of this species (2.2 birds/year) set for the Hawaii-based longline fishery in the short-tailed albatross Biological Opinion (FWS, 2000), even a small number of short-tailed albatross takes by a renewed recreational fishery at Midway would be of concern.

If the North Pacific-wide estimate of Asian longline interactions with albatross (Cousins *et al*., 2000) is anywhere close to actual encounter rates, all albatross species in the North Pacific will not be able to maintain stable population levels and will eventually demonstrate declining numbers of breeding pairs in the NWHI and elsewhere. Therefore, this factor has major significance for cumulative effects on seabirds.

Current and future regulatory regimes

The United Nations Food and Agriculture Organization (FAO) has endorsed (July 1999) a non-binding International Plan of Action for reducing the incidental catch of seabirds in longline fisheries. The United States is a party to five international treaties that deal with the conservation and management of migratory birds and NMFS has developed a National Plan of Action that is compatible with the FAO plan. Measures have already been adopted by the United States for reducing the incidental catch of albatross and other seabirds in the ground longline fishery and Pacific halibut fishery off Alaska (WPRFMC, 2001b). Understanding the rate of incidental albatross takes in foreign longline fisheries that operate in the North Pacific is an integral part of assessing cumulative effects on albatross populations, especially the endangered short-tailed albatross, whose foraging range overlaps with the foreign longline fishing effort to a far greater extent than with the Hawaii-based longline fishing effort. Existing and future regulatory regimes have significance for cumulative effects on seabirds.

Summary of cumulative impacts of the alternatives on seabirds

As described above, because of the above exogenous factors, significant adverse cumulative effects on seabirds would continue under all alternatives discussed here, although the actual significance for albatross populations is unknown at this time.

Significant cumulative impacts on seabirds requiring mitigation
Foreign fishing nations are not known to report seabird bycatch and fishers may not be able to identify seabirds or may have significant disincentives to do so for fear of consequences to the future of the fishery (FWS, 2000). No actions have been taken to coordinate policies, research, monitoring or enforcement by national fishery managers and the majority of central and North Pacific longline vessels continue to operate without employing seabird deterrent measures.

10.11.3 Cumulative impacts on marine mammals

Most stocks of large whales were severely depleted by modern whaling. Moratoriums on hunting by the International Whaling Commission have restricted this activity, but poaching of whales and other marine mammals still occurs. Four other major exogenous factors were identified as having the potential to contribute to cumulative effects on marine mammals:

- Fluctuations in the pelagic ocean environment
- Incidental take in other fisheries
- Ship traffic and anthropogenic noise
- Marine debris and waste disposal

Fluctuations in the ocean environment
Ocean climate fluctuations that change the habitat quality or the prey availability of marine mammals have the potential to affect their short-term or long-term distribution and abundance. Changes in oceanographic conditions may also alter rates of incidental takes of marine mammals in commercial fisheries. For example, during strong coastal upwelling events marine mammals that feed on zooplankton and small fish may be attracted to areas where fisheries are concentrated, and the concurrence of fishing effort and foraging animals may cause more entanglements than normal (NMFS, 2000). Regime shifts can also result in changes in prey availability that may reduce the abundance of some species of marine mammals. The magnitude of potential effects is uncertain but this factor could contribute significantly to cumulative effects on marine mammals.

Incidental take of marine mammals in other fisheries
Domestic and foreign fisheries outside the Western Pacific Region may adversely affect marine mammals through gear hooking, entanglement or ingestion or by removal of prey species. For example, the California/Oregon shark and swordfish drift gillnet fishery takes dolphins and whales (Forney *et al.*, 2000; Hill and DeMaster, 1999; NMFS, 2000). The Mexican swordfish driftnet fishery is currently making an effort to convert to a longline fishery, which would considerably reduce the incidental take of marine mammals (NMFS, 2000). This factor may contribute significantly to cumulative effects on marine mammals.

Ship traffic and anthropogenic noise
Collisions with vessels and disturbance from low frequency noise are potential threats to the recovery of large cetaceans. Because many of the ship strikes occur far offshore and, thus, are unreported, this impact on large whales is most likely underestimated (NMFS, 2000). The increasing levels of anthropogenic noise in the world's oceans may have an adverse effect on whales, particularly deep-diving whales that feed in the oceans' "sound channel" (Forney *et al.*, 2000). These effects are difficult to assess but they may be significant as part of cumulative effects on marine mammals.

Marine debris and waste disposal
Activities that may have adverse effects on marine mammal habitats include the dispersal of marine debris, large oil spills and other types of marine pollution. Petroleum has the potential to be toxic to marine mammals if it is inhaled, ingested or absorbed through the skin, mucous membranes or eyes, or if it inhibits feeding by fouling the baleen plates of whales. Hydrocarbons can also bio-accumulate in zooplankton and fish eaten by marine mammals and other wildlife. Any detrimental effects of marine pollution on their prey species would also affect marine mammals. Aside from large, catastrophic spills, the long-term effects of low levels of petroleum exposure are unknown. Marine debris can also be toxic to marine mammals if ingested or it can entangle them, leading to decreased ability to breathe, feed, breed, swim or haul out. The animals affected may be more vulnerable to predators or disease, reducing their survival or ability to reproduce. These factors can have significance in local areas, where they contribute to cumulative effects on marine mammals.

Summary of cumulative impacts of the alternatives on marine mammals
Given the lack of complete information on the rate of interactions between marine mammals and pelagic fisheries in the Western Pacific Region and on the condition of marine mammal stocks, the effects of the alternatives on marine mammals cannot be determined at this time with any degree of confidence. In addition, vessels displaced from the Hawaii-based longline fishery by the management measures proposed under these alternatives may shift to or remain in fisheries in which the interaction rates with marine mammals are unknown. Because of the substantial uncertainty of the effects of these alternatives on marine mammals, the cumulative effects of these alternatives are equally uncertain.

Cumulative impacts on seafood markets and consumers
Exogenous factors include:

- market demand for fishery products
- currency exchange rates
- alternate sources of the same pelagic fish species
- seafood product substitution

Market demand for fishery products
The present and projected market demand for fresh high quality pelagic fishery products is an example of an exogenous factor. All pelagic fisheries under the Pelagics FMP in the western

Pacific are focused primarily on the production of fresh, high quality and higher value seafood. There are currently no incentives to produce for the lower quality and lower value frozen seafood market with the exception of the small-boat longline fleet in American Samoa that produces albacore for the cannery market. Returns from frozen albacore sales to the canneries in American Samoa outweigh the incentives to ship fresh albacore by costly airfreight to distant markets. The Japanese market for fresh high quality tuna is believed to have peaked with little expectation for significant expansion. Meanwhile the fresh tuna market in the United States and to some extent, in Europe is expanding as consumers are offered increasing amounts of fresher higher quality tuna products from multiple international sources. The major market for fresh high quality swordfish is the U.S. seafood market. The price premium placed on fresh swordfish over frozen fish in the U.S. market persists as a strong incentive for domestic and international fleets to concentrate on producing fresh and not frozen swordfish.

Currency exchange rates

Currency exchange rates are another form of important exogenous factor affecting the market for pelagic fisheries products. In the foreseeable future, with the strong U.S. dollar and Japanese yen, there will be added incentive to export fresh pelagic fish to Japan and the U.S. market. However, the weaker European Union Euro has not provided incentives to greatly increase shipments from U.S. ports to the European market since the currency was adopted.

Alternative sources of the same pelagic fish species

Alternative sources and product forms of pelagic fish species would be expected to fill part of the void in the supply created by reduced production of fresh Hawaii pelagic fish resulting from management alternatives. The fresh swordfish supply available in the U.S. market is from domestic fisheries including the Hawaii-based fisheries and imports from numerous countries fishing in the Pacific, Atlantic and Indian Oceans. The U.S. swordfish market is also supplied by numerous sources of frozen loins and steaks. However, there is a price premium paid for fresh swordfish over frozen. Discriminating consumers that drive the market for fresh swordfish will continue to demand high quality fresh swordfish, independent of management actions in the Western Pacific Region. Should management actions continue to restrict swordfish production from Hawaii, imported fresh swordfish will likely continue to replace any supply deficit.

Some of the seasonal fresh tuna supply deficit is being and would likely continue to be, overcome with the importation and consumption of alternative product forms of frozen tuna treated with carbon monoxide. In recent years, processors in the Philippines, Taiwan and Indonesia have been processing raw tuna with carbon monoxide gas (and highly filtered wood smoke). This process is performed prior to freezing to impart an unnaturally bright cherry red color to the muscle similar but not identical to that of natural, high quality fresh tuna. The treated tuna products are being used in some markets in Hawaii and the continental United States to substitute for genuine high quality fresh tuna. If Hawaii supply of fresh longline-caught tuna declines further and the price of available supply increases, there will be increased incentive to substitute fresh tuna with frozen carbon monoxide or filtered smoke treated tuna. The primary active ingredient in filtered smoke is carbon monoxide. These treated frozen products are highly controversial in that carbon monoxide is not an approved food additive in the United States and treated products can be considered adulterated. Filtered smoke processing adds carbon monoxide to tuna, but these treated products are being imported into the U.S. market in increasing amounts.

Proponents of the filtered smoke process claim that the process should be considered safe simply because it is a component of wood smoke, a GRAS (generally regarded as safe) substance for treating tuna (HIS, 1999). The FDA has chosen not to challenge the company's claim that filtered smoke is GRAS at this time, but warns that tuna cannot be adulterated (color enhanced) or mislabeled (FDA, 2000). Consumers may be exposed to economic fraud if the products are misrepresented (mislabeled and/or color enhanced) as fresh tuna. Restaurants and retailers in Hawaii and the U.S. mainland are known to neglect proper disclosure of the treated and frozen tuna products. There are also concerns regarding the exposure of consumers to increased health risks because carbon monoxide treated tuna has an unnaturally red color that is unusually color stable (red color does not degrade at normal rate). This eliminates the effectiveness of practical indicators (off-color and off-odor) used by consumers to judge tuna product quality, decomposition (spoilage) and relative food safety (histamine poisoning and growing concerns about *Listeria monocytogenes*). Although the GRAS notification filed with FDA is limited to tuna treated with filtered smoke, frozen swordfish, *mahimahi* and tilapia fillets and steaks are also being treated and imported into the U.S. market.

Seafood product substitution

Seafood product substitution is another potential factor exogenous to the western Pacific fisheries under the management of the Pelagics FMP. This can be in the form of substituting alternative product sources or forms of the pelagic market species by other types of non-pelagic fishery products. For example, should the production of fresh domestic Hawaii-caught swordfish remain low and the market price increase, consumers may switch from swordfish to farm raised Atlantic salmon, or other fish such as halibut. Fresh swordfish and more recently fresh tuna have emerged as the premier steak fish in the U.S. market. This is because of the special product qualities (size of fish, large fillets without bones, meat-like qualities and consumer acceptance as steak fish for seafood grills). To the degree that total per capita seafood consumption is reduced, consumers who have been encouraged to include seafood in their diet to reduce intake of saturated fat for health reasons may be placed at increased risk of obesity and heart disease, both significantly impacting public health.

Cumulative impacts on society

Two major exogenous factors were identified as having the potential to contribute to cumulative social impacts.

- Fishermen's options for switching fisheries or relocating effort
- Economic climate

Fishermen's options for switching fisheries or relocating effort

Increasingly restrictive regulatory environments and escalating compliance costs were major factors in the relocation of longline vessels from the Gulf of Mexico and Atlantic to Hawaii in the late 1980s and early 1990s (Travis 1999). Since that time, longline operations in Hawaii have become similarly constrained by the implementation of a limited access program, area closures and other regulations. New areas that these vessels could move to without encountering significant regulatory or economic obstacles are limited. Some swordfish vessels displaced from the Hawaii fishery by the emergency closures have shifted to California. At this time, there is no federal management plan in place for the California longline fishery, but a FMP is currently being developed by the Pacific Council. State regulations prohibit the use of longline gear in the EEZ off Washington and California for vessels respectively registered. Some vessel operators may opt to shift to Atlantic or Gulf of Mexico fisheries, but acquiring access to these fisheries may be difficult due to license limitation programs.

Relocating to other island areas in the Western Pacific Region is also an option for longline vessels displaced from the Hawaii-based fishery, but these areas also have existing (or proposed) longline fishing regulations as well as logistical problems that could render the costs of longline fishing prohibitively high. In American Samoa, for example, longline vessels harvesting tuna or swordfish for the fresh fish market would have to overcome obstacles such as limited shoreside ice and cold storage facilities and infrequent and expensive air transportation links.

Economic climate
The economies of the island areas in the Western Pacific Region could be seriously affected by numerous factors exogenous to pelagic fisheries, including changes in regional tourism patterns and government spending. With the exception of American Samoa, commercial fishing in general plays a minor economic role in these island areas. Tourism is the most important industry in Hawaii, Guam, and the Commonwealth of the Northern Mariana Islands. Hawaii's tourist industry appears to be recovering after a sharp decline in Asian visitors during the 1990s. However, a listless overall state economy continues to hamper the ability of Hawaii fishers to adapt to regulatory changes by supplementing fishing incomes with shore-based employment. Labor market opportunities in construction and other economic sectors where Hawaii fishers have found employment in the past have not yet recovered to pre-1990 levels. Changes in the level of government-related activities, such as federally-funded capital works projects or defense spending, also have a dramatic effect on economic conditions in the island areas. The economy of American Samoa is especially dependent on federal assistance.

The possibilities for switching fisheries or relocating fishing effort have major significance for cumulative social effects.

Summary of cumulative impacts on society
Management regime changes in other U.S. fisheries could either mitigate or magnify the effects of alternatives that close off large areas to longline fishing year round or continue to restrict swordfish fishing by Hawaii-based longline vessels. It is likely that other fishery management regimes will become more rather than less restrictive. Therefore, these regulatory changes will have a significant negative cumulative effect on participants in the Hawaii longline fishery by further reducing their opportunities to shift to other fisheries.

The condition of island and regional economies could improve or worsen these effects. Should employment opportunities expand, displaced fishermen could possibly find new jobs. Should employment opportunities decrease, they will have more difficulty in finding new livelihoods. Therefore, the cumulative social effects associated with these economic variables may or may not be significant in a positive or negative direction.

Other cumulative impacts
None of the exogenous factors which contribute to cumulative effects on essential fish habitat, the marine environment or pelagic management unit species are expected to be modified by the indirect effects of any SEIS alternative discussed here.

When the estimated direct and indirect effects are combined with the potential effects of exogenous factors on essential fish habitat, the marine environment, or the stock status or availability of pelagic management unit species, none of the alternatives considered in the SEIS are likely to have significant effects on pelagic habitats and the ecosystem. This is largely because the FMP longline fisheries represent a very small amount (less than 5%) of Pacific wide catch and effort. No significant cumulative effects that need mitigation were identified for these resources.

11.0 Environmental Management Issues

This section analyses a number of environmental management issues including the short-term uses of resources versus their maintenance and enhancement of long-term productivity; irreversible and irretrievable commitments of resources; energy requirements and conservation potential of the alternatives; urban quality, historic resources and design of the built environment; cultural resources conservation potential of the alternatives; and possible conflicts between the alternatives and other plans; and adverse effects that cannot be avoided. It also includes a discussion of possible measures that could be used to mitigate unavoidable adverse effects.

Short-term uses versus long-term productivity
Short-term uses are generally those that determine the present quality of life for the public. The quality of life for future generations depends on *long-term productivity*; i.e., the capability of the environment to provide resources on a sustainable basis. It is known that fisheries have the potential to reduce long-term productivity of pelagic fish and non-fish resources if management standards are not met. Monitoring determines whether fishery control measures are effective and are being correctly applied to achieve management objectives. The framework procedure in the Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region (Pelagics FMP) allows for regulatory adjustments to be made in response to changing fisheries, resource conditions and environmental fluctuations.

None of the alternatives would be expected to cause long-term loss of productivity of fish resources (including sharks) harvested by Pelagics FMP-managed pelagic fisheries. Despite the inclusion of measures that would address albatross interactions in the Hawaii-based longline fishery, none of the alternatives are likely to prevent long-term loss of productivity of North Pacific seabird populations if interactions in other Pacific demersal and pelagic longline fisheries are not also reduced. Small numbers of protected sea turtles, especially leatherbacks, loggerheads and olive ridleys, would be expected to be killed in Hawaii-based longline fishery interactions under all of the alternatives. Even complete elimination of Hawaii-based longline fishing mortality would not ensure sea turtle species' survival and recovery because other sources of human-induced mortality would remain.

Irreversible resource commitments

Irreversible commitments of resources are actions which disturb either a non-renewable resource or a renewable resource to the point that it can only be renewed over a long period of time (decades). Loss of biodiversity may be an irreversible resource commitment. For example, extinction of an endangered species, such as the leatherback turtle, would constitute an irreversible loss.

All action alternatives include management and conservation measures intended to promote the recovery of endangered sea turtle populations. The cumulative effects of these alternatives on the status of threatened and endangered sea turtle species would not be expected to change significantly without a global conservation effort. Relocation of longline fishing effort displaced from the Hawaii-based longline fishery to areas with higher levels of sea turtle interaction (e.g., off Mexico, where there are important leatherback nesting beaches) has the potential to actually increase the mortality of some sea turtle species through indirect effects. It is reasonable to anticipate that markets previously supplied by Hawaii longline products will continue to much of the lost production with imports from international longline fisheries where the incidental take of sea turtles may be several times greater than the impact of the Hawaii-based longline fishery proposed under the action alternatives.

It is uncertain whether leatherback and loggerhead turtle populations can survive and recover after the high mortalities inflicted by the Asian high seas drift net fisheries during the 1980s. The effects of these fisheries on reproductive capacity are not fully known because juvenile turtles that survived during the 1980s may only now be reaching sexual maturity. Therefore, fishing mortality of even a small number of turtles from the pool of reproductive adults is considered a threat. Management of the Hawaii-based longline fishery in isolation is not likely to eliminate this threat, especially if Hawaii-based longline fishing effort in the central North Pacific is replaced by longline fishing effort from other sources (e.g., Japanese swordfish longline fleet).

Irretrievable resource commitments

An *irretrievable commitment* is the loss of opportunities for production or use of a renewable resource for a short to medium period of time (years). The alternatives considered in the EIS produce varying degrees of irretrievable resource commitments. These commitments parallel the environmental impacts evaluated for each resource. The difference between resource levels under each alternative and potentially higher levels that otherwise could be produced also represents an irretrievable commitment of resources. The difference in output levels is the opportunity cost or lost production. The commitments are not irreversible, however, because they could be reversed by changing management direction (the Pelagics FMP includes an adaptive procedure to allow for changes in management direction. Regulatory adjustments can be made based on changing fisheries, resource conditions or environmental fluctuation).

Energy requirements and conservation potential of the alternatives
The use of fossil fuels for fishing vessel operation and government surveillance and enforcement activities is an irreversible resource commitment. The alternatives discussed here are expected to have direct impacts, as well as indirect impacts, on energy requirements.

Direct impacts on energy requirements
Alternatives allowing wider-ranging and greater fishing effort or requiring higher levels of surveillance and enforcement would be expected to cause higher consumption of fossil fuels.

Indirect impacts on energy requirements
All alternatives may indirectly provide an incentive for increased effort by commercial troll and handline fishers in Hawaii to provide fresh tuna and associated pelagic fish as a substitute for seasonally reduced domestic longline production. Higher prices for such products during time/area closures of the tuna sector of the Hawaii-based longline fishery could motivate small-boat fishers to increase fishing effort, with associated increases in fuel consumption by small vessels that are less fuel efficient than longline boats. Thus, the potential exists for a net increase in energy requirements under alternatives that continue to restrict operations of the Hawaii-based tuna longline fishery.

Total ecological cost
Energy is not the only cost associated with fishing activities. All fishing has ecological costs, although these are often not recognized or acknowledged. Given alternative ways of harvesting a resource, ideally those with the lowest ecological costs could be chosen subject to private and social costs and returns ( ) However the major obstacle is in defining, measuring and comparing the ecological costs of these alternatives. For example, one way of harvesting a resource may require greater amounts of energy but another, less energy-intensive way may cause undesirable bycatches (Hall, 1998). These difficulties prevent a comparison of the alternatives in terms of their total ecological costs at this time.

Urban quality, historic resources and design of the built environment, including re-use and conservation potential of the alternatives
None of the alternatives would be expected to have appreciable effects on urban quality and the design of the built environment.

The re-use potential of the alternatives is related to the potential for redirection of asset use. Vessels displaced from the Hawaii-based longline fishery may not be adaptable to or economical for other fisheries. Re-use potential is directly related to the extent that each alternative results in vessels or gear becoming inappropriate and inefficient for other uses.

Cultural resource use potential of the alternatives
None of the alternatives have specific provisions that would encourage or discourage customary and traditional uses of pelagic resources by indigenous cultural practitioners in Hawaii, American Samoa, Guam or the Commonwealth of Northern Mariana Islands.

Possible conflicts between the alternatives and other plans
The action alternatives are not expected to conflict with any existing conservation plan for pelagic fish or non-fish resources. All action alternatives are consistent with the National Plan of Action for Seabirds as well as with NMFS's Recovery Plans for Sea Turtles. None of the Alternatives conflict with the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve. Under section 6(a) of the Coral Reserve Executive Order (EO), the boundary of the reserve extends seaward to 50 nm. This definition of the reserve area is the same as the "protected species zone" that was established through Pelagics FMP Amendment 3 in which longline fishing is prohibited.

None of the alternatives propose new activities that would conflict with the access and use restrictions within National Wildlife Refuge (NWR) boundaries in the Northwestern Hawaiian Islands, at Johnston, Jarvis, Howland or Baker Islands, at Kingman Reef, or at Midway, Palmyra or Rose Atolls (American Samoa).

Adverse impacts that cannot be avoided
Implementation of any of the alternatives would result in some unavoidable adverse environmental effects. The following adverse effects are inescapable under some or all of the alternatives.

Direct impacts on sea turtles associated with longline fishery interactions
All alternatives are associated with some level of interactions between sea turtles and FMP managed longline fisheries as there is no longline fishing style or technology which completely neutralizes this hazzard.

Indirect impacts on sea turtle mortality associated with transferred effects
During late 2000, much of the historical Hawaii-based swordfish longline fishing effort relocated to areas offshore of Mexico and California (Honolulu Fish. Co., Pacific American Fish Co. and Taiwan Fish Co., pers. comm., November 2000). Proximity to Mexico's leatherback turtle nesting beaches, coupled with a lack of regulatory measures to reduce and mitigate sea turtle interactions, is anticipated to have increased the incidental longline take of this species compared to the type and levels of Hawaii-based longline fishing analyzed here. This effort relocation was historically a seasonal event, however regulations that restricted Hawaii longline permit re-registrations to the month of October have prohibited regular switching between these two fisheries. Alternatives that would allow some swordfishing by Hawaii-based vessels could

persuade some of these vessel operators to permanently relocate back to Hawaii, and thus reduce their impacts on sea turtles.

Over time, regulation of the entire US swordfish-style longline fishery may have the effect of encouraging vessels to relocate outside of US jurisdiction to foreign fisheries where there may be a complete lack of regulations, monitoring and trained scientific personnel. Scientists involved in conservation of dolphins in the eastern Pacific purse seine tuna fishery have observed that the strict environmental standards of some developed countries sometimes result in their fleets relocating to developing nations, where regulations are less strict. The impacts do not disappear; they are simply transferred to other areas (Hall, 1998). Again, alternatives that would allow swordfishing by Hawaii-based vessels could persuade some of these vessel operators to permanently relocate back to Hawaii, and thus reduce their impacts on sea turtles.

Market-driven indirect effects on sea turtle takes and mortalities associated with increased imports of fresh tuna and swordfish

The alternatives discussed here would restrict the Hawaii-based longline fishery in isolation from the international supply and market systems for tuna and swordfish. As the United States is a major consumer of these products, the narrow management focus could encourage expansion of fisheries operating outside of the EEZ. High Seas fisheries are not subject to the management requirements and provisions for protected species that apply to the Hawaii-based longline fishery. Products from these other fisheries could compete in the U.S. seafood market, replacing the reduction in fish products supplied by regulated U.S. pelagic fisheries. Levels of take and mortalities of sea turtles and other protected species in many of the areas from which substitute pelagic fish products could be imported are higher than those in the Hawaii-based longline fishery. Adverse cumulative affects on sea turtle populations from longline fishing can only be completely mitigated by the successful export of environmentally responsible fishing technologies to all fishing nations.

Continued displacement of pelagics FMP-managed domestic longline fishing vessels and associated pelagic fish marketing

Some or all of the vessels that have historically participated in the Hawaii-based swordfish Longline fishery are likely to remain in California or elsewhere under all action alternatives. Although vessels that are presently rigged for swordfish or mixed target Longline fishing could be converted to target tuna around Hawaii, swordfish vessel operating costs and vessel debt payments for financed boats may be too high to be recovered by the revenue typically generated by targeting tuna. Alternative fisheries and uses are fewer for swordfish vessels than for typically smaller tuna vessels. Thus vessels that continue to be displaced from the Hawaii-based swordfish fishery may not be readily adaptable to or economical for other fisheries. Potential buyers for a limited number of vessels displaced from the Hawaii-based Longline fishery might be found in a few island areas (e.g., Tonga, Fiji) where Longline fisheries are expanding.

All action alternatives would be expected to continue recent reductions in the supply of fresh swordfish and tuna landed in Hawaii for fresh marketing. The Honolulu fish auction, seafood brokers, wholesalers and retailers, and restaurants and other outlets engaged in the buying and selling of fresh Hawaii fish will suffer economic losses to the extent that continued supply reductions affect the scale and success of their operations.

Possible mitigation measures for unavoidable adverse effects. This section lists some of the possible ways in which unavoidable adverse effects of the alternatives might be mitigated. No attempt has made to define detailed programs for implementation of any of the possible mitigation measures.

Mitigation of cumulative impacts preventing recovery of ESA listed species

It is clear from Congressional discussion of the proposed Endangered Species Act (ESA) prior to its enactment in 1973 that the Congress intended that ESA-listed species be protected throughout the range of their critical habitat regardless of national boundaries. "The dominant theme pervading all Congressional discussion of the proposed ESA was the overriding need to devote whatever effort and resources were necessary to avoid further diminution of national and worldwide wildlife resources (emphasis added)...." (Coggins, 1975). International cooperation is a must to achieve conservation goals for protected species such as sea turtles that live in, and travel across, many national jurisdictions. That cooperation, however, requires a harmonization of objectives that has not yet often been achieved. Even though management needs to be international, each region presents different problems that need to be addressed. Both the global and local aspects of protected species conservation need to be considered, as has been discussed at the recent Bellagio conference and other national and international forums.

Mitigation of cumulative effects preventing the recovery sea turtle populations

Significant progress toward comprehensive conservation of threatened or endangered sea turtle species is likely to occur as effective and practicable mitigation technologies are developed, implemented domestically, and transferred to foreign fishing nations as described above. Equally important is the continued development of conservation programs aimed at protecting sea turtles in their nesting and coastal habitats.

International programs to protect sea turtles

The continued development of effective and practicable mitigation technologies and conservation measures such as those contained in this document will allow multi-lateral actions ranging from sea turtle nesting habitat protection to turtle protection provisions in trade agreements to be considered and implemented through appropriate regional fisheries management organizations or commissions, and under the bycatch provisions of the United Nations Fish Stocks Agreement (UNFSA), and the Food and Agricultural Organization's (FAO) Code of Conduct for Responsible Fisheries.

Reduction of sea turtle takes in fisheries worldwide
Such reductions are likely to occur as effective and practicable mitigation technologies are developed, implemented domestically, and transferred to foreign fishing nations as described above. Without such technologies, significant reductions are unlikely to occur.

Aside from any possible U.S. government initiatives, consumers might make purchasing decisions aimed at mitigating adverse effects on sea turtles and other protected species. These market-driven actions might include as a broad category of possibilities, eco-labeling initiatives and consumer boycotts. The role of the consumer could be focused on helping to resolve the problems of transferred adverse impacts on sea turtles and other protected species associated with importing seafood products into the U.S. market.

The consumer has been shown to be a formidable force in promoting tangible outcomes on protected species. Consider the issue of dolphin safe canned tuna. The threat of a consumer boycott drove the leading U.S. tuna canners to adopt "dolphin safe" labeling requirements. The same type of market-driven effort might prove equally successful in applying consumer pressure to encourage producers overseas and domestically to reduce adverse impacts on sea turtles, sea birds and sharks. However without effective and practicable technologies to reduce and mitigate sea turtle interactions, it will be difficult for fishery participants to meet this demand on a sustained basis.

Reduction of green sea turtle takes by Hawaii recreational shoreline fisheries
The Hawaii recreational shore fishery is a source of mortality specifically for green turtles. Of the 299 documented turtle strandings in the main Hawaiian Islands during 1999, 15 percent, or 43 animals, had recreational fishing hooks in them. The most serious aspect of green turtle interactions with recreational shore fishers is entanglement in monofilament fishing line. The line may get wrapped around the turtle's flipper and restrict its movements and ultimately may even sever the appendage. Twenty of the 43 documented turtle strandings related to recreational fishing were dead when recovered. The remaining 23 turtles were entangled in monofilament line (NMFS, 2000a). Anecdotal information from recreational fishers suggests that the rate of interaction with shoreline fishing gear is much higher than the NMFS-documented strandings. Until this far greater source of mortality is mitigated, the green turtle population in Hawaii is likely to remain threatened. This fishery is currently the subject of a detailed examination by NMFS of its impacts on sea turtles and other marine resources.

Mitigation of cumulative effects preventing the recovery of albatrosses

Nesting and other critical habitat conservation
Japan's "Short-Tailed Albatross Conservation and Management Master Plan" identifies a possible long-term goal of establishing additional short-tailed albatross breeding grounds away from the primary nesting colony at Torishima once there are at least 1,000 short-tailed albatross on Torishima (cited in FWS, 2000). Midway Atoll National Wildlife Refuge has been identified as a possible site for establishing an additional breeding colony (FWS, 2000). The northwest Pacific coast of the United States is a historical foraging area for the short-tailed albatross

(WPRFMC, 2001b). Until other safe breeding sites are established, short-tailed albatross survival will continue to be at risk due to the possibility of significant habitat loss and mortality from natural catastrophic volcanic eruptions and by land and mud slides caused by monsoon rains at the principal Torishima and Tsubamezaki nesting colonies in Japan (FWS, 2000).

Reduction of albatross takes in fisheries worldwide

An array of seabird mitigation methods has proven to be effective in significantly reducing the incidental take of albatross (WPRFMC, 2001b). More widespread use of such deterrents is expected as more countries adopt and implement national plans of action in conformance with the non-binding FAO International Plan of Action to reduce seabird bycatch in longline fisheries.

Technological innovation is likely to improve on currently available mitigation methods which are recommended by the Council (WPRFMC, 2001b) and by organizations such as FAO. It is important to continually evaluate new seabird mitigation methods and modifications of existing methods to improve their effectiveness and ease of use and to cope with possible habituation by seabirds to particular methods (WPRFMC, 2001b). As described in Section 14.0 the Council is now reexamining current seabird regulations and new technologies for their effectiveness.

Loss of revenue to Hawaii-based longline fishery participants

Programs for pelagic fishing vessel buyback and conversion were established by the governments of Japan, Korea and Taiwan after high-seas drift net fisheries conducted by these nations' fleets were terminated in 1992 in a response to a United Nations' resolution (Huppert and Mittleman, 1993). Permit and vessel buyback programs were established for U.S. fisheries in the Atlantic that were considered to be overcapitalized. It is unknown whether the U.S. government would establish a buyback program for Hawaii-based longline vessel owners who would be displaced by implementation of certain of the alternatives. A similar mitigation measure would be compensation of discounted future earnings of the vessels for a fixed time period, assuming compensation was based on a fishery with no additional restrictions.

Some holders of a Hawaii-based longline limited access permit, if displaced by implementation of any of the alternatives, might be willing to sell their permit or vessel to the federal government or a third party for the sole purpose of retiring the permit or vessel. Subject to the availability of funds for this purpose, the government might be willing to buy these permits or vessels to enable and encourage fishers who wish to pursue alternatives to longline fishing for swordfish in the Western Pacific Region. Any such buyout would require, at a minimum, a willing seller, a willing buyer and available funds.

No mitigation measures have been identified to subsidize the costs that would be incurred during the transition into new fisheries or new areas by Hawaii-based longline fishers who would continue to be displaced by implementation of certain of the alternatives.

Adaptive resource management

Most fishery management decisions are made with some degree of uncertainty because of incomplete information and marine resource unpredictability. These issues are magnified because one of the management objectives is to avoid the likelihood of jeopardizing sea turtles. Incidental capture of sea turtles by the Hawaii-based longline fishery is a rare event. Estimating or predicting the number of sea turtles that may be taken by the Hawaii-based longline fishery during any given year is hampered by lack of data. The number of interactions varies depending on the amount, type and distribution of longline fishing effort, natural variation in ocean conditions and sea turtle abundance. The available estimates do not include uncertainty associated with small sample size in the scientific studies or differences in handling of captured sea turtles between scientific studies and fishing operations. For example, information about the distribution and nature of sea turtle interactions will continue to accumulate and should be evaluated before future management changes are considered. For this reason, adaptive management is the best strategy because it allows for learning and continual improvement of resource management strategy based on new information.

12.0 Reasons for Choosing the Preferred Alternative

Unlike most terrestrial species, threatened and endangered marine species often cross political boundaries, or are found in areas shared by all nations (the high seas). To date, US fishery managers have worked to recover these species through the implementation and enforcement of domestic laws applicable in domestic waters and to US vessel operators wherever they fish. Unfortunately this has not worked to recover many marine species including sea turtles and marine mammals.

Regarding sea turtles, this approach is unlikely to be successful for two reasons related to scale of impacts. First, the proportion of adverse impacts attributable to U.S. fishing operations (or taking place in U.S. waters) is negligible in comparison to the global impacts of all fisheries. Second, even global fishery impacts pale in comparison to the historical and potential impacts of predation and directed harvests of turtle eggs and adults.

The closure of US fisheries due to interactions with sea turtles appears especially problematic as economic theory (and common sense) would predict that without further action, domestic production will be replaced with similar imported fish. Given that turtle interactions are associated with certain target species and gear types, it is likely that this imported fish will be linked to the same adverse impacts as the domestic fish. However, if US fisheries can remain open through the implementation of new gear or other requirements to mitigate sea turtle interactions, domestic fisheries can provide environmentally responsible products to US consumers, thus reducing a source of demand for harvests from less environmentally friendly fisheries.

Beyond domestic requirements, the development and subsequent “export” of environmentally friendly fishing technologies is an essential step in recovering sea turtle populations. As long as there is demand for fish that is associated with sea turtle interactions, there will be fisheries attempting to target those fish. The US cannot begin to realistically attempt to reduce the impacts of these fisheries until practical and effective technologies and tools are available.

How will these tools be “exported,” what will motivate other nations or fleets to adopt them? It is unclear how many fishing nations have laws to protect endangered species, those that do are likely to have constituencies that would assist in raising awareness and enthusiasm for the implementation of environmentally friendly fishing methods. Assuming mitigation methods that are practical and effective, at least some nations or fleets would likely adopt them simply to reduce adverse impacts on sea turtles which are widely regarded as charismatic mega-fauna.

Simultaneously, the existence of practical and effective mitigation methods would allow for the negotiation of trade sanctions, similar to those in place for shrimp. This would provide significant support for the less prescriptive efforts described above, and improve their chances for success while also ensuring an effective and consistent underlying platform for cases in which they fail.

Finally, but most importantly, scientists have found that recovery of sea turtle populations requires protection of their nesting beaches and coastal foraging areas as it is in these areas that the majority of adverse impacts occur. These impacts include beach degradation, foraging by dogs and pigs, and directed harvests of eggs and adults. Although located in remote areas, US fishery managers and other agencies have begun to fund protection programs for some of these important areas. A similar approach has been proposed by domestic fishery organizations, with the acknowledged intent of gaining “offsets” in terms of turtles saved which then can be balanced against those interactions occurring in their fishery. To date this type of trade-off has not been allowed. This policy is significantly hampering the recovery of sea turtle populations by failing to involve those US citizens most directly impacted. Experience has shown that the inclusion of domestic fishermen and fishing organizations in the implementation and ongoing support of conservation programs has been successful not only in motivating those involved, but in raising awareness and altering behaviors of many of those who are also exposed to educational or media campaigns. The denial of any “offsets” to domestic fisheries also has the unfortunate effect of further reducing incentives to recover sea turtle populations as theory (and common sense) tells us that fishery interactions are only likely to increase as sea turtle populations increase.

Besides recommending the implementation of new technologies to directly reduce and mitigate interactions between the Hawaii longline fishery and sea turtles, the preferred alternative also includes a range of international conservation measures to help offset the remaining impact of the preferred alternative on sea turtles. The positive impacts of these conservation measures are discussed both qualitatively and quantitatively in Section 10.7.

Recognition of similar offsetting conservation measures, in locations other than the proposed actionwas similarly included by NMFS in their October 2000 BiOp for the California/Oregon (C/A) drift gillnet fishery. In that BiOp, NMFS concluded that a series of time area closures for the fishery would reduce the number of leatherback turtle interactions associated with these fisheries by approximately 78%, with an analogous reduction in the number of leatherback turtles that would be seriously injured or killed by the fishery. NMFS also examined numerous other measures, including additional time/area closures and gear modifications in an effort to eliminate the probability of any leatherback turtles from being taken in the CA/OR drift gillnet fishery but no satisfactory measures were identified.

In response, NMFS affirmed a commitment to continue funding and implementation of measures to protect and conserve leatherback turtle populations in the eastern Pacific Ocean and to expand these measures to the western Pacific Ocean. The October 2000 BiOp states that NMFS will continue its collaborative programs to protect and conserve eastern Pacific leatherback turtles. This includes working cooperatively with the government of Mexico and Costa Rica at three index beaches to protect nesting females, eliminate illegal egg harvest, relocate nests to protected hatcheries, and maximize protection of all secondary nesting beaches.

Moreover, NMFS also committed itself to fund and implement a similar program in the western Pacific Ocean using measures patterned after those that have been used in the eastern Pacific Ocean. This comprehensive program would similarly include protection of female leatherback killed while nesting, protection of leatherback nests, and reductions in the number of fishery interactions with leatherback turtles.

The objective of the inclusion of the offsite conservation measures in foreign countries in the BiOP was to offset the remaining effects of the proposed action (continued operation of the CA/OR drift gillnet fishery) on the eastern Pacific leatherback population. NMFS determined that the proposed reduction in impacts to leatherback turtles offered by the conservation measures to protect nesting leatherbacks, their eggs and hatchlings, was sufficient to support a no jeopardy conclusion.

In further recognition of the importance of such conservation measures, NMFS has indicated that Councils should carry out actions identified in Recovery Plans that are necessary to conserve affected species[13].

In evaluating conservation measures as part of a proposed action, the ESA requires that two standards be applied by NMFS, namely conservation measures must be reasonably certain to be implemented and reasonably certain to be successful. This does not imply a standard of absolute certainty but only that NMFS must have a rational basis for concluding the conservation measures will be implemented.

The use of offsetting conservation measures is also consistent with the objectives of international collaborative efforts to recover sea turtles. As discussed above, the recent international Bellagio Conference was convened, among other primary objectives, to gain international acceptance of offsetting conservation measures such as those presented here. The meeting draft report contains a recommendation to ‘promote a broad set of sea turtle conservation initiatives to offset all sources of fisheries related turtle mortality’.

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[13]. Powerpoint presentation given to Council Members at a Council Orientation Workshop, October 2003, by P. Williams, NMFS Office of Protected Resources, Silver Spring Md.

Besides being consistent with previous actions the inclusion of conservation measures as part of a this document's preferred alternative are consistent with the provisions of the Endangered Species Act in terms of providing beneficial measures to mitigate adverse effects of the action. Section 7 of the ESA requires federal agencies to consult with NMFS (or the FWS as appropriate) prior to undertaking any action that may affect listed species or their designated critical habitat. When the action is expected to have significant adverse effects on the listed species or habitat, the action agency and applicant may agree to include in the proposed action conservation measures that mitigate for such adverse effects, allowing the relevant Service to reach a "no jeopardy" conclusion in its Biological Opinion.

Unlike most terrestrial species, threatened and endangered marine species often cross political boundaries, or are found in areas shared by all nations (the high seas). To date, U.S. fishery managers have worked to recover these species through the implementation and enforcement of domestic laws applicable in domestic waters and to U.S. vessel operators wherever they fish. Unfortunately this has not worked to recover many marine species including sea turtles and marine mammals.

Regarding sea turtles, this approach is unlikely to be successful for two reasons related to scale of impacts. First, the proportion of adverse impacts attributable to U.S. fishing operations (or taking place in U.S. waters) is negligible in comparison to the global impacts of all fisheries. Second, even global fishery impacts pale in comparison to the impacts of predation and directed harvests of turtle eggs and adults.

The closure of U.S. fisheries due to interactions with sea turtles appears especially problematic as economic theory (and common sense) would predict that without further action, domestic production will be replaced with similar imported fish. Given that turtle interactions are associated with certain target species and gear types, it is likely that this imported fish will be linked to the same adverse impacts as the domestic fish. However, if U.S. fisheries can remain open through the implementation of new gear or other requirements to mitigate sea turtle interactions, domestic fisheries can provide "turtle safe" products to U.S. consumers, thus reducing a source of demand for harvests from less environmentally friendly fisheries.
Beyond domestic requirements, the development and subsequent "export" of environmentally friendly fishing technologies is an essential step in recovering sea turtle populations. As long as there is demand for fish that is associated with sea turtle interactions, there will be fisheries attempting to target those fish. We cannot begin to realistically attempt to reduce the impacts of these fisheries until we have practical and effective tools to offer.

How will these tools be "exported," what will motivate other nations or fleets to adopt them? It is unclear how many fishing nations have laws to protect endangered species, those that do are likely to have constituencies that would assist in raising awareness and enthusiasm for the implementation of environmentally friendly fishing methods. Assuming mitigation methods that are practical and effective, at least some nations or fleets would likely adopt them simply to reduce adverse impacts on sea turtles which are widely regarded as charismatic mega-fauna.

Simultaneously, the existence of practical and effective mitigation methods would allow for the negotiation of trade sanctions, similar to those in place for shrimp. This would provide significant support for the less prescriptive efforts described above, and improve their chances for success while also ensuring an effective and consistent underlying platform for cases in which they fail.

Finally, but most important, scientists have found that recovery of sea turtle populations requires protection of their nesting beaches and coastal foraging areas as it is in these areas that the majority of adverse impacts occur. These impacts include beach degradation, foraging by dogs and pigs, and directed harvests of eggs and adults. Although located in remote areas, U.S. fishery managers and other agencies have begun to fund protection programs for some of these important areas. A similar approach has been proposed by domestic fishery organizations, with the acknowledged intent of gaining "offsets" in terms of turtles saved which then can be balanced against those interactions occurring in their fishery. To date this type of trade-off has not been allowed. This policy is significantly hampering the recovery of sea turtle populations by failing to involve those U.S. citizens most directly impacted. Experience has shown that the inclusion of domestic fishermen and fishing organizations in the implementation and ongoing support of conservation programs has been successful not only in motivating those involved, but in raising awareness and altering behaviors of many of those who are also exposed to educational or media campaigns. The denial of any "offsets" to domestic fisheries also has the unfortunate effect of further reducing incentives to recover sea turtle populations as theory (and common sense) tells us that fishery interactions are only likely to increase as sea turtle populations increase.

To continue on the current course of doing no more than the Endangered Species Act requires (to regulate activities in US waters or by U.S. citizens) is not likely to lead to the recovery of sea turtle populations - which is the intent of the Act. We must begin to supplement these regulations with additional activities designed to take into consideration the realities and motivations that direct human behavior. To do otherwise is to stubbornly follow an outdated approach that focuses on legalities rather than solutions and because it fails to consider a global perspective, is likely to exacerbate rather than alleviate threats to sea turtle populations.

13.0 Mitigative Measures

Relevant mitigative measures are presented as terms and conditions in the 2004 Biological Opinion prepared by NMFS' Office of Protected Resources for this action and presented in Section 14. In addition, all action alternatives include the pursuit of a suite of conservation measures to protect eggs and turtles on nesting beaches and in coastal foraging waters (Section 8.2).

14.0 Developments since the DSEIS was Published

On February 23, 2004, NMFS' Office of Protected Resources completed its consultation on the preferred alternative. This consultation was conducted in accordance with section 7 of the Endangered Species Act and resulted in the issuance of a Biological Opinion (attached as Appendix V). That 2004 Biological Opinion concluded that the preferred alternative including three measures that are expected to be implemented through future rule-making within the next year, is not likely to jeopardize the continued existence of sea turtles or other species listed under the Endangered Species Act. The three "future" measures are:

a) A requirement that operators of vessels registered for use under longline general permits annually attend a NMFS-conducted protected species workshop and carry on board a valid certificate of completion of the workshop.

b) A requirement that owners and operators of vessels registered for use under longline general permits that have a freeboard of more than three feet carry line clippers and dip nets meeting certain minimum design standards and wire or bolt cutters capable of cutting through the vessel's hooks and use these items in specified manners to disengage sea turtles and that certain turtle handling resuscitation, and release methods be employed.

c) A requirement that owners and operators of vessels registered for use under longline general permits that have a freeboard of three feet or less carry and use line clippers capable of cutting the fishing line or leader within about one foot of the eye of an embedded hook and wire or bolt cutters capable of cutting through the vessel's hooks and use these items in specified manners to disengage sea turtles and that certain turtle handling resuscitation, and release methods be employed.

These measures are part of the June 12, 2002 regulations that will be vacated by court order on April 1, 2004. They were previously recommended by the Council and were inadvertently omitted from Council's November 25, 2003 action. Initial action towards their reimplementation is expected to be taken at the Council's 122nd meeting to be held March 22-25, 2004 in Honolulu, Hawaii.

The 2004 Biological Opinion also includes a series of non-discretionary terms and conditions that must be implemented in order for the Pelagics FMP to remain in compliance with the Endangered Species Act. The most relevant of these are summarized below, and all measures are either in place, are part of the preferred alternative, or are expected to be implemented within the next year as one of the above future measures.

1. NOAA Fisheries shall continue the observer program aboard Hawaii-based limited access permit vessels to collect data on the incidental take of marine mammals, sea turtles, and other protected species. No vessel using shallow-set gear in the Hawaii-based fisheries shall be permitted to fish without observer coverage. Observer coverage in the deep-set longline fisheries generally shall be maintained at an annual average level of at least 20 percent.

2. NOAA Fisheries shall establish an observer program, where feasible, aboard longline vessels fishing under a Pelagics FMP general permit or a limited access permit for the American Samoa-based domestic longline fishery should such a permit program become established.

3. NOAA Fisheries shall continue to conduct protected species workshops for skippers of vessels registered for use with longline fishing permits issued under the Pelagics FMP to facilitate proficiency on mitigation, handling, and release techniques for turtles.

4. All sea turtles shall be removed from fishing gear or brought on deck prior to continuing with gear retrieval.

5. Personnel aboard a vessel registered for use with a longline permit issued under the Pelagics FMP must remove the hook from a turtle, if feasible, as quickly and carefully as possible to avoid injuring or killing the turtle. Each vessel must carry a line clipper. If a hook cannot be removed (e.g. the hook is deeply ingested or the animal is too large to bring aboard), the line clipper must be used to cut the line as close to the hook as practicable and remove as much line as possible prior to releasing the turtle.

6. Each longline vessel registered for use with a longline permit issued for use under the Pelagics FMP must carry a sea turtle dip net to hoist a sea turtle onto the deck, if practicable, to facilitate the removal of the hook. If the vessel is too small to carry a dipnet, sea turtles must be eased onto the deck by grasping its carapace or flippers if practicable, to facilitate removal of the hook. Any sea turtle brought onboard must not be dropped on the deck.

7. Each longline vessel registered for use with a longline permit issued under the Pelagics FMP must have a wire or bolt cutter on board the vessel capable of cutting through a hook that may be embedded externally, including the head/beak area of a turtle.

8. In the event of an interaction with a sea turtle, an operator of a vessel not using longlines but using hooks (i.e. handline, troll, and pole-and-line vessels) to target Pacific pelagic management unit species in U.S. western Pacific EEZ waters, must handle the turtle in a manner to minimize injury and promote post-hooking survival. If the sea turtle is too large or hooked in such a manner as to preclude safe boarding without causing further injury/damage to the turtle, the fishing line must be severed and as much line removed as possible prior to releasing the turtle.

9. Operators of vessels registered for use with longline permits issued under the Pelagics FMP shall bring comatose sea turtles aboard, if feasible, and perform resuscitation techniques.

10. Dead sea turtles may not be consumed, sold, landed, offloaded, transhipped or kept below deck, but must be returned to the ocean after identification unless NOAA-Fisheries requests the turtle be kept for further study.

Using NMFS' revised post-hooking mortality rates discussed in Section 10.4.2, the Biological Opinion contains the following Incidental Take Statement for the fisheries managed under the

Pelagics FMP. This take statement represents the total number of sea turtle interactions (captures, including mortalities) and mortalities expected each year under the preferred alternative in conjunction with the three future measures discussed above.

Table 64. The annual number of turtles expected to be captured or killed in the shallow-set longline fishery based out of Hawaii

	number captured	number killed
green sea turtles	1	1
hawksbill sea turtles	0	0
leatherback sea turtles	16	2
loggerhead sea turtles	17	3
olive ridley sea turtles	5	1

Table 65. The annual number of turtles expected to be captured or killed in the deep-set longline fishery based out of Hawaii

	number captured	number killed
green sea turtles	6	5
hawksbill sea turtles	0	0
leatherback sea turtles	18	7
loggerhead sea turtles	4	2
olive ridley sea turtles	37	35

Table 66. The annual number of turtles expected to be captured or killed in the handline fisheries, troll fisheries, pole and line fisheries managed under the Pelagics Fishery Management Plan as well as the longline fishery based out of American Samoa.

	number captured	number killed
hardshell sea turtles	6	1
leatherback sea turtles	1	0

In addition, based on new information the Council is anticipated to take initial action at its March, 2004 meeting on a range of measures to further reduce seabird interactions with the Hawaii-based longline fishery. Gilman et al. (2003) found that the use of a side-setting technique nearly eliminates seabird captures by Hawaii-based pelagic longline vessels and is the mitigation method most acceptable to industry participants. Previous studies found that the use of underwater setting chutes can also be effective in reducing seabird interactions, however they were harder to use and not as well accepted by participants. Other issues to be considered by the Council include the continued use of blue-dyed bait and strategic offal discards which are now thought to be less effective then previously believed, and the potential use of both paired and unpaired towed streamer lines. A complete NEPA analysis and biological consultation under the ESA are expected to accompany the implementation of any new measures to reduce seabird bycatch.

The Council and NMFS are also exploring ways to reduce and mitigate fishery interactions with marine mammals and will review available information as well as a range of potential approaches at the March, 2004 Council meeting.

15.0 SEIS Summary

This SEIS augments information and analyses contained in the 2001 FEIS which considered all of the pelagic fisheries of the western Pacific region. The FEIS was developed primarily to consider the effect of the Hawaii-based longline fishery on sea turtles with additional concern expressed concerning interactions with seabirds. Although the interaction rates with sea turtles by the longline fishery were low, given the downward trajectory of several of the sub-populations of sea turtles in the Pacific, there was considerable public concern about these interactions. As a result, a number of sea turtle conservation regulations were implemented in the Hawaii longline fishery.

This SEIS builds on the original FEIS and incorporates a wide range of new scientific information which has been developed in the past two years. The objective of the preferred alternative under this SEIS is to achieve the optimum yield and promote domestic marketing of pelagic species from the Hawaii longline fishery on a long-term basis without jeopardizing threatened or endangered sea turtles or other marine species. The SEIS focuses on the Hawaii longline fisheries in the context of the opportunity to implement new fishing technologies in the Hawaii longline fishery for swordfish while still maintaining conservationist protections toward endangered and threatened sea turtles. Of particular importance to the preferred alternative was the development of new gear configurations – circle hooks with mackerel bait – during experiments conducted by NMFS in the Atlantic over the past three years. This new gear led to dramatic reductions in the rates of sea turtle interactions and mortalities for the U.S. swordfish vessels conducting the study. This alternative also includes the pursuit of conservation projects to be implemented throughout the Pacific rim in conjunction with national governments and non-governmental conservation organizations. These measures would include protection of eggs from directed harvest, predation and erosion on various nesting beaches, reduction of directed harvest of adult sea turtles in coastal waters, and workshops with local villagers to stress the importance of conserving sea turtles.

Longline-turtle regulations implemented in 2002 led to the closure of the Hawaii-based domestic longline fishery for swordfish and implementation of a time-area closure south of Hawaii for the remaining longline fishery for tuna. The effect of these closures was a 20% decline in landings and a 40% decline in ex vessel revenue. The longline fishery itself comprised over 70% of Hawaii's commercial fishery. This closure had a strong impact on all segments of the longline fishery, but particularly those which targeted swordfish. As the original FEIS indicated, there was also a strong environmental justice component to this impact, since many of the vessels which targeted swordfish were owned, captained and crewed by Vietnamese-Americans. Many of these fishermen moved their operations to California (where they are now facing increased restrictions if not closure) and as a result their families were disrupted. The Hawaii seafood market was also strongly affected, since swordfish represented an important export (to the mainland U.S.) product. In the meantime, there has been a substantial increase in unregulated foreign longline fishing in the swordfish grounds outside the Hawaii EEZ with their product appearing as imports in the domestic U.S. markets. The result may be that while well regulated U.S. longline vessels are precluded from fishing, foreign longline fishing may now be having as great an impact on sea turtles.

Litigation over the ESA section 7 Biological Opinion conducted for this fishery in 2001 and 2002 led to a Federal court decision in August 2003 to vacate these sea turtle conservation measures in April 2004 unless a new Biological Opinion was developed. In the absence of those regulations, either longline fishing in Hawaii as a whole would be subject to closure in the absence of an Incidental Take Statement authorized by a valid Biological Opinion or sea turtles would be at some risk given the absence of conservation measures.

The issues considered in this SEIS have been thoroughly discussed in the public over the past six months. The Council had initiated consideration of reductions or elimination in the southern time-area closure in June 2003. In September 2003 the Council proposed emergency measures in response to the Federal Court decision to vacate the previous regulations. Subsequently the Council established a special sea turtle advisory committee consisting of representatives of the four parties central to this issue: the Hawaii fishing industry, conservation organizations, the National Marine Fisheries Service, and the Council itself. This committee met three times during the fall, including once in Washington, D.C. and presented a series of recommendations to the Council for its October 2003 meeting where the measures which form the preferred alternative were approved. The first and last of these meetings were preceded by one or more announcements in the local newspaper inviting the public to attend (Honolulu Advertiser).

Coincidentally, the Pacific Islands Regional Office had initiated scoping for a separate SEIS to consider a broad range of issues concerning the pelagic fisheries of the western Pacific. These initially included seabird mitigation in various pelagic fisheries and a developing high seas squid fishery but subsequently considered other issues including sea turtle conservation in the Hawaii longline fishery. These meetings were held in American Samoa, Guam, several locations in Hawaii, and the Northern Mariana Islands in the Fall of 2003. Combined with the on-going Council meetings and those of its special sea turtle advisory committee, and the public attention to the Federal Court ruling, broad avenues have been available for public input into the issues to be considered by this SEIS.

There are a number of areas of potential controversy incumbent upon the preferred alternative. First, re-opening the swordfish component of the Hawaii longline fishery and the southern time-area closure for the tuna component is likely to increase sea turtle interactions when compared to the current regulations (which will be vacated on April 1, 2004 by court order). The status of two species of sea turtles taken in the Hawaii longline – leatherback and loggerhead – appears based on sampling at some nesting beaches to be dire due to decades of directed harvesting, habitat destruction, and coastal fisheries and potentially exogenous environmental factors such as climate changes which may affect reproductive success on the nesting beaches. Although the Hawaii longline fishery comprises a very small proportion of Pacific-wide longline fisheries, less than 3% percent by most recent estimates, many conservation groups are concerned with any take in the Hawaii longline fishery. (Indeed, it was originally litigation from conservation groups in 1999 that led to the first sea turtle conservation measures in the Hawaii longline fishery.) Second, there is substantial uncertainty about their precise population status as well as the biological and ecological dynamics of those populations. Several competing models have appeared in the scientific literature or from respected scientific research institutes. Lack of scientific consensus on the impact of the Hawaii longline fishery on sea turtles has been a substantial source of controversy and is likely to remain so for a number of years. A third issue is the efficacy of the Atlantic gear measures as applied to the Pacific. The NMFS Honolulu Laboratory conducted a variety of gear experiments in recent years because applicability of the gear configuration measures then being tested in the Atlantic seemed weak due to different fishing and oceanographic conditions in the Hawaii longline fishery. These experiments were halted by litigation since they involved a control-treatment approach which would have resulted in the take of substantial numbers of turtles. Fourth, the idea of "transferred effects," i.e., the potential substitution of Hawaii-harvested swordfish by foreign-harvested swordfish in seafood markets, has also been somewhat controversial. Although both intuition and anecdotal evidence on this is available, definitive studies have yet to be concluded. Finally, although the conservation projects are clearly beneficial to the sea turtle populations, questions continue concerning the duration of these projects and whether they should be viewed as "offsets" or mitigation to the remaining incidental takes in the Hawaii longline fishery.

The major conclusion of the SEIS is that implementation of Atlantic gear mitigation measures in the Hawaii swordfish fishery should be expected to reduce sea turtle interactions dramatically. The choice of the preferred alternative was premised on scientific information from the Pacific Islands Fishery Science Center and other sources, as well as on the Office of Protected Resources' review and ranking of the alternatives regarding their likelihood to jeopardize sea turtle populations. Also relevant is the potential the preferred alternative offers to "model" the new gear technologies for transfer to international longline fleets.

There remain a number of scientific issues to be resolved, particularly concerning the population dynamics of Pacific sub-populations of sea turtles and the efficacy of conservation projects in recovering those populations (although evidence from Atlantic and Caribbean nesting beach protection has shown dramatic turn-abouts in population trajectories in shorter time periods than might be expected). There also remains an issue concerning the ability of the United States to export this new gear technology to foreign longline fisheries, including those that have fished in the North Pacific near the Hawaii EEZ. The existence of the Hawaii longline fishery as a "model" for this gear, as well as concerted efforts to meet with fishing agencies and companies from Japan, South Korea, Taiwan, and China, should help resolve this issue.

In conclusion, the objective of this SEIS is to provide decision-makers, and the public, with a broad range of objective information on which to make a science-based conservation decision. It presents a wealth of new information since the publication of the FEIS in 2001, and at the same time it acknowledges the information on which to make this decision is not perfect. It is, however, the best available scientific information, and if transferred effects are on-going, delay in implementing these measures in the U.S. fishery in the central Pacific will not aid the status of sea turtles.

Scoping for a separate SEIS discussed above to examine a broad range of issues, potentially including the impacts of various pelagic fisheries on seabirds, the impact of a developing high seas squid fishery, and the impact of the growing deployment of private fish aggregation devices around Hawaii has been completed and a draft document is anticipated to be available in late 2004.

16.0 Consistency with 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 consistent with National Standard 1 because it would allow the Hawaii longline fishery to exploit the North Pacific swordfish resource, which is currently not being targeted by the Hawaii fleet. The diversification of fishing will promote greater economic opportunities for the Hawaii-based longline fishery, while the limited entry program and limits on shallow -sets minimizes any risks of over fishing or local depletion of the North Pacific swordfish resource. The diversification of fishing, through allowing shallow-set longlining for swordfish will also reduce the targeting of bigeye tuna and hence reduce the fraction of fishing mortality on this stock, generated by the Hawaii-based longline fleet. Pacific bigeye is currently thought to be fished at or approaching MSY throughout its range. Although not a target species, and not a component of the Pelagic Management Unit, the preferred alternative also mitigates fishery impacts on Pacific turtle populations.

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

The preferred alternative is based on the best scientific data available for new technologies and conservation programs as well as information on the Hawaii longline fishery, other Western Pacific pelagic fisheries, and potentially affected turtle populations. Information on the impacts of the alternatives on fish and turtle catches by the longline fishery were generated from a simulation model developed by the NMFS PIFSC from logbook and observer data. Given current uncertainty concerning sea turtle populations, the impacts of the preferred alternative were assessed using an extensively reviewed turtle population simulation model under a series of steady-state (turtle populations not declining) and increasingly worse scenarios (turtle populations declining.)

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 consistent with National Standard 3.The Council has considered and taken into account of the range of managed species in formulating these management measures for the Hawaii longline fishery. The preferred alternative specifically accounts for the extensive range of Pacific leatherback and loggerhead turtles, and their use of high seas, coastal and terrestrial habitat through the inclusion of turtle conservation measures. The turtle conservation measures focus on nesting beaches and foraging grounds, mainly at foreign locations along the Pacific Rim, to minimize impacts to the recruitment of loggerhead and leatherback turtles from both fishery and non-fishery related sources.

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 is consistent with National Standard 4 and does not discriminate between residents of different states. The Hawaii longline fishery is a limited entry fishery, with permits that are freely transferable between individuals from any US state or territory.

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 consistent with National Standard 5 as it would improve the efficiency of the Hawaii longline fishery. Under the current regulations the fishery is denied access to elements of the greater pelagic fish stock of the North Pacific, i.e. those species which require shallow longline sets to effect capture in economically viable quantities. The preferred alternative corrects this inefficiency by permitting the targeting of the underutilized swordfish resource.

National Standard 6 states that *conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources and catches*.

The preferred alternative is consistent with National Standard 6 because it contains management measures which focus on the Hawaii-based longline fishery that is where virtually all turtle interactions occur. The reopening of the swordfish fishery also provides the US consumer with the choice of buying swordfish from an environmentally-friendly longline fishery.

National Standard 7 states that *conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication*.

The preferred alternative is consistent with National Standard 7 because its gear modifications, (circle hooks and mackerel-type bait), are low cost, practicable and effective modifications to the method of longline fishing for swordfish. They do not differ markedly from fishing methods already employed by the longline fishery, but used in combination have been shown to greatly reduce turtle interactions, while increasing swordfish catches.

National Standard 8 states that *conservation and management measures shall be consistent with the conservation requirements of the Magnuson-Stevens 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 consistent with National Standard 8 in that it recognizes the importance of targeting the swordfish resource to the longline fishing community in Hawaii. The closure of the fishery reduced the revenues from the Hawaii longline fishery by about 40% and affected upwards of 500 jobs in the State of Hawaii. Further, the closure of the swordfish fishery in 2001 displaced over 20 longline vessels to California, where they could continue targeting North Pacific swordfish. These vessels will be able to resume operating from Hawaii with the restablishement of the preferred alternative, thus enabling the return and reunification of fractured families.

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 consistent with National Standard 9 because it maintains major reductions in turtle and seabird longline interactions, while allowing for limited swordfish targeting shallow-set longlining. The preferred alternative also included ‘hard limits’ for leatherback and loggerhead interactions that will close the swordfish fishery if these limits are reached or exceeded in a given year. The preferred alternative also includes conservation measures for loggerhead and leatherback turtles to counteract any additional harm posed by the Hawaii longline fishery.

National Standard 10 states that *conservation and management measures shall, to the extent practicable, promote the safety of human life at sea*.

The preferred alternative is consistent with National Standard 10. The gear requirements for the fishery are not dissimilar to those already used in the fishery and thus do not represent any additional hazard to fishermen. The use of circle hooks may in fact reduce accidental hookings of fishermen, and the use of dehookers may similarly reduce the opportunity for injuries that arise from removing hooks by hand.

16.1 Regulatory Flexibility Act

The Regulatory Flexibility Act, 5 U.S.C. 601 et seq. (RFA) requires government agencies to assess the impact of their regulatory actions on small businesses and other small organizations via the preparation of Regulatory Flexibility Analyses. Please see Appendix A for this analysis.

16.2 Executive Order 12866

In order to meet the requirements of Executive Order 12866 (E.O. 12866), NMFS requires that a Regulatory Impact Review (RIR) be prepared for all regulatory actions that are of public interest. This review provides an overview of the problem, policy objectives and anticipated impacts of the action and ensures that management alternatives are systematically and comprehensively evaluated such that the public welfare can be enhanced in the most efficient and cost effective way. Please see Appendix A for this analysis.

16.3 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 and territorial government agencies in Hawaii, American Samoa, Guam and CNMI for review and concurrence with a determination made by NMFS that the recommended measure is consistent, to the maximum extent practicable, with the state and territorial coastal zone management programs.

16.4 Endangered Species Act

Based on research, logbook, and observer information, the following endangered and threatened species occur in the action area and may be affected by the ongoing operations of domestic fisheries in the Western Pacific Region under the Pelagics FMP:

Marine Mammals	**Status**
Hawaiian monk seal (*Monachus schauinslandi*)	Endangered
Blue whale (*Balaenoptera musculus*)	Endangered
Fin whale (*Balaenoptera physalus*)	Endangered
Humpback whale (*Megaptera novaeangliae*)	Endangered
Northern right whale (*Eubalaena glacialis*)	Endangered
Sei whale (*Balaenoptera borealis*)	Endangered
Sperm whale (*Physeter macrocephalus*)	Endangered
Sea Turtles	
Green turtle (*Chelonia mydas*)	Endangered/Threatened
Hawksbill turtle (*Eretmochelys imbricata*)	Endangered
Leatherback turtle (*Dermochelys coriacea*)	Endangered
Loggerhead turtle (*Caretta caretta*)	Threatened
Olive Ridley turtle (*Lepidochelys olivacea*)	Endangered /Threatened
Seabirds	
Short-tail albatross (*Phoebastaria albatrus*)	Endangered

In general, four different fishing gear types are used under the Pelagics FMP: troll, handline, pole-and-line and longline gear. The type of fishing gear used and the area fished will affect the likelihood of an interaction with a sea turtle, marine mammal or seabird. Note: a Biological Opinion issued by the Fish and Wildlife Service (FWS) on November 28, 2000 and amended on November 18, 2002 examined the Hawaii-based longline fishery as it operated in 1999 (prior to the prohibition on shallow-setting) and included measures to mitigate interactions between shallow-setting vessels and seabirds. However, between the time the FWS BiOp was issued and implemented, shallow-setting was prohibited by NMFS. In acknowledgment of the outstanding requirement, all action alternatives would include implementation of this requirement and thus be in conformance with the FWS BiOp.

Troll fisheries: Although the spatial distribution of FMP troll fisheries overlaps with the distribution of sea turtles and listed marine mammals, there have been no reported interactions by vessel operators. In addition, sea turtles are not likely to interact with troll fishing gear because the gear is towed through the water faster than sea turtles may be traveling. Furthermore, sea turtles and listed marine mammals do not prey on the bait species used by the troll fisheries. A small potential exists that the fishing gear may incidentally hook or entangle a sea turtle or listed marine mammal when the gear is towed through the water. However, this type of an interaction is extremely rare, and the lack of any reported interactions in this fishery may confirm this assessment, although, a lack of reported information does not necessarily equate to a lack of interactions. Therefore, incidental capture of sea turtles or marine mammals in these fisheries is expected to be rare and, due to the immediate retrieval of the gear, not likely to result in serious injury or mortality of the captured animal. No listed seabird species are known to interact with this fishery.

Pole-and-line fishery: Although the distribution of the FMP pole-and-line fishery overlaps with the distribution of sea turtles and listed marine mammals, the likelihood of an interaction with a sea turtle or listed marine mammal is very low because the turtle or marine mammal would need to be in the vicinity and the fisher would need to hook the animal or the animal would need to strike the hook. This type of an event is unlikely to occur because sea turtles and listed marine mammals are not likely to prey on the anchovy bait typically used, and the fish feeding frenzies produced by fishing operations would deter turtles from remaining in the area. No listed seabird species are known to interact with this fishery.

Handline fisheries: There have been no reported interactions between gear used in the Pelagics FMP handline fisheries and sea turtles or listed marine mammals. Although there is the risk that sea turtles or listed marine mammals may become hooked or entangled in the fishing gear, any caught animal can be immediately dehooked or disentangled and released. Moreover, most turtles or listed marine mammals found in the area of the handline fisheries are not likely to prey on the baited hooks. No listed seabird species are known to interact with this fishery.

Longline gear - Hawaii-based fishery:
Please see Sections 9.1.4 through 9.1.4.17 for a detailed description of this fishery and its impacts on endangered and threatened species.

On February 23, 2004, NMFS completed a consultation on the preferred alternative under section 7 of the Endangered Species Act. This consultation resulted in the issuance of a Biological Opinion (attached as Appendix V). That Opinion concluded that the preferred alternative, including three measures expected to be implemented within the next year, is not likely to jeopardize the continued existence of sea turtles or other species listed as threatened or endangered under the Endangered Species Act. The three “future” measures are:

a) a requirement that operators of vessels registered for use under longline general permits annually attend a NMFS-conducted protected species workshop and carry on board a valid certificate of completion of the workshop;

b) a requirement that owners and operators of vessels registered for use under longline general permits that have a freeboard of more than three feet carry line clippers and dip nets meeting certain minimum design standards and wire or bolt cutters capable of cutting through the vessel’s hooks and use these items in specified manners to disengage sea turtles and that certain turtle handling resuscitation, and release methods be employed; and

c) a requirement that owners and operators of vessels registered for use under longline general permits that have a freeboard of three feet or less carry and use line clippers capable of cutting the fishing line or leader within about one foot of the eye of an embedded hook and wire or bolt cutters capable of cutting through the vessel's hooks and use these items in specified manners to disengage sea turtles and that certain turtle handling resuscitation, and release methods be employed.

These measures are part of the June 12, 2002 regulations that will be vacated by court order on April 1, 2004. They were previously recommended by the Council and were inadvertently omitted from Council's November 25, 2003 action. Initial action towards their reimplementation is expected to be taken at the Council's 122nd meeting to be held March 22-25, 2004 in Honolulu, Hawaii.

Using the revised post-hooking mortality rates discussed in Section 10.4.2, the Biological Opinion contains the following Incidental Take Statement for the fisheries managed under the Pelagics FMP. This take statement represents the total number of sea turtle interactions (captures, including mortalities) and mortalities expected each year under the preferred alternative in conjunction with the three future measures discussed above.

Table 67. The annual number of turtles expected to be captured or killed in the shallow-set longline fishery based out of Hawaii

	number captured	number killed
green sea turtles	1	1
hawksbill sea turtles	0	0
leatherback sea turtles	16	2
loggerhead sea turtles	17	3
olive ridley sea turtles	5	1

Table 68. The annual number of turtles expected to be captured or killed in the deep-set longline fishery based out of Hawaii

	number captured	number killed
green sea turtles	6	5
hawksbill sea turtles	0	0
leatherback sea turtles	18	7
loggerhead sea turtles	4	2
olive ridley sea turtles	37	35

Table 69. The annual number of turtles expected to be captured or killed in the handline fisheries, troll fisheries, pole and line fisheries managed under the Pelagics Fishery Management Plan as well as the longline fishery based out of American Samoa.

	number captured	number killed
hardshell sea turtles	6	1
leatherback sea turtles	1	0

16.5 Marine Mammal Protection Act

All pelagic fisheries in the Western Pacific Region under Council jurisdiction are classified as Category III under Section 118 of the Marine Mammal Protection Act (MMPA) of 1972 (FR 66 42780). Based on research, logbook, and observer data, marine mammals not listed as endangered or threatened under the ESA (and therefore not discussed in Section 10.3 above) that are believed to be in the action area 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*)

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.

16.6 Paperwork Reduction Act

Among other measures, the preferred alternative (Alternative 4) would limit the Hawaii-based pelagic longline fishing fleet to 2,120 shallow sets annually and require all longline vessels targeting swordfish to use circle hooks and mackerel-type bait. In order to effectively implement a fishing effort limitation program, a system was selected as a preferred option that would divide allowable effort (sets) equally among interested permit holders each year (Participation Option 5). Under this system, all vessel owners who hold Hawaii longline limited access permits would be asked, prior to the beginning of each calendar year, to inform NMFS of their interest in receiving shares of the allowable effort or longline sets. The shares would then be distributed equally to all interested permit holders. There is a maximum of 164 permit holders in the Hawaii longline limited access fishery.

The annual process by which fishermen would inform NMFS of their interest in obtaining shares of shallow-set longline effort is a collection-of-information activity subject to review and approval by the Office of Management and Budget, in compliance with the Paperwork Reduction Act (PRA) and its implementing regulations. It is projected that between 100 and 164 permit holders would annually inform NMFS of their interest in receiving allowable set shares. Permit holders would simply indicate to NMFS an affirmative ("yes") or negative ("no") interest. No response from a permit holder by a specified date, published in the Federal Register, will be considered a negative interest in obtaining allowable set shares for the forthcoming calendar year.

The public reporting burden for this collection-of-information (no form) is estimated at 10 minutes per response, which includes the time to send a letter, via mail or facsimile, to the NMFS Pacific Regional Office in Honolulu.

Implementation of the preferred alternative in a cost-effective manner requires a high level of observer coverage in the reactivated swordfish sector of the Hawaii-based longline fishery. Initially, NMFS intends to place observers aboard all vessels registered for use with Hawaii longline permits during trips that target swordfish. In order for NMFS to determine for logistical purpose which vessel trips will be required to carry an observer, a permit holder or an agent designated by the permit holder must declare to NMFS - prior to leaving port on a fishing trip- the type of fishing (swordfish or tuna) his or her vessel will be engaged in. This declaration will be included in the current pre-trip observer notification (50 CFR §660.23) which is currently covered under OMB No. 0648-0214. The public reporting burden for this collection-of-information (no form), including the declaration of fishing trip type, is estimated at 4 minutes per trip.

16.7 Essential Fish Habitat

None of the alternatives are expected to have adverse impacts on EFH or HAPC for species managed under the Pelagics, Bottomfish and Seamount Groundfish, Precious Corals, Crustaceans, or Coral Reef Ecosystems FMPs for the Western Pacific Region. EFH and HAPC for these species groups have been defined as presented in Table 70. Longline fishing consists of suspending a series of steel hooks from nylon lines within the epi-pelagic zone of the high seas.

This action would not have any substantial impact on the physical and chemical properties of the water column, given the inert nature of the materials used and the suspension of longlines beyond any demersal substrates in shallow or coastal waters. Longline fishing by the Hawaii fleet, is thus unlikely 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.

16.8 Traditional Indigenous Fishing Practices

None of the alternatives will have any impact on traditional and indigenous fishing practices.

Table 70. 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

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)

17.0 Index

NOTE: This index is not exhaustive in its references, but it provides the primary location for information about the given subject.

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