Amendment 18 to the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region

Including a Final Supplemental Environmental Impact Statement,
Regulatory Impact Review, and
Initial Regulatory Flexibility Act Analysis

Management Modifications for the
Hawaii-based Shallow-set Longline Swordfish Fishery that Would
Remove Effort Limits, Eliminate the Set Certificate Program, and
Implement New Sea Turtle Interaction Caps

Western Pacific Regional Fishery Management Council
1164 Bishop Street, Suite 1400
Honolulu, HI 96813

March 10, 2009

Cover photo: Fresh swordfish (headed and gutted) landed by the Hawaii longline shallow-set fishery and on sale at Hawaii's wholesale fish auction, the United Fishing Agency in Honolulu, HI. Photo courtesy of the Western Pacific Regional Fishery Management Council.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
PROGRAM PLANNING AND INTEGRATION
Silver Spring, Maryland 20910

MAR 18 2009

Dear Reviewer:

In accordance with provisions of the National Environmental Policy Act (NEPA), we enclose for your review, "Amendment 18 to the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region: Management Modifications for the Hawaii-based Shallow-set Longline Swordfish Fishery that Would Remove Effort Limits, Eliminate the Set Certificate Program, and Implement New Sea Turtle Interaction Caps." Amendment 18 includes a Final Supplemental Environmental Impact Statement (FSEIS)," dated March 10, 2009.

This FSEIS is prepared pursuant to NEPA to assess the environmental impacts associated with NOAA proceeding with management modifications for the Hawaii-based shallow-set longline fishery. Based on the alternatives considered, the Western Pacific Fishery Management Council has recommended that the National Marine Fisheries Service implement the following proposed action: remove the effort set limit and implement a new loggerhead sea turtle interaction hard cap at 46, and eliminate the set-certificate program. The purpose and need for this action is to provide increased opportunities for the sustainable harvest of swordfish and other fish species, while continuing to avoid jeopardizing the existence and/or recovery of threatened and endangered sea turtles or their habitat.

The FSEIS supplements the analysis in the "Final Environmental Impact Statement regarding Pelagic Fisheries of the Western Pacific Region, Fishery Management Plan To Analyze Longline, Commercial Troll and Recreational Troll Fisheries, Commercial Pelagic Handline and Commercial Pole and Line Skipjack Fishery, Hawaii, American Samoa, Guam and Commonwealth of the Northern Mariana Islands," which was made available to the public on May 11, 2001, through ERP No. F-NOA-K91008-00.

A draft SEIS was made available for a 45-day public comment period on August 22, 2008, through EPA Notice [ER-FRL-8584-8] as EIS No. 20080320. Seven comment letters were received and the comments were considered in preparing this FSEIS.

Additional copies of the FSEIS are available in hard copy or on a compact disk from the Responsible Program Official identified below. A complete electronic version is also available electronically through the Western Pacific Fishery Management Council's website at: http://www.wpcouncil.org/pelagic.htm or through NOAA National Marine Fishery Services' Pacific Islands Regional Office at: http://www.fpir.noaa.gov/DIR/dir_public_documents.html.

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NOAA is not required to respond to comments received as a result of issuance of the FSEIS. However, comments received by May 11, 2009, will be reviewed and considered for their impact on issuance of a record of decision (ROD). Please send comments to the responsible official identified below. The ROD will be made available publicly following final agency action in or around June 2009.

Responsible Program Official:

William L. Robinson
Regional Administrator
Pacific Islands Regional Office
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
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Telephone: (808) 944-2200 Fax: (808) 973-2941
Mail or fax comments to the above address or

Thank you for your continued interest in Western Pacific pelagic fishery management measures for the Hawaii-based shallow-set longline fishery.

Sincerely,

for Paul N. Doremus, Ph.D.
NOAA NEPA Coordinator

Enclosure

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Hawaii-based Shallow-set Longline Swordfish Fishery that Would
Remove Effort Limits, Eliminate the Set Certificate Program, and
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March 10, 2009

Responsible Agency:

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Abstract:
This document analyzes management alternatives that would modify the existing regulatory regime for the Hawaii-based shallow-set longline fishery that primarily targets swordfish on the high seas of the North Pacific. Categories of alternatives include: shallow-set effort, administration of fishery participation, and time/area closures. Based on the alternatives considered, the Western Pacific Regional Fishery Management Council has recommend that the National Marine Fisheries Service implement the following proposed action: remove the effort set limit and implement new loggerhead and leatherback sea turtle interaction hard caps at 46 and 16, respectively, eliminate the set certificate program, and do not implement any time/area closures. The purpose and need for this action is to provide increased opportunities for sustainable harvest of swordfish and other fish species, while continuing to avoid jeopardizing the existence and/or recovery of threatened and endangered sea turtles or their habitat. A Notice of Availability initiating a 45-day public comment period on the Draft Supplemental Environmental Impact Statement that preceded this document appeared in the *Federal Register* on August 22, 2008. That 45-day public comment period ended October 6, 2008, and responses to public comments received appear in Appendix VII.

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Executive Summary

This document describes and analyzes the potential environmental and social-economic impacts of proposed regulatory modifications for the Hawaii-based shallow-set longline fishery (shallow-set fishery) which is managed under the Fishery Management Plan (FMP) for Pelagic Fisheries of the Western Pacific Region (Pelagics FMP). All measures currently applicable to Hawaii-based deep-set longline fishing targeting bigeye tuna and other species will remain unchanged. The current shallow-set fishery[1], which targets swordfish, began operations as a model fishery in the fourth quarter of 2004 and is subject to a suite of regulations intended to reduce the potential number and severity of interactions between fishing gear and sea turtles which are listed as threatened and endangered under the Endangered Species Act (ESA). Among other requirements, vessel operators in the Hawaii-based shallow-set fishery must use large (18/0) circle hooks with a 10 degree offset and mackerel-type bait, may not make more than a total of 2,120 shallow-sets per year, must comply with a set certificate program, and may not interact with (hook or entangle) more than a total of 17 loggerhead sea turtles or 16 leatherback sea turtles each year. In addition, every vessel must carry a Federal observer when shallow-setting (100 percent observer coverage). Note that the existing annual sea turtle interaction limits of 17 loggerheads and 16 leatherbacks do not represent the upper limit of allowable interactions; rather, they were based on expected effort multiplied by interaction rates derived from studies using circle hooks and mackerel bait in U.S. longline fisheries in the Atlantic. In combination with the measures to reopen the shallow-set fishery in 2004, the Western Pacific Regional Fishery Management Council (WPRFMC or Council) implemented sea turtle conservation projects to benefit the survival and recovery of Pacific loggerhead and leatherback sea turtle populations.

The required use of circle hooks and mackerel-type bait in the shallow-set fishery has reduced sea turtle interactions rate by approximately 90 percent for loggerheads, 83 percent for leatherbacks, and 89 percent for combined species, compared to the previous period (1994–2002) when the fishery was operating without such gear (Gilman and Kobayashi, 2007). Because the use of circle hooks and mackerel-type bait have proven effective in reducing interaction rates, this document examines a range of alternative shallow-set fishery regimes that would: allow increased shallow-set fishing effort and changes to associated sea turtle interaction hard caps; maintain or eliminate the set certificate program; and potentially adopt time-area closures.

In February 2007, the Hawaii Longline Association (HLA) provided the Council and the National Marine Fisheries Service (NMFS) a proposal to amend certain FMP regulations applicable to the shallow-set fishery. HLA's proposal requested the following regulatory changes: 1) elimination of the existing effort limit of 2,120 sets, 2) new sea turtle interaction

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[1] The Hawaii-based longline fishery for swordfish began in the late-1980s and has since been managed under the Pelagics FMP. The fishery was closed from 2001-2003 due to concerns with sea turtle interactions. The fishery was reopened in 2004 with gear and bait requirements to reduce sea turtle interactions as well as hard limits on sea turtle interactions, that if reached, close the fishery for the remainder of the year.

limits premised upon a projected increase in the annual shallow-set fishing effort to 3.5 million hooks, and 3) track sea turtle interactions over a three year period. HLA's proposal provided for the continuation of all other existing management and conservation measures. According to HLA, the proposal is premised upon three sources of data and information that were not available in 2004 when the current shallow-set fishery was implemented: 1) the actual sea turtle interaction and mortality rates experienced by the Hawaii-based fishery since the 2004 implementation of new gear requirements, 2) the beneficial effects of ongoing sea turtle conservation measures being undertaken by the Council to offset sea turtle interactions occurring in the combined Hawaii-based longline fisheries, and 3) the transferred effects on sea turtle conservation from shallow-set fishing effort restrictions in Hawaii.

In response to the HLA's proposal, the Council developed and recommended NMFS implement Amendment 18, which is described in this document. The purpose of this amendment to the Pelagics FMP is to provide increased opportunities for the shallow-set fishery to sustainably harvest swordfish and other fish species while continuing to avoid jeopardizing the continued existence and recovery of threatened and endangered sea turtles as well as other protected species. The proposed modifications to the shallow-set fishery management measures are intended to further the purposes of the Magnuson-Stevens Act (MSA) by encouraging optimum yield (OY) from the shallow-set fishery, while minimizing bycatch and bycatch mortality.

Description of Alternatives Considered in Detail

Under all alternatives, current regulations requiring circle hooks and mackerel-type bait, 100 percent observer coverage, the use of sea turtle interaction caps to control the number of annual interactions, and other measures would remain in place. Also under all alternatives, the Council has requested that NMFS consider using a three-year incidental take statement (ITS) to provide administrative flexibility in the ITS re-consultation process should the annual hard caps be exceeded because of an inability to successfully close the fishery on a timely basis (which can happen, for example, if the sea turtle hard cap is reached while other vessels have lines in the water). Other existing regulations would be maintained for the fishery. Under all alternatives the Council's ongoing sea turtle conservation projects would continue.

Topic 1: Shallow-set Longline Fishing Effort Limits

Alternatives under this topic are included for further study because the fishery is currently operating under a set limit of 2,120 shallow-sets per year, which is half the fishery's average effort during 1994-1999.

Alternative 1A: No Action: Continue Current Annual Set Limit

Under this alternative, the maximum annual limit on the number of shallow-sets would remain at 2,120.

Alternative 1B: Allow up to 3,000 Sets per Year

Under this alternative, the maximum annual limit on the number of shallow-sets would be 3,000. This effort limit was chosen as a middle-ground effort alternative which is between the current set limit and the average annual effort between 1994 and 1999 (approximately 4,240 sets).

Alternative 1C: Allow up to 4,240 Sets per Year
Under this alternative, the maximum annual limit on the number of shallow-sets would be 4,240, which represents the average number of annual sets between 1994 and 1999 or double the current set limit of 2,120.

Alternative 1D: Allow up to 5,500 Sets per Year
Under this alternative, the maximum annual limit on the number of shallow-sets would be 5,500 which is nearly the annual maximum number sets for any one year from 1994-1999.

Alternative 1E: Set effort level commensurate with current condition of North Pacific Swordfish Stock (~9,925 sets per year)
Under this alternative, the effort level for swordfish would be established based on the condition of the swordfish stock in the North Pacific and the Maximum Sustainable Yield (MSY) for this stock. Establishment of this effort limit would take into account catches by other longline fleets and the fraction of the total swordfish catch contributed by the Hawaii fleet. Current (domestic and foreign) swordfish landings in the North Pacific amount to about 14,500 mt, which, according to a recent stock assessment, amounts to about 65% of an estimated MSY of 22,284 mt (Kleiber and Yokawa 2004; Bigelow, PIFSC, pers. comm. January 2008). Given an MSY of about 22,284 mt for North Pacific swordfish, and a current swordfish catch by the Hawaii-based fishery of between or 850-1,637 mt, (1,861,391-3,602,339 lbs) the amount of effort to catch 7,784 mt of additional swordfish would amount to about 9,925 sets per year, if the Hawaii longline fishery were to fish the North Pacific swordfish stock up to the level of the MSY. Based on the best available information, the effort limit under this alternative would be adjusted as appropriate.

Alternative 1F- Remove Effort Limit (Preferred)
Under this alternative, the annual shallow-set effort limit would be removed and fishery would not be managed under an annual set limit cap. In association with removing the effort limit, but allowing for reasonable expansion in the fishery, the Council recommended that annual sea turtle interaction caps be set at 46 interactions for loggerheads and 16[2] interactions for leatherbacks.

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[2] At its 142nd meeting (June 2008), the Council recommended, (among other things), annual turtle hard caps of 19 leatherback interactions and 46 loggerhead interactions. In October 2008 (following the release of the DSEIS for this action), NMFS released a Biological Opinion (BiOp) that examined the Council's recommendations under section 7 of the ESA. The BiOp concluded that the preferred alternative of the DSEIS (i.e., limiting annual interactions to 46 loggerheads and 19 leatherbacks) would not jeopardize the continued existence and recovery of leatherback and loggerhead sea turtle populations. However, due to uncertainty in the status and population trend of the non-Jamursba-Medi component of the western Pacific leatherback population the BiOp authorizes no more than 16 annual leatherback interactions (and 46 loggerhead interactions). Following the release of the BiOp, the Council reconsidered this issue and at their 143rd meeting (October 2008) revised their recommendation to set annual leatherback interaction hard caps at 16 to mirror the authorized interactions contained in the BiOp.

Sea turtle hard caps under Topic 1 Alternatives
For all but one of the alternatives listed above under Topic 1, the annual sea turtle interaction hard caps for the fishery would be set according to anticipated sea turtle interactions, which are based on sea turtle interaction rates multiplied by the effort limit of each alternative. In the case of Alternative 1F (Remove Effort Limit), the sea turtle interaction hard caps were recommended by the Council and took into account sea turtle population impacts of those hard caps (Snover 2008; Appendix II) as well as anticipated, reasonable increases in shallow-set fishing participation in the fishery.

Topic 2: Fishery Participation
This topic is included because currently the annual effort limit is allocated amongst interested Hawaii-based longline fishery participants and tracked using a set certificate program (i.e., participants must attach a set certificate to each daily fishing log for each set made). The Council is reconsidering the set certificate program now that sufficient time has passed to understand the operational and fishery management benefits compared with the costs of the program. The set certificate program is administered by NMFS PIRO, which in November of each year provides notices to Hawaii longline fishery participants that set certificates are available. Set certificates are transferable amongst the Hawaii-based longline fleet.

Alternative 2A: No Action: Continue Set Certificate Program
Under this alternative, shallow-set certificates would continue to be made available and issued to all interested Hawaii longline permit holders. For each shallow-set made north of the equator, vessel operators would continue to be required to possess and submit one valid shallow-set certificate for each shallow-set made.

Alternative 2B: Discontinue Set Certificate Program (Preferred)
Under this alternative, shallow-set certificates would no longer be issued or required and the annual set-certificate solicitation of interested parties would be ended. Under alternatives which include effort limits, sets would be cumulatively accounted for on a fleetwide basis and the fishery would close for the remainder of the year when and if the annual set limit was reached. Fishery participants would continue to be required to notify NMFS at least 72 hrs before making a shallow-set trip.

Topic 3: Time-Area Closures
Time-area closures are being considered as a way to increase annual fishery profits from swordfish fishing by limiting the number of turtle interactions that could occur in the first quarter of each year. Interaction rates are significantly higher during this period and it has been hypothesized that reducing fishing effort would increase fishery profits by reducing the risk of exceeding a turtle hard cap very early when there are still many more shallow-sets allowed to be made, as occurred in 2006. Alternatives under this topic could apply in addition to any other management action which may be implemented under the proposed action.

Alternative 3A: No Action: Do Not Implement Time-Area Closures (Preferred)
Under this alternative, the fishery would continue to operate under the current regulations with no time-area closures. The alternative was recommended as preferred by the Council because it is unknown whether the displaced fishing effort would be relocated to other areas or to other months, and what impacts this displacement would have on turtles and other protected species as well as target catch rates. Hard caps to limit interactions with loggerhead and leatherback turtles would remain, ensuring that interactions limits are not exceeded.

Alternative 3B: Implement January Time-Area Closure
Under Alternative 3B, an area closure would be implemented during January of each calendar year. The area closure would be located between 175° W and 145° W longitude and encompass the sea surface temperature band of 17.5°-18.5° C. The latitudinal location of this temperature band varies inter-and intra-annually; however, in January it is generally located near 31°-32° N latitude. Research has suggested that the area between sea surface temperatures of 17.5-18.5°C may be a loggerhead sea turtle "hotspot" based on historical and contemporary distribution and foraging studies as well as location data for observed loggerhead sea turtle interactions with the fishery (Howell, PIFSC, pers. comm., December 2007). The month of January was selected because it may be that the number of loggerhead interactions during January is pivotal to whether or not the fishery will reach its annual sea turtle interaction hard cap before all allowable sets are used. For example, in 2006, the fishery interacted with eight loggerheads in January and the fishery reached the cap of 17 on March 17, 2006. In 2007, the fishery did not interact with any loggerheads during January, but ended the first quarter of the year with 15 loggerhead interactions and did not reach the sea turtle cap.

Alternative 3C: Implement In-season Time-area Closure
Under Alternative 3C, the sea surface temperature-based area closure described for Alternative 3B would be implemented in those years for which 75% of the annual loggerhead turtle cap was reached and the closure would remain in effect for the remainder of the first quarter. As with Alternative 3B, this alternative is being considered as a way to increase annual fishery profits through reductions in the number of turtle interactions that occur in the first quarter of each year. This alternative differs from Alternative 3B in that it is contingent on high numbers of interactions during the first quarter of the year.

Proposed Action
Based on the alternatives considered and the findings of NMFS' 2008 BiOp (NMFS 2008c), the Council has recommend that the National Marine Fisheries Service implement the following Federal regulatory action: remove the existing effort set limit, implement new loggerhead and leatherback annual sea turtle interaction hard caps at 46 and 16, respectively, and eliminate the set certificate program. No time/area closures would be implemented under the proposed action.

While not part of the proposed federal action, the Council also recommended, as a non-regulatory measure, the continuation of the Council's sea turtle conservation projects that have successfully conserved and protected hundreds of thousands of loggerhead and leatherback hatchlings as well as reduced juvenile and adult loggerhead and leatherback mortalities.

Impacts of the Alternatives

The Council and NMFS adopted a conservative approach in the impact analysis contained in this document (see Chapter 4) with regard to impacts to sea turtles. This approach purposefully skewed the analysis of the predicted fishing effort for Alternatives 1A, 1B, and 1C under Topic 1 towards the first quarter of the fishing year when loggerhead turtle interactions are highest. Evaluation of the model shallow-set fishery under the current regulatory regime indicates that the current sea turtle hard caps of 17 loggerheads and 16 leatherbacks resulted in a shift of fishing effort towards the first quarter of the year – a shift from the historical fishery (1991-2001) which had higher effort in the second quarter. Swordfish Catch Per Unit Effort (CPUE) is highest in the first quarter, as is the interaction rate for loggerhead turtles. Thus, it appears that fishery participant behavior in response to the current regulations resulted in a “race to the turtles” scenario, where participants wanted to ensure sufficient catches while the numbers of interactions under the hard caps were low and the fishery was open.

In addition, the fishery was closed in March 2006 because the annual loggerhead turtle hard cap was reached. In calculating effort distributions in response to varying regulatory restrictions under the alternatives for Topic 1, first quarter 2006 effort data was used while recognizing that the second, third, and fourth quarters of 2006 did not experience effort because the fishery was closed. Using first quarter 2006 effort data as 100% annual effort for that year biases the predicted effort distributions towards the first quarter for Alternatives 1A, 1B, and 1C. This allows the analysis to present “worst-case” scenarios in terms of sea turtle impacts as interactions are highest in the first quarter of the year. A strictly objective statistical approach was not possible because data only exist for two full years of fishing effort at the time this analysis was developed.

Furthermore, the impacts on sea turtles identified in this document rely on key pieces of information such as post-hooking mortality rates. For example, loggerhead post-hooking mortality, which is based on the location of the hooking or entanglement, is currently estimated by NMFS to be 20.5% in the Hawaii shallow-set fishery. However, no dead turtles have been observed during shallow-set operations since 2004 (using 100% observer coverage), and the hook and entanglement location is recorded for all turtle interactions, followed by strict handling and release procedures. The location of the hooking (e.g., mouth hooked vs. swallowed hook) or entanglement corresponds to an estimated level of mortality which is based on a 2006 NMFS policy (see Table 1 in Appendix II). A recent empirical study that tracked tagged loggerheads after interactions in the Hawaii shallow-set fishery suggests that loggerhead post-hooking mortality actually may be 9.5%.

With regard to leatherback turtles, the leatherback post-hooking mortality rate in the Hawaii shallow-set fishery is currently estimated to be 22.9% which is significantly higher than the 6.3% -12.5% that was predicted in the 2004 Biological Opinion on the Hawaii shallow-set fishery. The reason that the current leatherback post-hooking mortality is estimated to be at 22.9% is because one leatherback interaction out of 18 observed interactions was hooked inside soft tissue of mouth where the hook insertion point was visible, but the hook was unable to be removed by the observer (See Appendix III). This type of leatherback interaction is estimated to have an 85%

level of post-hooking mortality. However, all other observed leatherback interactions in the fishery since 2004 have involved external hookings (e.g., flipper-hooked, not in beak or mouth) or entanglements where the majority of those interactions have significantly lower post-hooking mortality rates (e.g., 63% of 16 interactions have estimated post-hooking mortality rates of 10-15%) than the estimated 22.9% referred to above (See Appendix III). As opposed to loggerhead turtles, it is generally believed that leatherbacks do not readily attempt to eat the mackerel bait on the circle hook (leatherbacks primarily eat jellyfish), but rather most often get caught up in the longline gear leading to external hooking and entanglement. Therefore, that single interaction event significantly raised the leatherback post-hooking mortality rate, and thus the predicted impacts of the alternatives.

Finally, at the request of the Council, NMFS' Pacific Islands Fisheries Science Center (PIFSC) conducted a Susceptibility to Quasi-Extinction (SQE) analysis (see Appendix II) which the Council used to evaluate potential sea turtle annual hard caps. In addition to the conservative loggerhead and leatherback post-hooking mortality rates (described above) that were applied in the analysis, the SEQ analysis also used a conservative Quasi-Extinction Threshold (QET) of 50% as recommended by the International Union for Conservation of Nature (IUCN). QET is the level at which a number of adult sea turtles may be insufficient to assure persistence of the species. Thus, the SEQ analysis in this document assumed that a 50% reduction of current sea turtle populations would be insufficient to assure persistence of the species. In contrast, a 2008 SQE analysis conducted by NMFS for the northeast Atlantic sea scallop fishery used a QET of 0.7%. Varying levels of QET would significantly alter the results of the SQE analysis; however, 50% was chosen because it would achieve the resolution necessary to detect changes in risk of quasi-extinction.

Furthermore, the SQE analysis on the shallow-set fishery relies on nesting beach trends to evaluate the status of the population and incorporated loggerhead nesting data up to the year 2007. In 2006 and 2007, nesting beach counts were lower than previous years, suggesting a declining trend. Recent information, however, indicates that Japan loggerhead nesting in 2008 is approximately at least 2.5 times greater than in 2007, which should positively affect the North Pacific loggerhead population as well as further evaluation of the fishery's impact on North Pacific loggerhead turtles. Also, the SQE analysis on the shallow-set fishery examined impacts on Eastern Pacific leatherback nesting aggregations; however, a recent evaluation of the genetic samples taken from leatherbacks that interacted with the shallow-set fishery, indicates that all leatherback interactions in the shallow-set fishery involve Western Pacific leatherbacks. Although the only long term nesting data for Western Pacific leatherbacks shows a declining trend, recent studies have suggested that the Western Pacific leatherback metapopulation is larger than once believed, and is currently estimated to be between 2,700 and 5,100 nesting females. However, nesting beach trend information is not available for the recently recorded leatherback nesting sites in the western Pacific.

The following tables summarize the environmental impacts presented in this document. Note that for brevity in the following table, impacts to protected species under Topic 1 are listed only for loggerhead and leatherback sea turtles. See Chapter 4 for a complete discussion on impacts to all protected species and seabirds.

	Anticipated Impacts from Topic 1: Shallow-set Effort Limit					
Resource Category	***Alt. 1A- No Action (2,120 set limit)***	***Alt. 1B- 3,000 set limit***	***Alt. 1C- 4,240 set limit***	***Alt. 1D- 5,550 set limit***	***Alt. 1E- 9,925 set limit***	***Alt. 1F- Remove Effort Limit (preferred)***
Target and Non-target Species	4.6 million lb of swordfish representing ~ 9% of MSY Well below 1% of MSY for species with known MSYs, - ~0.096% of the MSY for WCPO bigeye.	6.5 million lb of swordfish ~ 13% of MSY No significant adverse impacts to other target and non-target species; shift effort from deep-set (tuna) to shallow-set (swordfish)	8.6 million lb of swordfish ~ 18% of MSY No significant adverse impacts to target and non-target species; shift effort from deep-set (tuna) to shallow-set (swordfish)	10.6 million lb of swordfish ~ 21% of MSY No significant adverse impacts to other target and non-target species; shift effort from deep-set (tuna) to shallow-set (swordfish)	19.1 million lb of swordfish representing ~ 39% of MSY ~0.37% of the MSY for WCPO bigeye No significant adverse impacts to other target and non-target species; shift effort from deep-set (tuna) to shallow-set (swordfish)	Likely in the range between Alt. 1A-1D: 4.6-10.6 million pounds/yr of swordfish No significant adverse impacts to other target and non-target species; shift effort from deep-set (tuna) to shallow-set (swordfish)
Predicted Number of Sea Turtle Interactions	Logg. 18.05 (1.06 AFM*) Leath. 6.29 (0.79 AFM)	Logg. 25.54 (1.39 AFM) Leath. 8.90 (1.12 AFM)	Logg. 34.42 (1.88 AFM) Leath. 12.65 (1.60 AFM)	Logg. 42.46 (2.32 AFM) Leath. 16.50 (2.08 AFM)	Logg. 76.63 (4.18 AFM) Leath. 29.78 (3.77 AFM)	Loggerheads 46 (2.51 AFM) Leatherbacks 16 (2.02 AFM)
Fishery Participants And Regional Economy	$10.8 million ex-vessel revenue $26.3 million in direct and indirect business sales $11.7 million in personal and corporate income 362 jobs, $2 million in state and local taxes	$15.3 million ex-vessel revenue $37.2 million in direct and indirect business sales $16.5 million in personal and corporate income 513 jobs, and $2.8 million in state and local taxes	$20.5 million ex-vessel revenue $49.7 million in direct and indirect business sales $22.1 million in personal and corporate income, 685 jobs, and $3.7 million in state and local taxes	$25.03 million ex-vessel revenue $60.7 million in direct and indirect business sales $27 million in personal and corporate income 837 jobs, and $4.5 million in state and local taxes	$45.17 million ex-vessel revenue $109.5 million in direct and indirect business sales $48.7 million in personal and corporate income, 1,510 jobs, and $8.1 million in state and local taxes	Likely in the range of Alt. 1C-1D: $20.5- $25.03 million ex-vessel revenue $49.7 - $60.7 million in direct and indirect business sales $22.1 - $27 million in personal and corporate income 685 - 837 jobs, and $3.7 - $4.5 million in state and local taxes
Admin. and Enforcement	Current annual cost of 100% observer coverage: $1.8 million	Predicted annual cost of 100% observer coverage: $2.7 million	Predicted annual cost of 100% observer coverage: $ 3.9 million	Predicted annual cost of 100% observer coverage: $ 5.1 million	Predicted annual cost of 100% observer coverage: $ 12.7 million	Predicted annual cost of 100% observer coverage: $1.8- $5.1 million

*AFM = Adult Female Mortalities. Adult females are the only component of the affected sea turtle populations for which data are available to build a population model, such as the SQE analysis, that indicates the population impact of the proposed action on affected sea turtles. See Chapter 4 and Appendices II and VI for further information on impacts to sea turtle populations from the proposed action.

	Topic 2: Fishery Participation	
Resource Category	***Alternative 2A- No Action (continue shallow-set certificate program)***	***Alternative 2B- Discontinue Shallow-set Certificate Program (preferred)***
Target and Non-target Species	No major adverse impacts to target stocks and non-target stocks are anticipated.	Discontinuing the set certificate program would have no impact on target and non-target species as it is primarily an administrative measure to track participation and effort. 100% observer coverage would continue to be required for the fishery which would allow for adequate tracking of participation and effort.
Protected Species (Sea Turtles)	Would not impact protected species. Fishery managers would be able to track participation through the fishery year, ensuring that allowed effort is not exceeded and unconsidered impacts not realized.	Discontinuing the set certificate program would have no impact on protected species as it is primarily an administrative measure to track participation and effort. Circle hooks and mackerel-type bait would continue to be required as well as hard caps and 100% observer coverage. Impacts to marine mammals and seabirds are not expected to increase from discontinuing the set certificate program as fishing operations and gear would not change.
Fishery Participants And Regional Economy	Allows potential participants the opportunity to obtain set certificates which they could either fish their certificates themselves, trade, sell, or give to other Hawaii longline limited access permit holders for use. Financial impacts would be imposed on potential participants who must buy certificates from other participants. On the other hand, financial gains would be obtained by those participants willing to sell their certificates to other participants.	Discontinuing the set certificate program would benefit current shallow-set participants by eliminating the burden to provide written notice by November 1 of each year to obtain certificates. Revenue from selling set certificates to other participants would be eliminated and vice versa, potential costs of buying certificates from other participants.
Administration and Enforcement	Annual costs are estimated to be $4,430 for NMFS to administer the program. Enforcement agencies such as USCG must verify set certificates when conducting boarding of fishing vessels on shallow-set trips.	Would relieve NMFS of the annual administrative burden of processing the certificate requests and issuing the certificates. Would relieve the U.S. Coast Guard and NMFS OLE enforcing the requirement to possess and use shallow-set certificates for each set made. However, if an annual effort limit is continued, NMFS must develop a method to track and limit effort in the fishery.

	Topic 3:Time-Area Closures		
Resource Category	***Alternative 3A: No Action: Do Not Implement Time-Area Closures (preferred)***	***Alternative 3B: Implement January Time-Area Closure between 17.5°-18.5 ° C***	***Alternative 3C: Implement In-season (1st quarter) Time-area Closure between 17.5°-18.5 ° C***
Target and Non-target Species	No additional impacts to target and non-target stocks	Impacts to target stocks have not been quantified; however, ongoing work by PIFSC appears to indicate decreases in annual catches. It is reasonable that if impacts to target stocks are reduced, than impacts to non-target stocks would also decrease.	Similar impact as 3B in that closures examined to date would reduce annual fishery revenues as a result of decreases in annual catches.
Protected Species (Sea Turtles)	No additional impacts to protected species	Expected to reduce the number of sea turtle interactions in January of each year, but impacts have not been quantified. It is unknown whether the displaced fishing effort would be relocated to other areas or to other months, and what impacts this displacement would have on turtles and other protected species. Hard caps to limit interactions with loggerhead and leatherback turtles would remain, ensuring that interactions limits are not exceeded.	Impacts to protected species have not been quantified, but Alternative 3C would be expected to potentially reduce the number of sea turtle interactions in the first quarter of each year. It is unknown whether the displaced fishing effort would be relocated to other areas or to other months, and what impacts this displacement would have on turtles and other protected species. The use of hard caps to limit interactions with loggerhead and leatherback turtles would remain in place.

	Alternative 3A: No Action: Do Not Implement Time-Area Closure (preferred)	*Alternative 3B: Implement January Time-Area Closure between 17.5°- 18.5 ° C*	*Alternative 3C: Implement In-season (1st quarter)Time-area Closure between 17.5°- 18.5 ° C*
Fishery Participants And Regional Economy	No additional or new impacts expected to result to participants or regional economy.	A reduction in fishable area in the swordfish grounds may decrease sea turtle interactions, while simultaneously decreasing annual fishery revenues and presumably profits, as fishing effort would be pushed into less productive or less profitable times and areas. Fishery participants may find it difficult to respond to in-season changes of closed areas based on sea surface temperatures which can vary in location on a daily basis.	Similar to 3B, a reduction in fishable area in the swordfish grounds during the 1st quarter may decrease sea turtle interactions while simultaneously decreasing annual fishery revenues and presumably profits, as fishing effort would be pushed into less productive or less profitable times and areas. Fishery participants may find it difficult to respond to in season changes of closed areas based on sea surface temperatures which can vary in location on a daily basis.
Administration and Enforcement	No additional or new impacts expected to administration and enforcement.	USCG and NMFS OLE would find it difficult to enforce time-area closures based on sea surface temperatures. Temporary, short-term closures can be difficult to enforce as well as to communicate to the fishing fleet. Closed areas that geographically shift through a season may also cause confusion and make at-sea enforcement more difficult because fishing trips would have to be reviewed in sections based on closed areas that were in force during specific segments of a fishing trip.	Similar to 3B, enforcement agencies would find it difficult to enforce time-area closures based on sea surface temperatures.

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List of Acronyms/Abbreviations

AFM	Adult Female Mortalities
B	Biomass
BET	Bigeye Tuna
BFAL	Black-footed Albatross
BiOp	Biological Opinion
C	Celsius
CNMI	Commonwealth of Northern Mariana Islands
CPUE	Catch Per Unit Effort
Council	Western Pacific Regional Fishery Management Council
DNA	Deoxyribonucleic acid
DSEIS	Draft Supplemental Environmental Impact Statement
E	East
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EPO	Eastern Pacific Ocean
ESA	Endangered Species Act
F	Fishing Mortality
FAD	Fish Aggregation Device
FEIS	Final Environmental Impact Statement
FEP	Fishery Ecosystem Plan
FMP	Fishery Management Plan
FNA	Females Nesting Annually
FR	Federal Register
FSEIS	Final Supplemental Impact Statement
HIHWNMS	Hawaiian Islands Humpback Whale National Marine Sanctuary
HLA	Hawaii Longline Association
HMS	Highly Migratory Species
IATTC	Inter-American Tropical Tuna Commission
ISC	International Scientific Committee
ITS	Incidental Take Statement
lb	Pound or Pounds
MHI	Main Hawaiian Islands
MMPA	Marine Mammal Protection Act
MPA	Marine Protected Area

MSY	Maximum Sustainable Yield
mt	Metric Tons
MUS	Management Unit Species
N	North
NEPA	National Environmental Policy Act
nm	Nautical Mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NPTZ	North Pacific Transition Zone
NWHI	Northwestern Hawaiian Islands
OLE	Office of Law Enforcement
PFMC	Pacific Fishery Management Council
PIFSC	Pacific Islands Fisheries Science Center
PIRO	Pacific Islands Regional Office
PMP	Preliminary Management Plan
PMUS	Pelagic Management Unit Species
PNG	Papua New Guinea
ppm	Parts Per Million
PRIA	Pacific Remote Island Areas
RecFIN	Recreational Fisheries Information Network
RFMO	Regional Fishery Management Organization
RPA	Reasonable and Prudent Alternative
S	South
SAFE	Stock Assessment and Fishery Evaluation
SAFZ	Subartic Frontal Zone
SAR	Stock Assessment Report
SCB	Southern California Bight
SSC	Scientific and Statistical Committee
SSTF	South Subtropical Front
STAJ	Sea Turtle Association of Japan
STAL	Short-tailed Albatross
STF	Subtropical Front
STFZ	Subtropical Frontal Zone
SWFSC	Southwest Fisheries Science Center
TED	Turtle Excluder Device
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
W	West
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and central Pacific Ocean
WMA	Wildlife Management Area
WPRFMC	Western Pacific Regional Fishery Management Council
WWF	World Wildlife Fund

YFT	Yellowfin Tuna

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Chapter 1: Introduction

1.0 Introduction

This document describes proposed Amendment 18 to the Fishery Management Plan (FMP) for Pelagic Fisheries of the Western Pacific Region (Pelagics FMP) and analyzes the impacts of the proposed FMP amendment and alternatives on the environment. The proposed FMP amendment would modify the existing fishery management regime for the Hawaii-based shallow-set longline fishery (shallow-set fishery) in that it would remove the effort limit, increase the annual loggerhead and leatherback interaction hard caps, and eliminate the shallow-set certificate program. All measures currently applicable to Hawaii-based deep set longline fishing targeting bigeye tuna and other species will remain unchanged.

Chapter 1 provides introductory material and background information. Chapter 2 describes the alternatives considered in this document. Chapter 3 describes the affected environment of the action area as well as other pertinent environmental information. Chapter 4 provides the analysis of the environmental impacts of the alternatives. Chapter 5 discusses the proposed action's consistency with the MSA. Chapter 6 discusses the proposed action's consistency with other applicable laws. Chapter 7 provides draft regulations, Chapter 8 contains references used in this document, and Chapter 9 lists of the preparers of this document. Chapter 10 provides the DSEIS public distribution list.

1.1 Background Information

In 2004, the shallow-set fishery, which primarily targets swordfish in the North Pacific 600-1,000 nm north of Hawaii, was reinitiated under a suite of regulations intended to reduce the potential number and severity of bycatch interactions, particularly between longline fishing gear and sea turtles listed as threatened and endangered under the Endangered Species Act (ESA). Among other requirements, such as a Hawaii longline limited-access permit, shallow-set fishery regulations include mandatory use of large (18/0) circle hooks with a 10 degree offset and mackerel-type bait, a maximum effort limit of 2,120 shallow-sets per year administered through a set certificate program, annual sea turtle interaction hard caps of 17 loggerhead and 16 leatherback sea turtles, and a requirement for 100 percent observer coverage.

The shallow-set fishery was reinitiated to serve as a model fishery to test the effectiveness of circle hooks and mackerel-type bait in the Pacific, as this gear and bait combination had only been tested in Atlantic experiments prior to approval for use in Hawaii fishery. The 2,120 set effort limit and sea turtle interaction hard caps[3] were instituted as measures to control fishing effort and sea turtle interactions while information was being gathered on the model fishery.

[3] Note that the existing annual sea turtle interaction limits of 17 loggerheads and 16 leatherbacks do not represent the upper limit of allowable interactions, that if exceeded, would constitute significant adverse impacts to these populations; rather, the sea turtle interaction caps were calculated from the expected effort (2,120 sets) multiplied by loggerhead and leatherback interaction rates that were derived from

The use of circle hooks and mackerel-type bait by the Hawaii-based shallow-set fishery has reduced the sea turtle interaction rate by approximately 90 percent for loggerheads, 85 percent for leatherbacks, and 89 percent for combined species, compared to the period (1994-2001) when the fishery was operating without such gear (Gilman and Kobayashi 2007). Because the use of circle hooks and mackerel-type bait has proven effective in reducing sea turtle interaction rates, and swordfish stocks in the North Pacific are being harvested under MSY, this document examines a range of management alternatives for the shallow-set fishery that would: maintain, increase, or remove the shallow-set fishing effort limit; maintain or eliminate the set certificate program; and implement time-area closures or leave the fishing areas open. Other existing regulations would be maintained. Also to be maintained would be the Western Pacific Regional Fishery Management Council (WPRFMC or Council) sea turtle conservation projects, which have conserved and protected loggerhead and leatherback nesting sites, resulting in the production of thousands of hatchlings that otherwise would have died, and reduced loggerhead mortalities in coastal fisheries that operate in Baja California Sur, Mexico. These projects are aligned with those identified in the recovery plans for loggerhead and leatherback sea turtles and are believed to be benefiting the survival and recovery of sea turtle populations.

In February 2007, the Hawaii Longline Association (HLA) provided the Council and NMFS a proposal to amend certain FMP regulations applicable to the shallow-set fishery. HLA's proposal requested the following regulatory changes: 1) elimination of the existing effort limit of 2,120 sets, 2) new sea turtle interaction limits premised upon a projected increase in the annual shallow-set fishing effort to 3.5 million hooks set, and 3) sea turtle interaction limits tracked over a three year period. HLA's proposal provided for continuation of all other existing management and conservation measures. According to HLA, the proposal is premised upon three sources of data and information that were not available in 2004 when the current shallow-set fishery was implemented: 1) the sea turtle interaction and mortality rates actually experienced since late 2004 using the existing fishery management measures; 2) the beneficial effects of ongoing sea turtle conservation measures undertaken by the Council to enhance sea turtle conservation and reproduction and offset sea turtle interactions occurring in the combined Hawaii-based longline fisheries; and 3) the adverse transferred effects to sea turtle conservation from shallow-set fishing effort restrictions in Hawaii.

1.2 Magnuson-Stevens Fishery Conservation and Management Act

Enacted in 1976, and subsequently reauthorized in 1996 and 2006, the Magnuson-Stevens Fishery Conservation and Management Act (MSA) is the principal Federal statute regarding the management of U.S. marine fisheries. The purposes of the MSA include the following: the conservation and management of the fishery resources of the United States; the protection of essential fish habitat (EFH); the establishment of regional fishery management councils; the preparation and implementation of fishery management plans (FMPs); the promotion of

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studies using circle hooks and mackerel bait in U.S. longline fisheries in the Atlantic.

domestic, commercial, and recreational fishing; the support and encouragement of international fishery agreements; and the development of fisheries that are underutilized or not utilized.

The MSA established both required and discretionary provisions of an FMP and created ten National Standards (see Chapter 6) to ensure that any FMP or FMP amendment is consistent with the MSA. Each FMP and its amendments contain a suite of management measures that together characterize a fishery management regime.

The MSA created eight regional fishery management councils to provide advice and recommendations to the Secretary of Commerce through the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), and National Marine Fisheries Service (NMFS). The fishery management councils are responsible for the preparation and transmittal to the Secretary of appropriate, science-based FMPs (and amendments to those plans) for fisheries under their jurisdiction. The Secretary may approve, disapprove, or partially approve each FMP or amendment and, if approved, implement them through Federal regulations which are enforced by the U.S. Coast Guard (USCG) and NMFS Office of Law Enforcement (OLE). NMFS OLE also provides funding to local government agencies through cooperative/joint enforcement agreements to enforce federal fisheries regulations.

1.2.1. Western Pacific Regional Fishery Management Council

Under the MSA, the Western Pacific Regional Fishery Management Council (Council) has management responsibility for U.S. fisheries in the Pacific Ocean seaward of American Samoa, Commonwealth of Northern Mariana Islands (CNMI), Guam, Hawaii, and the Pacific Remote Island Areas (16 U.S.C. § 1852(a)(H)). The Council has 13 voting members, eight of whom are appointed by the Secretary, and five of whom are the principal Federal, and State, Territory or Commonwealth officials with fishery management responsibility. The Council also retains three non-voting members that include: U.S. Department of State, U.S. Fish and Wildlife Service, and U.S. Coast Guard. The Council's office is located in Honolulu, Hawaii.

Domestic fisheries that operate within the U.S Exclusive Economic Zone (EEZ) waters and high seas in the Western Pacific Region are currently managed under five FMPs: Bottomfish and Seamount Groundfish, Coral Reef Ecosystems, Crustaceans, Precious Corals, and Pelagics.

1.2.2 Pelagics Fishery Management Plan of the Western Pacific Region

After transmittal by the Council to the Secretary of Commerce for approval, the Pelagics FMP was implemented by NMFS on February 27, 1987 (52 FR 5983). At the time the Pelagics FMP was drafted, the U.S. government was in the process of attempting to limit foreign longline fishing effort within the EEZ, while encouraging more domestic harvesting and utilization of fishery resources. The Pelagics FMP replaced a previous preliminary management plan (PMP), which governed foreign longline fishing in the EEZ of the Western Pacific Region. Management measures originally put in place under the Pelagics FMP included the following:

1. Establishment of a triggering mechanism to institute new area closures for foreign longline vessels in the EEZ;
2. Elimination of existing quotas on foreign longline catches in the EEZ;
3. Requirements for federal longline catch reports, including interactions with protected species in the EEZ;
4. Prohibition on the use of drift gill nets in the EEZ (except by domestic vessels fishing under an experimental permit); and
5. In cooperation with the U.S. State Department, establishment of a process to obtain data on the incidental catch of pelagic fishes in the EEZ by tuna pole-and-line and purse seine[4] vessels.

A subsequent rule effective November 26, 1990 (55 FR 42967) requires that catch-and-effort data for management unit species (MUS) managed under the FMP be reported to the State of Hawaii, the Territory of American Samoa, and the Territory of Guam in compliance with the respective laws and regulations of each area.[5]

FMP Objectives

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.

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[4] The original Pelagics FMP contained no restrictions on foreign or domestic purse seine or pole-and-line tuna vessels, as tuna were not yet included as fish under the MSA or as MUS under the FMP. Amendment 6 to the FMP added tuna and related species to the FMP and closed the U.S. EEZ to foreign purse seine and pole-and-line tuna vessels. The U.S. tuna purse seine fleet in the western Pacific is generally managed under the South Pacific Tuna Act of 1988 via implementing regulations at 50 CFR part 300, subpart D, although provisions of the Pelagics FMP apply to those vessels when fishing within the U.S. EEZ.

[5] At that time, the CNMI was not yet included in the management area of the Pelagics FMP.

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.

Over the years, the FMP has been amended several times. Table 1 summarizes these amendments to the Pelagics FMP.

Table 1: Amendments to the Pelagics FMP

AMENDMENTS		
No.	**Effective Date**	**Action**
1	1991	Provides: (a) a measurable definition of recruitment overfishing for billfishes, mahimahi, wahoo, and oceanic sharks; (b) a revised definition of OY; and (c) a revised set of objectives to conform to the MSA.
2	1991	(Preceded by an emergency rule.) Requires longline and transshipping vessel owners to obtain permits for their vessels, and requires vessel operators to maintain and submit to NMFS logbook data on their fishing and transshipping activities. Extends the jurisdiction of the FMP to include the CNMI. Adds tuna to Pelagic MUS (PMUS) list. Establishes a protected species zone in the NWHI such that vessel operators intending to fish in this zone must notify NMFS in advance and carry an observer if requested. Requires notification of NMFS within 12 hours of return to port after any transshipment activity or landing.
3	1991	(Preceded by an emergency rule.) Prohibits longline fishing within 50 nm of the NWHI as well as within corridors between those islands. Abrogates the requirement for observers established in Amendment 2. Requires notification of NMFS when transiting the protected species zone.

4	1991	(Preceded by an emergency moratorium and establishment of a control date for possible use in a limited entry program.) Extends until April 1994 a moratorium on the issuance of new permits to participate in the Hawaii-based longline fishery. Provides a framework under which vessel monitoring systems (VMS) may be required.
5	1992	(Preceded by an emergency rule.) Prohibits longline fishing within 75 nm of the islands of Oahu, Kauai, Niihau, and Kaula, and within 50 nm of the islands of Hawaii, Maui, Kahoolawe, Lanai, and Molokai. A longline closure of approximately 50 nautical miles is also implemented around Guam and its offshore banks. Establishes framework procedures to adjust the size of the closed areas and modify criteria for exemptions.
6	1992	Adds tuna and related species to FMP. Extends closed areas and requirements applicable to foreign longline vessels to foreign baitboat and purse seine vessels.
7	1994	Establishes a limited entry program for the Hawaii longline fishery for pelagic species. Includes broad framework measures for more efficient management of the fishery.
8	1999	Establishes permit and reporting requirement for pelagic troll and handline fishery in the PRIA.
9	In Revision	(Draft amendment establishing limits on shark landings was rendered moot by the Shark Finning Prohibition Act.)
10	2004	Prohibits fishing for PMUS in Coral Reef Ecosystems FMP no-take Marine Protected Areas. Amends list of PMUS.
11	2005	Establishes a limited entry program for the American Samoa longline fishery.
12	Reserved	
13	Reserved	

14	2007	This amendment was partially approved by the Secretary of Commerce and was developed in response to NMFS' notifications that Pacific-wide bigeye and Western and Central Pacific yellowfin tuna were subject to overfishing. It contained recommendations regarding both international and domestic management, including a mechanism by which the Council could participate in international negotiations regarding these stocks. Amendment 14 also contained measures to implement control dates for Hawaii's non-longline commercial pelagic vessels (70 FR 47781, see above) and purse seine and longline vessels (70 FR 47782, see above), as well as requirements for federal permits and reporting for Hawaii-based non-longline commercial pelagic vessels. NMFS disapproved the Amendment's international measures as premature given ongoing international negotiations as well as the development of a memorandum of understanding by the Councils and the Secretary of Commerce, in consultation with the Secretary of State, regarding participation in U.S. delegations and other issues. NMFS disapproved Amendment 14's domestic permit and reporting requirements as duplicative of existing requirements imposed by the State of Hawaii and stated that they were working with the State to improve their data collection and processing system. NMFS also noted that Amendment 14 met the requirements of the Magnuson-Act regarding overfishing of fisheries that have been determined to be subject to overfishing due to excessive international fishing pressure.
FRAMEWORK AMENDMENTS		
No.	**Effective Date**	**Action**
1	2002	Prohibits vessels greater than 50 feet in length overall from fishing for PMUS between 3 and 50 nautical miles around the islands of American Samoa.
2	2002	(Preceded by an emergency rule.) Requires Hawaii longline limited access vessels operating north of 23° N to employ a line-setting machine with weighted branch lines (45g minimum) or use basket style gear, and to use blue-dyed bait and strategic offal discards during setting and hauling longlines. Also requires certain seabird handling techniques and attendance by owners and operators at an annual protected species workshop conducted by NMFS.

REGULATORY AMENDMENTS		
1	2002	Prohibited targeting of swordfish north of the equator by Hawaii longline vessels, closes all fishing to longline vessels during April and May in waters south of the Hawaiian Islands (from 15° N to the equator and from 145° W to 180°), and prohibited the landing or possessing of more than 10 swordfish per trip by longline (limited entry or general) vessels and possession of light sticks. Vessels with a freeboard of more than 3 feet must carry line clippers, dip nets, wire, or bolt cutters. Float lines must be longer than 20 meters. If monofilament longline is used, it must have at least 15 branch lines between floats. If basket-style gear is used, it must have at least 10 branch lines between floats. The deepest point of the main longline between any 2 floats must be 100 meters. Vessel operators must attend and be certified for a protected species workshop.
2	2002	Establishes permit and reporting requirements for any U.S. fishing vessel that uses troll or handline gear to harvest PMUS in the EEZ around the PRIA.
3	2004	Reopens the swordfish-directed component of the Hawaii-based longline fishery and eliminates the seasonal closure for longline fishing in an area south of the Hawaiian Islands. For swordfish fishing, requires circle hooks and mackerel-type bait, annual fleet-wide limits on interactions with leatherback and loggerhead sea turtles, an annual fleet-wide limit on fishing effort, and seabird mitigation measures including the requirements for setting at night when fishing above 23° N.
4	2005	Implemented measures to minimize interactions with turtles by non-Hawaii based domestic longline vessels operating in the western Pacific under general longline permits. Required vessels with longline general permits making shallow sets north of the equator to use 18/0 offset circle hooks, with mackerel-type bait and dehookers to release any accidentally caught turtles. The amendment also required both operators and owners of vessels with general longline permits to annually attend protected species training workshops as well as carry and use specific mitigation gear to aid in the release of sea turtles accidentally hooked or entangled by longlines. These include dip nets, long-handled line clippers and bolt cutters (with allowances for boats with < 3' freeboard). This regulatory amendment also required operators of non-longline pelagic vessels (e.g., trollers and handliners) to follow handling guidelines and remove trailing gear wherever they fish.

5	2005	Allowed operators of Hawaii-based longline vessels fishing north of 23 degrees north latitude, as well as those targeting swordfish south of 23 degrees north, to utilize side-setting to reduce seabird interactions in lieu of the seabird mitigation measures required by Framework Measure 1. Side-setting was tested on Hawaii-based longline vessels and found to be highly effective in reducing seabird interactions.
6	2007	(Preceded by temporary rule). Removed the delay in effectiveness for closing the Hawaii-based longline shallow-set swordfish fishery as a result of it having reached one of its turtle interaction limits (71 FR 14416). This rule was implemented as vessel communications had improved to the point that vessel operators could be immediately notified of a closure, thus removing the possibility of exceeding a turtle limit during the notification period.
7	2007	Provided pelagic fishery participants the option of using NMFS approved electronic logbooks in lieu of paper logbooks. This measure was implemented to improve the efficiency and accuracy of catch reporting.

For the complete list of regulations pertaining to the Pelagics FMP as well as other federal fisheries regulations that apply to the Western Pacific Region, see 50 CFR Part 665. Species currently managed under the Pelagics FMP are listed in Table 2.

Table 2: Pelagic Management Unit Species

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	*Carcharinus falciformis*
Oceanic whitetip shark	*Carcharhinus longimanus*
Blue shark	*Prionace glauca*

Common Name	**Scientific Name**
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*
Pacific bluefin tuna	*T. orientalis*
Skipjack tuna	*Katsuwonus pelamis*
Kawakawa	*Euthynnus affinis*
Dogtooth tuna	*Gymnosarda unicolor*
Moonfish	*Lampris* spp.
Oilfish and snake mackerel family	Gempylidae
Pomfret	Bramidae
Other tuna relatives	*Auxis* spp., *Scomber* spp.; *Allothunus* spp.

1.2.3 Background Information on Previous Actions Affecting Sea Turtles

As discussed in Section 1.1.2, management under the FMP for the Hawaii-based longline fishery has been ongoing since 1987. Amendment 2 (implemented in May 1991) required vessel operators to contact NMFS before fishing in a 50 nm protected species zone around the Northwestern Hawaiian Islands (NWHI) for potential observer placement. These federal observers are carried onboard to collect information on interactions with sea turtles and other protected species. Amendment 3 (October 1991) established a 50 nm area closure around the NWHI, which together with 25-75 nm longline area closures around the main Hawaiian Islands (MHI) implemented through Amendment 5 (March 1992) to reduce gear conflicts between longliners and troll and handline vessels, afforded protection to green turtles foraging in nearshore coastal waters of the MHI or NWHI as well as nesting in the NWHI. Amendments 4 and 7 (October 1991 and June 1994, respectively) implemented a moratorium followed by 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 limiting the fleet’s range and fishing capacity.

In response to a Biological Opinion (BiOp) completed by NMFS following a consultation under section 7 of the Endangered Species Act (ESA), all operators of Hawaii-based longline vessels are required to carry federal observers upon notification by NMFS, regardless of area fished. This requirement became effective in April 1994. BiOps are written in response to federal actions (such as proposed changes to fishery regulations) or new information regarding species listed as endangered or threatened under the ESA. All five species of sea turtles found in the Western Pacific Region are listed under the ESA. A BiOp concludes with a finding of either “no jeopardy” or “jeopardy”. All BiOps issued for the Hawaii longline fishery to date have concluded with no jeopardy determinations. A jeopardy determination means that the action (or fishery) being analyzed is likely to jeopardize the continued existence and recovery of one or more listed species. In either case the issuing agency may include "terms and conditions" and/or "reasonable and prudent alternatives" that will reduce the impact of the action (or fishery) on listed species. BiOps also include "incidental take statements" which authorize the fishery to have a specific number of protected species interactions without being prosecuted under the ESA. Incidental take statements are sometimes known as "anticipated take statements," as they are the issuing agency's best estimate of the number of interactions anticipated to occur each year under the requirements of the BiOp. If the take limit in the incidental take statement is exceeded, the issuing agency may choose to reexamine the action or fishery (as well as any governing terms and conditions or reasonable and prudent alternatives) to understand why actual interactions were higher than anticipated. If the interactions are found to be due to positive natural population variations, no management changes may be needed; however if they are found to be due to management measures not working as expected, changes may be required. An incidental take statement does not represent a jeopardy "threshold" and should not be regarded as such. Rather it is the issuing agency's estimate of the number of interactions that are anticipated to occur under the BiOp's requirements.

In April 2000, operators of Hawaii-based longline vessels became subject to new requirements to carry and use dip nets and line-clippers to disengage sea turtles hooked or entangled by their fishing gear as well as new requirements concerning the handling, resuscitation and release of sea turtles.

An emergency interim rule effective April 5 through June 8, 2002, prohibited longline fishing north of 26 degrees north latitude and prohibited the retention or landing of more than 10 swordfish by longline vessels fishing for tuna north of the equator. This rule was issued following interactions with three loggerhead turtles north of 30 degrees north latitude, which was in excess of the interaction levels anticipated in NMFS' March 29, 2001 BiOp.

Regulatory Amendment 1 to the FMP became effective in June 2002 and incorporated the reasonable and prudent alternative of a March 2001 BiOp issued by NMFS. To mitigate interactions with sea turtles, this amendment prohibited shallow-set pelagic longlining north of the equator by vessels managed under the FMP and closed waters between 0° and 15° N from April through May of each year to longline fishing. It also instituted sea turtle handling requirements for all vessels using hooks to target pelagic species in the region's EEZ waters and extended existing annual protected species workshop attendance requirement to include the operators of vessels registered to longline general permits as well as those registered to Hawaii limited entry longline permits. Protected species workshops are used to inform fishery participants about the status and biology of protected species, to demonstrate the proper use of sea turtle mitigation gear and resuscitation procedures, and to answer questions regarding protected species.

In December 2001, NMFS reinitiated section 7 consultation on the Western Pacific Region's pelagic fishery. At the conclusion of this reconsultation, NMFS issued a new BiOp (November 15, 2002), which maintained Regulatory Amendment 1's regulations including the ban on shallow-setting north of the equator and the April-May southern area closure. However, in

August 2003, the Federal Court invalidated this 2002 BiOp and the associated regulations put in place in June 2002. In October 2003, the Federal Court stayed the execution of the August 2003 order until April 1, 2004 to allow NMFS to develop a new BiOp and render a more permanent solution than interim or emergency measures.

Regulatory Amendment 3 became effective April 2, 2004 and established a limited "model" Hawaii-based shallow-set swordfish fishery using circle hooks with mackerel-type bait. This hook and bait combination was found to reduce interactions with leatherback and loggerhead turtles by 67 percent and 92 percent respectively in the U.S. Atlantic longline fishery. In order to test (or model) the use of this gear in Pacific longline fisheries, fishing effort in the model fishery was limited to 50 percent of the 1994-1999 annual average number of sets, or just over 2,100 sets which were distributed equally among those permit holders who applied each year to participate in the fishery. As an additional safeguard a "hard limit" was implemented for the number of turtle interactions that could occur in the swordfish fishery, with the fishery closing for the remainder of the calendar year if either limit is reached. In addition, the amendment required 100 percent observer coverage for the fishery and included a range of conservation projects to protect sea turtles in their nesting and coastal habitats. These measures were proposed by the Council and analyzed in a February 23, 2004 BiOp issued by NMFS.

Current Hawaii-based Shallow-set Longline Fishery Regulations Limiting Effort and Annual Sea Turtle Interactions

Annual shallow-set effort limit (2,120 sets)

The maximum number of annual shallow-sets made available to Hawaii longline limited access permit holders is based on an established annual limit of 2,120 shallow-sets. Each calendar year the NMFS PIRO Regional Administrator divides these 2,120 sets into equal shares such that all holders of a Hawaii longline limited access permit (164 permits total) who provide proper notice of interest to the Regional Administrator (no later than November 1 prior to the start of the calendar year) receive an equal number of shares for each permit held. If such division would result in shares containing a fraction of a set, the annual effort limit is adjusted downward such that each share consists of a number of whole sets. Each set is represented by a unique paper certificate that permit holders must attach to their fishing logbook report form.

Annual sea turtle interaction hard caps

Existing annual sea turtle hard cap limits are based on the incidental take statement contained in the 2004 BiOp (16 leatherback interactions and 17 loggerhead interactions, with an interaction defined as a hooking or entanglement). As described above, if the shallow-set fishery reaches either of these interaction limits, the fishery will immediately close for the remainder of the calendar year. These limits do not represent a jeopardy threshold that, should they be exceeded would jeopardize loggerhead or leatherback populations; rather, they were instituted in 2004 as the number of interactions anticipated by NMFS to occur under the current regulatory structure.

Results of the 2004 regulations

Gilman and Kobayashi (2007) analyzed NMFS' observer information (2004-2007) from the Hawaii shallow-set fishery and found significant reductions in sea turtle interaction rates compared to the historical fishery, as well as reductions in the type of incidental hookings (i.e., lightly hooked vs. deeply hooked in the mouth or swallowed) observed. Combined sea turtle interaction rates have declined by 89% (Figure 1). Deep hooking rates (thought to result in higher sea turtle mortality rates than light hookings) have also declined to 15% of all loggerhead interactions and zero percent of leatherback interactions. Prior to the required use of circle hooks and mackerel-type bait, 51% of sea turtle interactions in the fishery were believed to have involved deeply hooked turtles (Table 3). These results were equal to, and in some cases exceeded, those results observed in experiments conducted in the Atlantic. For example, results from the Atlantic experiments suggested leatherback interactions would be reduced by 67% with circle hooks and mackerel bait; however, in the Hawaii fishery leatherback interactions were reduced by 85%. See Section 3.3.1 for more information on sea turtles.

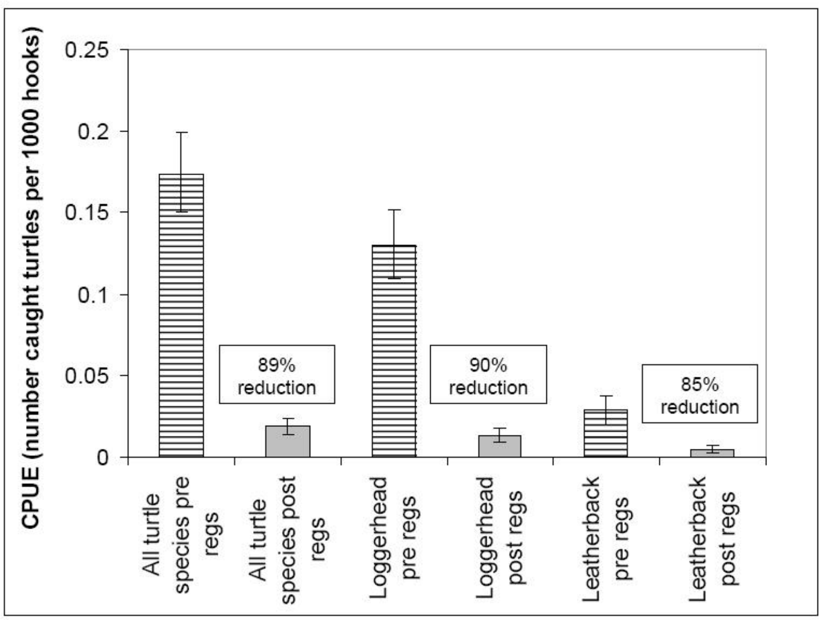

Figure 1: Sea turtle interaction rates in the Hawaii-based longline swordfish fishery, 1994-2001 (before gear modifications) and 2004-2007 (after gear modifications)
Source: Gilman and Kobayashi 2007.

Table 3: Number of observed turtles entangled, lightly-hooked, vs. deeply-hooked in the Hawaii shallow-set fishery, 1994-2007

	Manner of Sea Turtle Capture			
	Lightly Hooked	Deeply Hooked	Entangled [1]	Unknown [2]
2 March 1994 – 20 Feb 2002				
Combined species	95	111	5	12
Loggerhead	61	99 [3]	3	4
Leatherback	26	3	2	6
Olive ridley	3	7	0	0
Green	5	0	0	0
Unknown hardshell	0	2	0	2
3 May 2004 – 31 March 2007				
Combined species	41	6	4	4
Loggerhead	29	6	4	1
Leatherback	12	0	0	1
Olive ridley	0	0	0	0
Green	0	0	0	0
Unknown hardshell	0	0	0	2

Source: Gilman and Kobayashi 2007.

See Table 14 for updated numbers of interactions between the fishery and sea turtles up to the first quarter of 2008. NOAA Fisheries Pacific Islands Region also maintains a website[6] that is updated upon any interaction between the fishery and leatherback and loggerhead turtles.

1.3 Purpose and Need for Action

The Hawaii-based shallow-set longline fishery currently operates on a limited basis under a suite of regulations (adopted in 2004) designed to test the use of gear and bait technologies that had proven in Atlantic experiments to be successful at reducing both sea turtle interaction rates and the severity of such interactions. Based on the successful results in the Hawaii-based fishery demonstrated between 2004-present, the purpose of this action is to provide increased opportunities for the Hawaii-based shallow-set longline fishery to sustainably harvest swordfish and other fish species, while continuing to avoid jeopardizing the continued existence and recovery of threatened and endangered sea turtles as well as other protected species. The proposed modifications to the shallow-set fishery management are intended to further the purposes of the MSA by encouraging optimum yield from the shallow-set longline fishery, while minimizing bycatch and bycatch mortality.

[6] http://www.fpir.noaa.gov/SFD/SFD_turtleint.html

1.4 Proposed Action

Pursuant to the MSA, the Council recommends the preferred alternatives in this document to the Secretary of Commerce for implementation as a Federal regulatory action.

Based on the information and alternatives considered here, and the findings of the Biological Opinion completed by NMFS in October 2008 (NMFS 2008c, see Section 1.4.3), the Council recommends that NMFS implement the following regulatory actions: 1) remove the Hawaii-based shallow-set longline fishery's existing effort set limit and implement new loggerhead and leatherback annual sea turtle interaction hard caps at 46 and 16, respectively, and 2) discontinue the shallow-set certificate program.

The Council recommends that current regulations requiring 100 percent observer coverage and the use of circle hooks and mackerel-type bait, as well as other regulatory measures, remain in place. Although not included as part of the Federal regulatory proposed action, the Council also recommends, as a non-regulatory measure, the continuation of the Council's sea turtle conservation projects.

1.5 Developments Since the DSEIS was Published

In October 2008, NMFS released a BiOp pursuant to section 7 of the ESA that examined the DSEIS' preferred alternative. Relying on the best information available, the BiOp concluded that the DSEIS preferred alternative limiting annual interactions to 46 loggerheads and 19 leatherbacks would not jeopardize the continued existence and recovery of leatherback and loggerhead sea turtle populations. However, due to uncertainty in the status and population trend of the non-Jamursba-Medi component of the Western Pacific leatherback population, the BiOp authorizes no more than 16 annual leatherback interactions and 46 loggerhead interactions. Following the release of the BiOp, the Council reconsidered this issue and at their 143rd meeting (October 2008) revised their recommendation to mirror the authorized interactions contained in the BiOp. The 2008 BiOp can be found in Appendix VI. This revised recommendation comprises the preferred alternative under Topic 1 in this document (see Section 2.1.1).

1.6 Action Area

For the purposes of this analysis, the action area is U.S. EEZ waters of the western Pacific region and areas of the high seas of the Pacific Ocean where the Hawaii-based shallow-set fishery operates, generally between 175° W-145° W longitude and 20° N- 40° N latitude (see Figure 2).

1.7 National Environmental Policy Act

The National Environmental Policy Act (NEPA; 42 U.S.C. § 4331, *et seq*.) establishes the Nation's environmental policy, provides an interdisciplinary framework for environmental planning by Federal agencies, and contains procedures to ensure that Federal decision-makers take environmental factors into account. NEPA does not require that the most environmentally desirable alternative be chosen, but does require that the environmental effects of a reasonable range of alternatives be analyzed equally for the benefit of decision-makers and the public.

NEPA has two principal purposes:

> 1. To require Federal agencies to evaluate the potential environmental effects of any major planned Federal action to ensure that public officials make well-informed decisions about the potential impacts.
>
> 2. To promote public awareness of potential impacts at the earliest planning stages of major Federal actions by requiring Federal agencies to prepare a detailed environmental evaluation for any major Federal action significantly affecting the quality of the human environment.

NEPA requires an assessment of the biological, social and economic consequences of major Federal actions and provides members of the public with an opportunity to be involved in and to influence decision-making on Federal actions. In short, NEPA ensures that environmental information is available to government officials and the public before decisions are made and actions taken.

Federal fishery management actions subject to NEPA requirements include the approval under the MSA of FMPs, FMP amendments, and regulations implementing FMPs. Such approval requires preparation of the appropriate level of NEPA analysis (Categorical Exclusion, Environmental Analysis, or Environmental Impact Statement). On the basis of a review of NEPA and NOAA Administrative Order 216-6, NMFS has determined that data related to the positive results of 2004 regulations requiring circle hooks and mackerel bait have brought forth new information pertinent to the current management of the fishery, and that a Supplemental EIS (SEIS) is the appropriate level of analysis to inform the decision considered here.

The Hawaii-based shallow-set longline fishery is currently operating under the management measures in the Western Pacific Pelagic Fisheries FMP and in accordance with the NEPA analysis in the accompanying EIS (WPRFMC 2001a,b), and in accordance with the 2004 FSEIS on *Management Measures to Implement New Gear Technologies for the Longline Fisheries of the Western Pacific Region* (WPRFMC 2004). Additional management measures and related NEPA documents relevant to the authorization of the fishery include: the 2005 FSEIS on *Seabird Interaction Avoidance Methods under the Pelagics FMP of the Western Pacific Region* (NMFS 2005), the 2005 Environmental Assessment (EA) on *Sea Turtle Mitigation Measures: Gear and Handling Requirements; Protected Species Workshop Attendance; and Shallow-setting Restrictions* (WPRFMC 2005), the 2006 EA on *Management Measures for Pacific Bigeye Tuna and Western and Central Pacific Yellowfin Tuna*, and the 2007 *Draft Programmatic EIS on Toward an Ecosystem Approach for the Western Pacific Region: From Species-Based FMPs to Place-Based Fishery Ecosystem Plans* (NMFS 2007d). The impacts of the current fishery were considered in these NEPA documents and in the BiOps that were issued for the fishery. These documents contain information on portions of the fishery that, as appropriate, may not be covered in detail in this FSEIS.

This NEPA document supplements the previous analysis of the fishery as a whole, and is limited to the new actions that are being considered. This amendment to the Council's Pelagics FMP has been written and organized in a way that meets the requirements of the NEPA as well as MSA, and thus this is a consolidated document including a Supplemental Environmental Impact Statement, as described in NOAA Administrative Order 216-6. This FSEIS supplements the analysis in the "Final Environmental Impact Statement regarding Pelagic Fisheries of the Western Pacific Region, Fishery Management Plan To Analyze Longline, Commercial Troll and Recreational Troll Fisheries, Commercial Pelagic Handline and Commercial Pole and Line Skipjack Fishery, Hawaii, American Samoa, Guam and Commonwealth of the Northern Mariana Islands," which was made available to the public on April 6, 2001, through EIS No. 010104 (66 FR 18243).

1.7.1 Public Scoping

In August 2007, NMFS and the Council published in the *Federal Registe*r a Notice of Intent to prepare a Draft SEIS (72 FR 46608). Public comments were accepted for 30 days and NMFS received four letters. On August 30, 2007, Council staff conducted a public scoping meeting in Honolulu. See Appendix I for the public scoping report and written comments provided to NMFS and the Council.

Members of the public were provided an opportunity to review a preliminary draft (dated February 22, 2008) of this document available on the Council's website (www.wpcouncil.org) and at the 97th Science and Statistical Committee (SSC) meeting, March 3-6, 2008, at the 140th Council meeting in Guam and Saipan, March 17-21, 2008, the 141st meeting in Honolulu, April 14, 2008. A later version (dated May 29, 2008) was available on the Council's website and provided at the 98th SSC June 7-9, 2008, and 142 Council Meeting, June 16-19, 2008 in Honolulu. The DSEIS for this action was made available for a 45-day public review and comment period, which ended on October 6, 2008.

1.8 Lead Agency: National Marine Fisheries Service

The lead agency for this action is NMFS (also known as NOAA Fisheries). NMFS is a bureau within the U.S. Commerce Department's NOAA, and is the primary Federal agency responsible for stewardship of the nation's living marine resources and their habitats. NMFS is represented in the Western Pacific Region by its Pacific Islands Regional Office and Pacific Islands Fisheries Science Center, both located in Honolulu, Hawaii.

1.9 Public Review Process and Schedule

The public has been provided the opportunity to review the drafts of this document at the 97th SSC (February 2008), the 140th Council meeting (March 2008), the 141st Council meeting (April

2008), the 98th SSC (June 2008), and the142nd Council meeting (June 2008). This document was also available to the public for a 45-day public comment period beginning August 22, 2008, and ending October 6, 2008 (73 FR 49667, August 22, 2008). Written public comments received, as well as responses to them, can be found in Appendix VII. NMFS also held a public informational meeting in Honolulu on September 24, 2008, on the proposed action and the issues and potential environmental impacts that were identified in the DSEIS.

Chapter 2: Description of the Alternatives

2.0 Introduction

This chapter describes the management alternatives considered in detail in this document as well as alternatives that were eliminated from further detailed study and the reasons for their elimination.

2.1 Alternatives Considered in Detail

Under all alternatives, current regulations requiring circle hooks and mackerel bait, 100% observer coverage, and the use of annual loggerhead and leatherback sea turtle interaction hard caps, in addition to other measures, would remain in place. The following alternatives considered in detail meet the purpose and need of this action in that they examine the potential for increased opportunities for the Hawaii-based shallow-set longline fishery to sustainably harvest swordfish and other fish species, while continuing to avoid jeopardizing the continued existence and recovery of threatened and endangered sea turtles as well as other protected species.

2.1.1 Topic 1: Shallow-set Longline Fishing Effort Limits

Alternatives under this topic are included for further study because the fishery is currently regulated with a set limit of 2,120 shallow-sets per year and it is appropriate to look at effort limits when considering an expansion of the fishery. The existing effort limit, which is half the fishery's average annual effort during 1994-1999, was instituted to implement the model fishery utilizing new (at the time) gear and bait combinations (circle hooks and mackerel bait) that were successful in fishing experiments in the Atlantic. The existing annual sea turtle interaction hard caps of 17 loggerhead turtles and 16 leatherback turtles were implemented under the model fishery and determined based on experimental (Atlantic Ocean) interaction rates multiplied by the 2,120 set limit. For each of the alternatives listed below under Topic 1, the annual sea turtle interaction hard caps for the fishery are predicted using actual (observed) Pacific Ocean sea turtle interaction rates multiplied by each alternative's effort limit. In the case of Alternative 1F (Remove Effort Limit), preliminarily preferred annual sea turtle interaction hard caps of 19 leatherback interactions and 46 loggerhead interactions were recommended by the Council taking into account the potential for reasonable increases in fishing effort as well as a range of interaction hard caps and their likely impacts on sea turtle populations (see Appendix II). In October 2008, NMFS released a BiOp pursuant to section 7 of the ESA that examined the DSEIS' preferred alternative. Relying on the best information available, the BiOp concluded that the DSEIS' preferred alternative would not jeopardize the continued existence and recovery of leatherback and loggerhead sea turtle populations. However, due to uncertainty in the status and population trend of the non-Jamursba-Medi component of the Western Pacific leatherback population the BiOp authorizes no more than 16 annual leatherback interactions (and 46 loggerhead interactions). Following the release of the BiOp, the Council reconsidered this issue and at their 143rd meeting (October 2008) and revised their recommendation to mirror the authorized interactions contained in the BiOp. The 2008 BiOp can be found in Appendix VI.

This revised recommendation comprises the preferred alternative (1F) under Topic 1 in this document.

2.1.1.A Alternative 1A: No Action: Continue Current Annual Set Limit

Under this alternative, the maximum annual limit on the number of shallow-sets would remain at 2,120.

2.1.1.B Alternative 1B: Allow up to 3,000 Sets per Year

Under this alternative, the maximum annual limit on the number of shallow-sets would be 3,000. This effort limit was chosen as a middle-ground effort alternative which is between the current set limit and the average annual effort between 1994 and 1999 (approximately 4,240 sets).

2.1.1.C Alternative 1C: Allow up to 4,240 Sets per Year

Under this alternative, the maximum annual limit on the number of shallow-sets would be 4,240, which represents the average number of annual sets between 1994 and 1999 or double the current set limit of 2,120 (see Figure 27).

2.1.1.D Alternative 1D: Allow up to 5,500 Sets per Year

Under this alternative, the maximum annual limit on the number of shallow-sets would be 5,500 which is nearly the annual maximum number sets for any one year between 1994 and 1999 (See Figure 27).

2.1.1.E Alternative 1E: Set Effort Level Commensurate with Current Condition of North Pacific Swordfish Stock (~9,925 sets per year)

Under this alternative, the effort level for swordfish would be established based on the condition of the swordfish stock in the North Pacific and the MSY for this stock. Establishment of this effort limit would take into account catches by other longline fleets and the fraction of the total swordfish catch contributed by the Hawaii fleet. Current (domestic and foreign) swordfish landings in the North Pacific amount to about 14,500 mt, which, according to a recent stock assessment, amounts to about 60% of an estimated MSY of 22,284 mt (Kleiber and Yokawa 2004; Bigelow, PIFSC, pers. comm. January 2008).[7] Given an MSY of about 22,284 mt for North Pacific swordfish, and a current swordfish catch by the Hawaii-based fishery of between 850-1,637 mt, (1,861,391-3,602,339 lb) the amount of effort to catch the remaining available 7,784 mt of additional swordfish would amount to about 9,925 sets per year, if the Hawaii longline fishery were to fish the North Pacific swordfish stock up to the level of the MSY. Based

[7] The Klieber and Yokawa (2004) stock assessment contains caveats dealing with a truncated data set (historical catches from Hawaii and Japanese longline fisheries) and model results indicating relative high levels of natural mortality.

on the best available information, the effort limit under this alternative would be adjusted as appropriate.

2.1.1.F Alternative 1F: Remove Effort Limit (Preferred)

Under this alternative, which is the preferred alternative for the effort limit topic, the annual shallow-set effort limit would be removed and fishery would not be managed under an annual set limit cap. Instead, fishing effort would be indirectly restricted by modifying the annual sea turtle interaction hard caps to be set at 46 interactions with loggerhead sea turtles and 16 interactions with leatherback sea turtles (see Section-1.2.3 for more information about sea turtle interaction limits).

2.1.1.2 Alternatives Not Considered in Detail Under This Topic

Reduce or Prohibit Shallow-set Fishing by Hawaii-based Longline Vessels
The best available scientific information suggests that the North Pacific swordfish stock is being fished at levels well below MSY and, therefore, reducing or prohibiting fishing effort for swordfish by the Hawaii-based longline fleet would be inconsistent with the MSA principles given the current status of the primary target species. Reducing effort from the status quo or prohibiting shallow-set fishing effort by Hawaii-based longline fleet due to concerns regarding interactions with protected species is also inconsistent with the MSA as no protected species are being jeopardized under the current regulatory regime for the fishery. Reductions or elimination of the shallow-set fishery is also believed to lead to adverse transferred effects in that more harm to sea turtle populations could result as foreign, unrestricted fisheries using harmful fishing gear increase their effort to fill the market void of a reduced or eliminated Hawaii shallow-set fishery (see Section 4.4.2.1 for more information). U.S. fisheries managed under the MSA may incidentally interact with protected species as afforded under U.S. laws such as the ESA and the Marine Mammal Protection Act (MMPA). The amount or level of interactions protected species populations can sustain is dependent on their status and other factors. See Chapter 3 for more information on the status of protected species in the Western Pacific Region and the level of interactions between protected species and the shallow-set fishery.

2.1.2 Topic 2: Fishery Participation

This topic is included because currently the annual effort limit is allocated amongst interested Hawaii-based longline fishery participants and tracked using a set certificate program. In this program, participants must attach a set certificate to each daily fishing log. The set certificate program is administered by NMFS PIRO, which, in November of each year, provides notices to Hawaii longline fishery participants that set certificates are available. Set certificates are transferable amongst the Hawaii-based longline fleet. The Council and NMFS are considering the set certificate program now that sufficient time has passed to understand the operational and fishery management benefits compared with the costs of the program.

2.1.2.A Alternative 2A: No Action: Continue Set Certificate Program

Under this alternative, shallow-set certificates would continue to be made available and issued to all interested Hawaii longline permit holders. For each shallow-set made north of the equator, vessel operators would continue to be required to possess and submit one valid shallow-set certificate for each shallow-set made.

2.1.2.B Alternative 2B: Discontinue Set Certificate Program (Preferred)

Under this alternative, which is the preferred alternative for the fishery participation topic, shallow-set certificates would no longer be issued or required and the annual set-certificate solicitation of interested parties would end. Under alternatives which include effort limits, sets would be cumulatively accounted for on a fleetwide basis and the fishery would close for the remainder of the year when and if the annual set limit was reached. Fishery participants would continue to be required to notify NMFS at least 72 hrs before making a shallow-set trip.

2.1.3 Topic 3: Time-Area Closures

Time-area closures are being considered as a way to increase annual fishery profits through potential reductions in the number of sea turtle interactions that may occur in the first quarter of each year. Interaction rates for loggerhead turtles highest during the first quarter of the year, and it has been hypothesized that reducing fishing effort in areas where swordfish and loggerhead turtle habitats may overlap could increase fishery profits by reducing the risk of exceeding a turtle hard cap very early in the year when there are still many more shallow-sets allowed to be made.

2.1.3.A Alternative 3A: No Action: Do Not Implement Time-Area Closures (Preferred)

Under this alternative, which is the preferred alternative for the time-area closures topic, the fishery would continue to operate without time-area closures.

2.1.3.B Alternative 3B: Implement January Time-Area Closure

Under Alternative 3B, an area closure would be implemented during January of each calendar year. The area closure would be located between 175° W and 145° W longitude and encompass the sea surface temperature band of 17.5°-18.5° C. The latitudinal location of this temperature band varies inter-and intra-annually; however, in January it is generally located near 31°-32° N latitude. Research has suggested that the area between sea surface temperatures of 17.5°-18.5° C may be a loggerhead sea turtle “hotspot” based on historical and contemporary distribution and foraging studies as well as location data for observed loggerhead sea turtle interactions with the fishery (Howell, PIFSC, pers. comm., December 2008). The month of January was selected because it may be that the number of loggerhead interactions during January is pivotal to whether or not the fishery will reach its annual sea turtle interaction hard cap before all allowable sets are used. For example, in 2006, the fishery interacted with eight loggerheads in January and the fishery reached the cap of 17 on March 17, 2006. In 2007, the fishery did not interact with any loggerheads during January, but ended the first quarter with 12 loggerhead interactions and did not reach the sea turtle cap.

2.1.3.C Alternative 3C: Implement In-Season Time-Area Closures

Under Alternative 3C, the sea surface temperature-based area closure described for Alternative 3B would be implemented in those years for which 75 percent of the annual loggerhead turtle cap was reached and the closure would remain in effect for the remainder of the first quarter. As with Alternative 3B, this alternative is being considered as a way to increase annual fishery profits through reductions in the number of turtle interactions that occur in the first quarter of each year. This alternative differs from Alternative 3B in that its implementation is contingent on high numbers of interactions during the first quarter.

2.2 Topics Considered but Not Analyzed in Detail

Several additional topics (and associated alternatives) were also considered, but have been identified as not reasonable in relation to the purpose and need of the proposed action and were therefore eliminated from detailed study. These topics and the reasons that they were not considered in detail are also summarized below.

2.2.1 Sea Turtle Interaction Hard Caps (remove or maintain as management measure)

Reasons for elimination from further study
This topic would have involved alternatives that examined the use of sea turtle interaction hard caps as a management tool. Currently, the Hawaii-based shallow-set longline fishery is closed for the fishing year if and when either of the annual sea turtle (loggerhead or leatherback turtle) interaction hard caps is reached for either species. In 2006, the fishery reached the loggerhead turtle hard cap and the fishery was subsequently closed for the remainder of the calendar year. Hard caps have proven to be an effective management measure to eliminate the possibility of additional turtle interactions. No interest has been expressed from the longline fishery, managers, or relevant environmental groups to eliminate sea turtle hard caps as a management measure.

2.2.2 Sea Turtle Interaction Hard Caps (reduce number of allowable interactions)

Reasons for elimination from further study
This topic would have evaluated an alternative of operating the fishery under more stringent hard caps than are currently in place for loggerhead (17) and leatherback (16) sea turtles. This alternative was eliminated from further study because it would be inconsistent with the purpose and need of the proposed action, which is to provide increased opportunities for the shallow-set fishery to sustainably harvest swordfish and other fish while continuing to avoid jeopardizing the continued existence and recovery of threatened and endangered sea turtles, as well as other protected species. Under National Standard 1 of the MSA, fishery management measures must

prevent overfishing while achieving, on a continuing basis, the optimum yield from the fishery. Optimum yield is generally seen as the amount of harvest in a fishery which will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems including harvest at sustainable levels. Under the 2008 BiOp that analyzed the impacts of the proposed action, the level of turtle interactions that were authorized in the Incidental Take Statement is a number of interactions that is not expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of sea turtles. An alternative that reduces the hard caps below this level would prevent fulfilling National Standard 1 because the fishery would close before producing optimum yield. For these reasons, this topic was eliminated from further consideration.

2.2.3 Sea Turtle Interaction Assessment Methodology

Reasons for elimination from further study

This topic would have reviewed as specific, separate alternatives various timeframes for assessing turtle interactions under ITSs that are issued by NMFS. Typically, the BiOp (BiOp) that takes into account the potential effects of the fishery on threatened and endangered species establishes an estimated maximum number of interactions between the fishery and sea turtles. When this number is exceeded, NMFS must reinitiate consultation under the ESA for the fishery. Sea turtle interaction rates fluctuate intra- and inter-annually due to variable oceanographic conditions and other factors. Because the annual sea turtle hard caps are being maintained as a management measure under the proposed action, the fishery would close if the annual turtle hard cap were to be reached, regardless if a one year or a multi-year ITS is used. A multi-year ITS, however, offers somewhat more flexibility in that if the fishery should happen to exceed the maximum number of interactions under a hard cap, reinitiation of ESA consultation on the underlying BiOp would not be required provided the excess interactions are not greater than a pre-determined number set forth in the BiOp. In addition, the number of excess interactions would be deducted from the number of allowable interactions the following fishing year under a multi-year ITS. The fishery, however, would still be closed during any year at the time the annual sea turtle hard cap is reached regardless of whether the ITS is for one year or multiple years. Because sea turtle hard caps will be retained as a management tool for the fishery, there is no difference in operation of the fishery under a single year or multi-year ITS. For this reason, considering the various timeframes for assessing turtle interactions as a management alternative was not considered for further study in this document. However, the impacts of operating the fishery under a multi-year ITS are included for discussion in Section 4.1.6.3.2.1.

2.2.4 Sea Turtle Avoidance Incentives

Reasons for elimination from further study

The topic would involve alternatives that would examine the use of transferable or non-transferable individual sea turtle limits or quotas for fishery participants. There is little information on whether or not an incentive or allocation type program would result in conservation benefits to sea turtles while being fair and equitable amongst fishery participants.

For example, Gilman et al. (2006) found it difficult to determine whether some vessels have disproportionately higher numbers of sea turtle interactions than others, as some vessels only fished prior to the new 2004 regulations while others only fished after 2004. In light of the lack of evidence showing that individual sea turtle avoidance incentives would be practical, useful, or beneficial, the use of these incentives was eliminated from further consideration. Furthermore, there is little interest amongst the fishery participants or the environmental community in the development of a program to implement individual vessel sea turtle limits. For these reasons, this topic category (and associated alternatives) has been eliminated from further detailed study.

2.2.5 Observer Coverage

Reasons for elimination from further study

This category of alternatives was eliminated from further study because the Council, NMFS, HLA, and environmental groups do not support removing the 100% observer coverage requirement for the fishery at this time. Because the cost of this coverage remains an important issue, the Council and NMFS have included in Chapter 4 the analysis of shallow-set effort on administrative observer costs in relation to potential increases in shallow-set effort.

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Chapter 3: Affected Environment

3.0 Introduction

As stated in Section 1.6, the action area contemplated in this analysis is the portion of the North Pacific Ocean between 175° W-145° W longitude and 20° N- 40° N latitude, including the Hawaiian Archipelago. This chapter provides background information on the following topics of the action area: the natural environment in which the shallow-set fishery operates, target and non-targets stocks, sea turtles and other protected species, Hawaii longline fishery statistics, and Hawaii socio-economic information. Other environmental information is also included for reference. For further detailed information on several of the environmental resource categories above, refer to the 2001 Final EIS on the Pelagics FMP (NMFS 2001), 2005 Final EIS on Seabird Mitigation Measures (NMFS 2005), 2006 FMP Amendment 14 on Bigeye and Yellowfin Overfishing (WPRFMC 2006), and 2008 Draft Programmatic EIS on the transition from species-based FMPs to place-based Fishery Ecosystem Plans (NMFS 2007d).

3.1 Physical Pelagic Environment

3.1.1 North Pacific Transition Zone

The action area is in the North Pacific subtropical gyre (large-scale surface current) which rotates in a clockwise direction. At approximately 30°- 45° N latitude is the North Pacific Transition Zone (see Figure 2), which is ocean water bounded to the north and south by large-scale surface currents originating from subarctic and subtropical locations (Polovina et al. 2001). The North Pacific Transition Zone is an area between the southern boundary of the Subartic Frontal Zone (SAFZ) and the northern boundary of the Subtropical Frontal Zone (STFZ; see Figure 2) consisting of several convergent fronts. A front is defined simply as an area of rapid change in a physical variable, such as temperature, over a small spatial distance, horizontal or vertical (Olson et al. 1994). Remotely sensed satellite data have been used to identify sea surface temperature (SST) and chlorophyll fronts (Polovina et al. 2001). Individual temperature and salinity gradients are observed within each front, but generally the SAFZ is colder (approximately 8° C) and less salty (approximately 33.0 ppm) than the STFZ (18° C, approximately 35.0 ppm, respectively). The North Pacific Transition Zone (NPTZ) supports a marine food chain that experiences variation in productivity in localized areas due to changes in nutrient levels brought on, for example, by storms or eddies. A common characteristic among some of the most abundant animals found in the NPTZ such as flying squid, blue sharks, Pacific pomfret, and Pacific saury is that they undergo seasonal migrations from summer feeding grounds in subarctic waters to winter spawning grounds in the subtropical waters. Other animals found in the NPTZ include swordfish, tuna, albatross, whales, and sea turtles (Polovina et al. 2001).

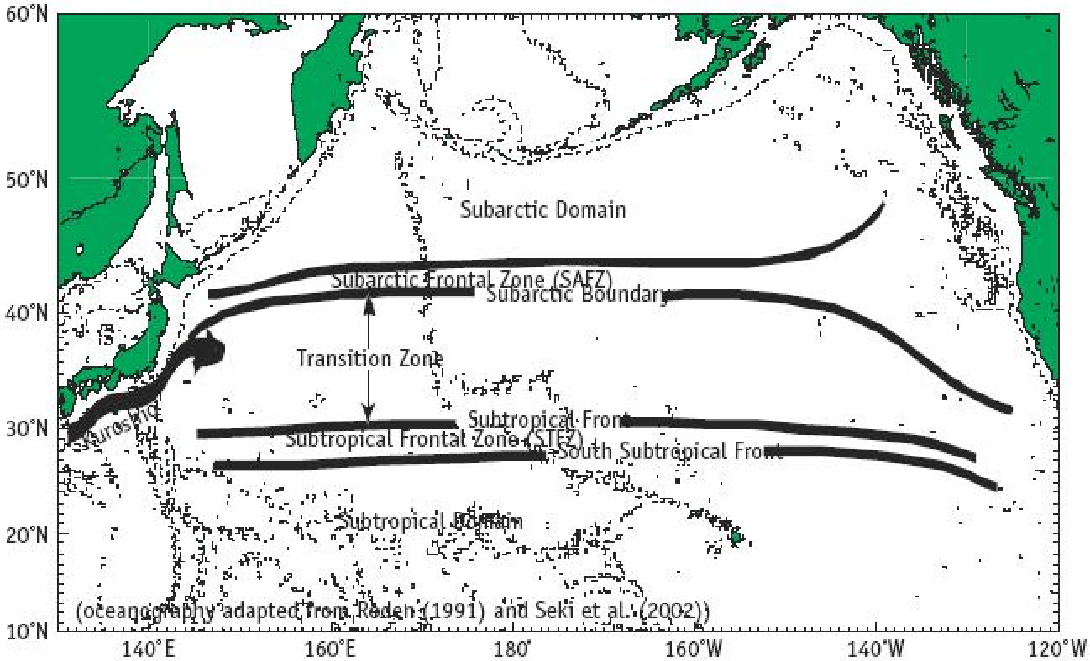

Figure 2: North Pacific Transition Zone
Source: Seki et al. 2002

Near Hawaii, there are two prominent frontal zones which are associated with two isotherms (17° C and 20° C), and are 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. 2002). Both the STF and SSTF represent important habitat 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. 2002), 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. 2002). Squid is also the primary prey item for albatross (Harrison et al. 1983); hence, albatross and longline vessels targeting swordfish are often present at the same time in the same area of biological productivity.

Generally, at high latitudes of the North Pacific, high surface chlorophyll concentrations are found and at mid-latitudes low concentrations are observed (Lewis et al. 1988). For example, in the subtropical gyre, surface chlorophyll concentrations were 0.15 mg/m^3 and in the subarctic gyre and Transition Zone they were 0.25 mg/m^3 (Figure 3, Polovina et al. 2001).

Along the interface between the low-surface chlorophyll subtropical gyre and the high-surface chlorophyll subarctic gyre is a basin-wide chlorophyll front. Seasonally, this front migrates over 1000 km from its southernmost position during the first quarter at about 30–35° N and its northernmost position during the third quarter at about 40–45° N (Figure 3).

Polovina et al. (2001) reported that these frontal zones have also been found to be likely migratory pathways across the Pacific for loggerhead turtles. Loggerhead turtles are opportunistic omnivores that feed on floating prey such as the pelagic cnidarian, *Vellela vellela,* ("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. 2001).

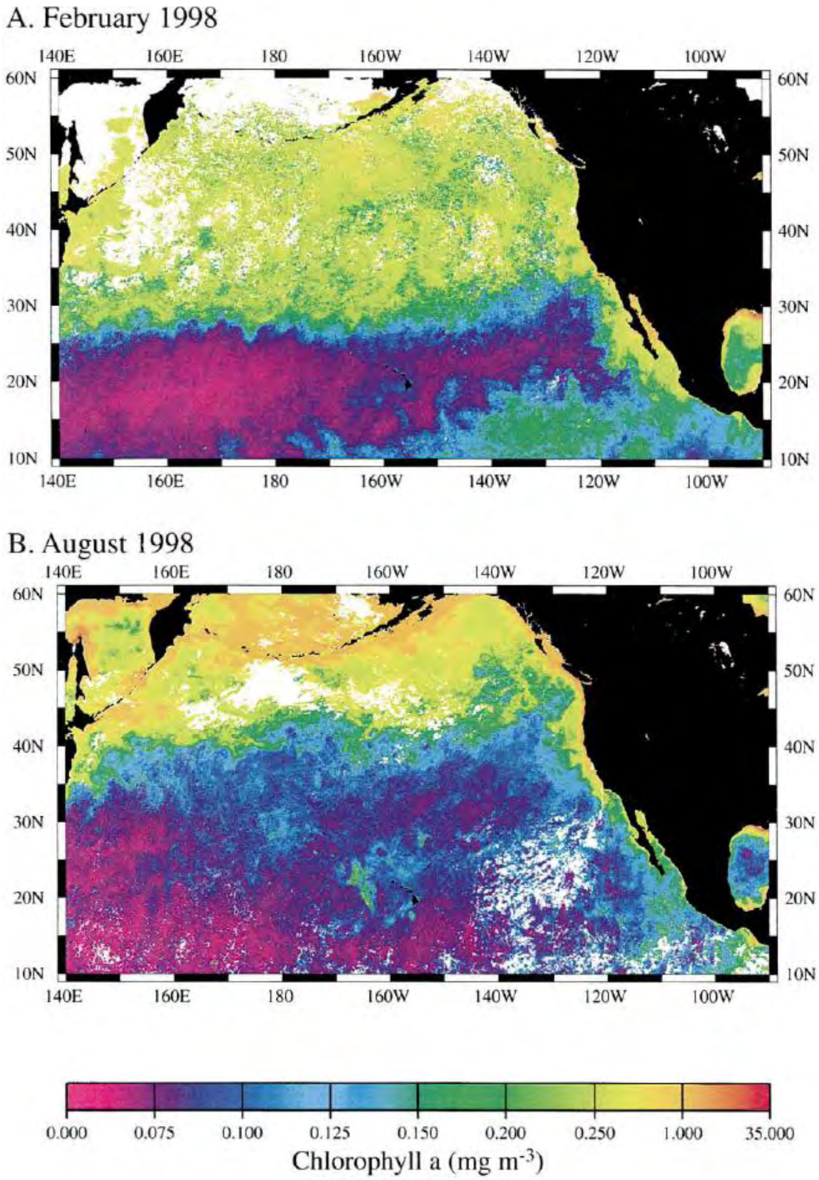

Figure 3: Surface chlorophyll density estimated from SeaWiFS ocean color for the North Pacific, A) February and B) August 1998
Source: Polovina et al. 2001

3.1.2 Other Physical Environmental Factors

A significant source of inter-annual physical and biological variation is 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.

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.

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. Tuna 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.

3.1.3 Physical Environment and Global Climate Change

The global mean temperature has risen 0.76° C over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (IPPC 2007a). Ample evidence now exists supporting the wide-ranging ecological impacts of global climate change (Walther et al, 2002). There is a high confidence, based on substantial new evidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. These changes include shifts in ranges and changes in algal, plankton, and fish abundance (IPPC 2007b).

The seasonal north-south movements of many large pelagics in the NPTZ appear to track the similar peak migration of primary productivity. Using remotely-sensed chlorophyll[8] concentrations from satellite observations, Polovina et al. (2008) have found that over the past decade primary productivity in the subtropical and transition zone has declined an average of 1.5% per year with about a 3% per year decline occurring at the southern limit of the NPTZ. The expansion of the low chlorophyll waters is consistent with global warming scenarios based on increased vertical stratification in the mid-latitudes. Expanding oligotrophic[9] portions of the subtropical gyres in the world's oceans in time will lead to a reduction in chlorophyll density and carrying capacity in the larger subtropical gyres, thus impacting the abundance of pelagic species. For example, a recent scientific study using an enhanced version of the spatial ecosystem and population dynamics model (SEAPODYM[10]) suggests that by the end of this century, ocean temperatures in the WCPO will increase to levels that will not support bigeye populations in the WCPO (J. Sibert, PFRP, pers. comm. July 2008). An international program called CLIOTOP (climate impacts on oceanic top predators) is currently gathering information on climate change and its effects on pelagic ecosystems. Within this group, the SEAPODYM model is being applied to investigate the future management of tuna stocks and other highly migratory species in the context of climate and ecosystem variability, as well as to investigate potential changes due to greenhouse warming.

3.2 Biological Pelagic Environment

Species of oceanic pelagic fishes 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. A pelagic food web of the Central Pacific Ocean is provided in Figure 4.

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. Adult pelagic fishes in the western Pacific range as far north as Japan and as far south as New Zealand. Alba-

[8] Chlorophyll is the green pigment found in phytoplankton that absorbs light energy to intiate the process of photsynthesis.
[9] Meaning waters where relatively little plant life or nutrients occur, but are rich in dissolved oxygen.
[10] The model based on advection-diffusion-reaction equations explicitly predicts spatial dynamics of large pelagic predators, while taking into account data on several mid-trophic level components, oceanic primary productivity and physical environment.

core, 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.

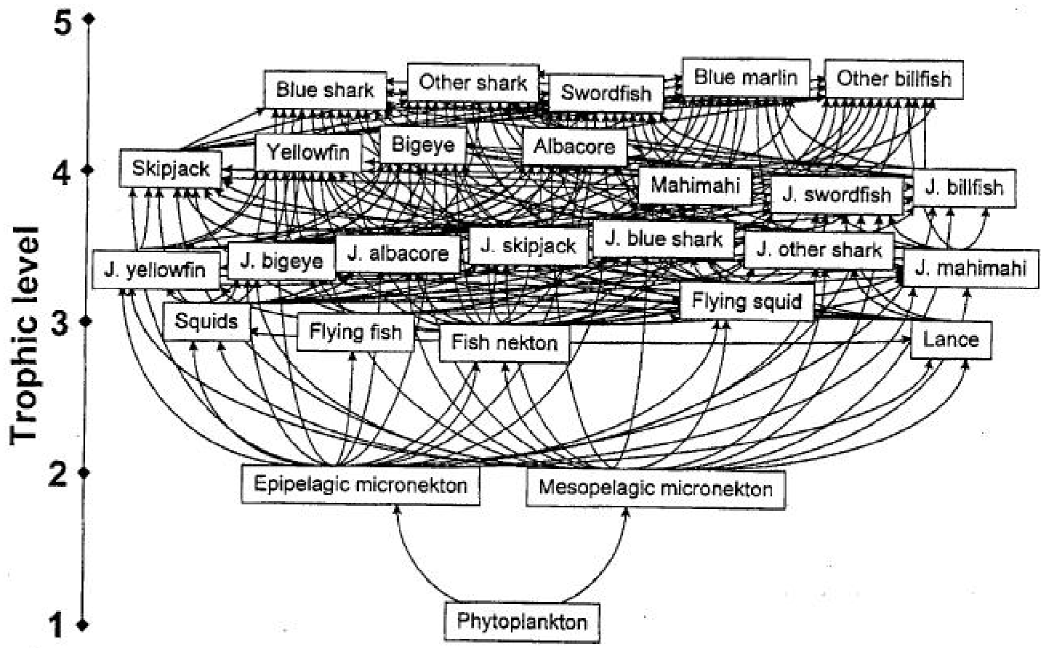

Figure 4: Central Pacific Pelagic Food Web
Source: Kitchell et al. 1999

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. 2002) and enhance migration by providing an energetic gain by moving the fish along with favorable currents (Olson et al. 1994).

3.2.1 Target Species: Swordfish

Swordfish (*Xiphias gladius*) are the primary target species of the Hawaii-based shallow-set fishery, typically comprising 90 percent of the landed catch.

3.2.1.1 Swordfish Life History

Numerous studies on the taxonomy, biology, diet, stock structure and exploitation of swordfish have been conducted. Information on billfishes, including swordfish, is summarized in Nakamura et al. (1968) and Nakamura (1985). Palko et al. (1981) and Joseph et al. (1994) provide a detailed synopsis of the biology of swordfish. An extensive review of the biology of swordfish and the status of swordfish fisheries around the world was published by Ward and Elscot (2000).

Broadbill swordfish are worldwide in distribution in all tropical, subtropical and temperate seas, ranging from around 50° N to 50° S (Nakamura 1985; Bartoo and Coan 1989). The adults can tolerate a wide range of water temperature, from 5°-27° C, but are normally found in areas with SSTs above 13° C (Nakamura 1985). Larvae and juveniles occur in warmer tropical and subtropical regions where spawning also occurs. Swordfish occur throughout the entire region of the Council’s jurisdiction and in the EEZs of neighboring countries and adjacent high seas zones.

Swordfish have separate sexes with no apparent sexual dimorphism, although females attain a larger size. Fertilization is external and the fish are believed to spawn close to the surface. There is some evidence for the pairing of spawning adults as the fish apparently do not school (Palko et al. 1981).

Swordfish are voracious feeders at all life stages. Adults feed opportunistically on a wide range of squids, fish and crustaceans. Sex ratio appears to vary with fish size and spatial distribution.

Most large sized fish are females and females appear to be more common in cooler waters. Beckett (1974) noted that few males were found in waters below 18° C, but make up the majority of warm water landings. Details of growth, maturity, fecundity and spawning are given later in this report.

Little is known about migration in Pacific swordfish although limited tagging data support a general west to east movement from Hawaii toward North America. There is some evidence that there may be several semi-independent stocks in the Pacific (a northern stock, a southwest stock and two or three eastern stocks) (Alvarado et al. 1996).

Swordfish are targeted by the Hawaii-based longline fishery that occurs primarily to the north of the EEZ around Hawaii. Incidental or targeted catches within the EEZ around Hawaii are made by longline and handline vessels fishing primarily for tuna species.

Larval and Juvenile Stages

Swordfish larvae have been noted in tropical and subtropical waters of the three major oceans between about 30° N and 30° S. In a survey of swordfish larvae collections, Grall et al. (1983) determined that larval swordfish were abundant in the Pacific within latitudes 35° N to 25° S. Peak spawning occurs in the North Pacific between May and August, from December to January in the South Pacific and from March to July in the central Pacific (Nishikawa et al. 1978, Palko et al. 1981). Sexually mature and ripening female swordfish have been noted in Hawaiian waters during the spring and early summer (Uchiyama and Shomura 1974). This observation is in agreement with an estimated spawning period of April to July based on the collection of larvae and juveniles near Hawaii (Matsumoto and Kazama 1974). It is probable that some degree of spawning occurs throughout the year in tropical waters, between 20° N and 20° S, with the distribution of larvae associated with SSTs between 24° and 29° C (Tåning 1955, Yabe et al. 1959, Nishikawa and Ueyanagi 1974).

Juvenile swordfish gradually metamorphose from larval state to adult, and it is difficult to elect a length or age when the juvenile stage has been reached. However, early development is rapid and juvenile fish greater than approximately 55 cm resemble a miniature adult swordfish. In the Pacific, fish of this size (51-61 cm) have been estimated to be approximately one-year old (Yabe et al. 1959, Dewees 1992).

There are few specific references on the distribution of juvenile swordfish in the Pacific. Swordfish recruit to longline gear at juvenile sizes of approximately 50 to 80 cm (rear of eye orbit to caudal fork), which can be monitored by catch statistics. Dewees (1992) stated that swordfish tend to concentrate along productive thermal boundaries between cold upwelled water and warmer water masses where they feed on fish and squid.

Adult Stage

Adult swordfish are the most widely distributed of all billfish species, ranging from approximately 50° N to 50° S in the Pacific as indicated by catch records of commercial longline vessels. Adult swordfish are able to occupy a very broad range of water temperatures, from 5°-

27° C with a preferred temperature range of 18°-22° C (Nakamura 1985). Individuals can exceed 500 kg in weight with females growing larger than males. The larger fish occupy cooler waters, with few fish less than 90 kg and few males found in waters less than 18° C (Palko 1981).

Wilson and Dean (1983) estimated a maximum age of nine years for males and 15 years for females from otolith analysis. Radtke and Hurley (1983), using otoliths, estimated a maximum age of 14 years for males and 32 years for females. Research on the reproductive biology and size at maturity of swordfish is reviewed by DeMartini (1996). Yabe et al. (1959) estimated that swordfish reach maturity between 5 and 6 years of age at a size of 150-170 cm (eye to fork length). Sosa-Nishizaki (1990) estimated that female swordfish in the Pacific mature at 140-180 cm based on gonad indices. Length at first maturity has been observed in females as small as 101-110 cm (Nakano and Bayliff 1992). Spawning occurs in the upper mixed layer of the water column from the surface to 75 m (Nakamura 1985).

Swordfish are found in waters with a wide range of SSTs and sonic tracking experiments indicate that they spend prolonged periods in deep, cooler water and can therefore tolerate water temperatures that are considerably cooler than at the surface. Swordfish can forage at great depths and have been photographed at a depth of 1,000 m by deep diving submersible (Mather 1976). Carey (1982) and other researchers have suggested that specialized tissues warm the brain and eyes, allowing swordfish to successfully forage at great depths in frigid waters. Holts (1994) used acoustic telemetry to monitor an adult swordfish and notes that the fish spent about 75 percent of its time in or just below the upper mixed layer at depths of 10 to 50 m in water temperatures about 14° C and made excursions to approximately 300 m where the water was close to 8° C.

The horizontal and vertical movements of several swordfish tracked by acoustic telemetry in the Atlantic and Pacific are documented by Carey and Robison (1981). Studies have noted a general pattern of remaining at depth, sometimes near the bottom, during the day and rising to near the surface during the night in what is believed to be a crepuscular foraging strategy. More recently a tagging project was undertaken in New Zealand waters utilizing pop-off satellite archival tags (PATS) to track movements of swordfish during a time when they would be expected to visit sub-tropical spawning grounds and return to temperate waters (Holdsworth et al. 2007). They found all swordfish to make occasional excursions to the surface during the day; a behavior more prevalent in larger fish, which may be the “basking” behavior described in Dewar and Polovina (2005).

Adult swordfish are opportunistic feeders, preying heavily 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. Swordfish are relatively abundant near boundary zones where sharp gradients of temperature and salinity exist (Palko et al. 1981). Sakagawa (1989) notes that swordfish are found in areas of high productivity where forage species are abundant near current boundaries and frontal zones.

3.2.1.2 Swordfish Landings

U.S. landings

North Pacific swordfish are targeted by U.S. vessels based out of California and Hawaii. 2006 data for all U.S. longline fisheries operating in the Western and Central Pacific Ocean (WCPO) out of both Hawaii and California show the bulk of the swordfish were harvested from north Pacific waters and a small amount from south Pacific waters (Table 4). Other U.S. fisheries such as the drift gillnet fishery operating in the Eastern Pacific Ocean (EPO) also harvest North Pacific swordfish.

Table 4: **U.S. landings of Pacific swordfish, 2003 - 2006**

Year	North Pacific (mt)	South Pacific (mt)	Total (mt)
2003	1,957	7	1,964
2004	1,072	4	1,076
2005	1,451	3	1,454
2006	1,131	30	1,161

Source: NMFS 2007 unpublished data

The spatial distribution of the swordfish catch in the WCPO by the U.S. longline fleet is shown below with the majority of the catch centered around 160° W and 30-35° N (Figure 5). Most of the effort in Figure 5 is from vessels based in Hawaii. When the Hawaii-based shallow-set fishery was closed from 2001-2003, several vessels relocated to California and continued to fish for swordfish until that was prohibited under the West Coast Highly Migratory Species (HMS) FMP.

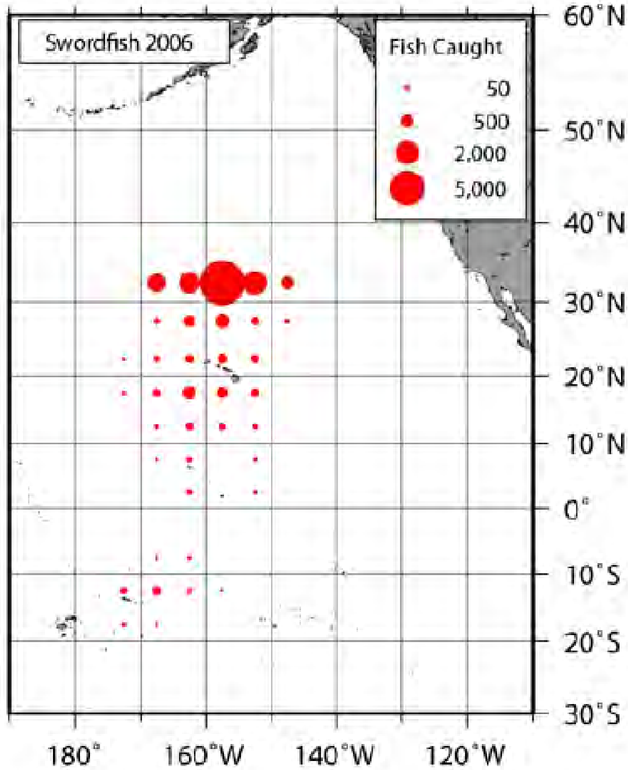

Figure 5: Spatial distribution of reported logbook swordfish catch in the WCPO by the U.S. longline fleet, in numbers of fish (includes retained and released catch), in 2006 (provisional data)
Source: NMFS 2007

Hawaii-based Swordfish Fisheries

In the Hawaii-based pelagic fisheries, swordfish landings peaked in 1993 and subsequently decreased (Figure 6). The trend in swordfish landings reflected both an increase in the number of vessels in the longline fishery and widespread targeting of swordfish by the fishery. Landings remained relatively steady up to 2000 but dropped dramatically with the prohibition on targeting swordfish by the longline fishery. Although the longline fishery for swordfish was reopened under a new set of regulations in April 2004, landings have remained substantially lower than historical levels. Swordfish landings are primarily from the longline fishery with some small amounts by the main Hawaiian Islands (MHI) commercial troll and handline fisheries (e.g., 14,000 lb in 2007; Table 5). Provisional data indicate that approximately 3.7 million pounds of swordfish was caught by the shallow-set fishery in 2007 (WPRFMC 2008, see Figure 6).

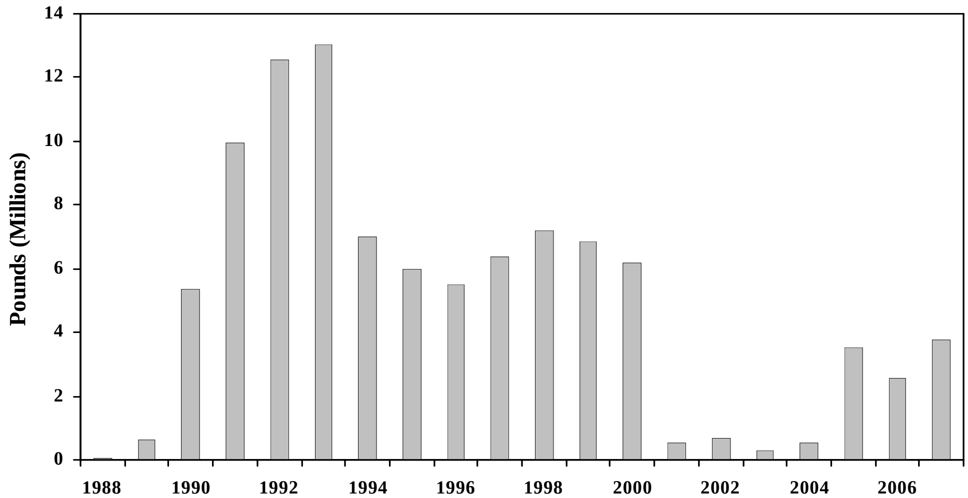

Figure 6: Swordfish Landings from the Hawaii-based pelagic fisheries 1987 - 2007
Source: 2007 WPRFMC Pelagics Annual Report

Table 5: Swordfish Landings from the Hawaii-based pelagic fisheries 1987 - 2007

	Swordfish Landings (1000 Pounds)			
Year	**Longline**	**MHI Troll**	**MHI Handline**	**All Gear**
1988	52	2	11	65
1989	619	2	14	635
1990	5,372	1	10	5,383
1991	9,939	1	13	9,953
1992	12,566	0	3	12,569
1993	13,027	0	9	13,036
1994	7,002	1	7	7,010
1995	5,981	1	12	5,994
1996	5,517	1	11	5,529
1997	6,352	1	15	6,368
1998	7,193	1	14	7,208
1999	6,835	1	19	6,855
2000	6,205	5	193	6,404
2001	519	4	39	562
2002	681	3	19	703
2003	300	2	19	324
2004	549	0	16	598
2005	3,527	1	11	3,539
2006	2,573	1	9	2,583
2007	3,781	2	12	3,796
Average	**4,930**	**1**	**23**	**4,956**
Std. Dev.	**3,851**	**1**	**40**	**3,848**

Source: 2007 WPRFMC Pelagics Annual Report

Hawaii charter fisheries are considered commercial fisheries by the State of Hawaii and are included in the table above with the MHI troll fishery category. There are anecdotal reports of charter swordfish fishing off Kona, HI; however, the amount of catch is likely small and encapsulated in the MHI troll fishery statistics listed above. Hawaii pelagic handline fisheries primarily target bigeye and yellowfin tuna as well as monchong, and commercial landings of swordfish from MHI handline fisheries have been relatively stable over time; however, in 2000, 193,000 lbs of swordfish was reported to be landed from the handline fishery. Although information in lacking on recreational swordfish fisheries in Hawaii, landings are likely very small and likely below the statistics associated with MHI troll fisheries (see Section 3.2.2.12 for more information about Hawaii's recreational pelagic fisheries).

West Coast Commercial and Recreational Swordfish Fisheries
The following information was taken from the *Status of the U.S. West Coast Fisheries for Highly Migratory Species through 2005* (PFMC 2006).

Commercial Harpoon Fishery for Swordfish
California's harpoon fishery for swordfish developed in the early 1990s. Prior to 1980, harpoon and hook-and-line gears were the only methods of take authorized to commercially harvest swordfish. At that time, harpoon gear accounted for the majority of swordfish landings in California ports. In the early 1980s, a limited entry drift gill net fishery was authorized by the State Legislature. Soon afterward drift gillnets replaced harpoons as the primary method for catching swordfish and the number of harpoon permits decreased from a high of 1,223 in 1979 to a low of 23 in 2001. Fishing effort typically occurs in the Southern California Bight (SCB) from May to December, peaking in August, depending on weather conditions and the availability of fish in coastal waters. Some vessel operators work in conjunction with a spotter airplane to increase the search area and to locate swordfish difficult to see from the vessel. This practice tends to increase the catch-per-unit-effort compared to vessels that do not use a spotter plane. To participate in the harpoon fishery, a permit and logbook are required in addition to a general resident or non-resident commercial fishing license and a current California Department of Fish and Game vessel registration. Additionally, the HMS FMP requires a Federal permit with a harpoon gear endorsement for all U.S. vessels that fish for HMS within the West Coast EEZ and to U.S. vessels that pursue HMS on the high seas (seaward of the EEZ) and land their catch in California, Oregon, and Washington. In 2004, the annual harpoon swordfish catch was 69 mt from 28 vessels, and in 2005 it was 74 mt from 24 vessels participating in the fishery. Fishing effort was concentrated in coastal waters off San Diego and Orange Counties in the SCB and landings occurred May through December, peaking in August.

The ex-vessel revenue for 2005 was $782,920 compared to $669,955 in 2004. Because harpoon vessels spend less time on the water and are a low-volume fishery, their catch is often fresher than drift-gillnet-caught fish, so markets tend to pay more for harpooned fish. The average ex-vessel price-per-pound for harpooned fish was $7.84 compared to $3.41 for drift gillnet caught fish in 2005.

Commercial Drift Gillnet

California's swordfish fishery transformed from primarily a harpoon fishery to a drift gillnet fishery in the early 1980s and landings soared to a historical high of 2,371 mt by 1985. The drift gillnet fishery is a limited entry program managed through gear restrictions, seasons, and area closures. The limited entry program was established in 1980 and about 150 permits were initially issued. The permit is transferable under very limited conditions and it is linked to an individual fisherman, not a vessel; thus the value of the vessel does not become artificially inflated, allowing permittees to buy new vessels as needed. Since 1984, the number of permits has declined from a high of 251 in 1986 to a low of 86 in 2007; however, only 46 vessels participated in the California swordfish fishery in 2007. Annual fishing effort has also decreased from a high of 11,243 sets in the 1986 fishing season to 1,043 sets in 2005. Industry representatives attribute the decline in vessel participation and annual effort to regulations implemented to protect threatened and endangered marine mammals, sea turtles, and seabirds. To keep a permit active, current permittees are required to purchase a permit from one consecutive year to the next; however, they are not required to make landings using drift gillnet gear. In addition, a general resident or non-resident commercial fishing license and a current vessel registration are required to catch and land fish caught in drift gillnet gear. A logbook is also required. The HMS FMP requires a Federal permit with a drift gillnet gear endorsement for all U.S. vessels that fish for HMS within the West Coast EEZ and to U.S. vessels that pursue HMS on the high seas (seaward of the EEZ) and land their catch in California, Oregon, and Washington. Historically, the California drift gillnet fleet has operated within EEZ waters adjacent to the state and as far north as the Columbia River, Oregon, during El Niño years. Fishing activity is highly dependent on seasonal oceanographic conditions that create temperature fronts that concentrate feed for swordfish. Because of the seasonal migratory pattern of swordfish and seasonal fishing restrictions, over 90 percent of the fishing effort occurs August 15 through January 31.

In 2001, NMFS implemented two Pacific sea turtle conservation areas on the West Coast with seasonal drift gillnet restrictions to protect endangered leatherback and loggerhead turtles. The larger of the two closures spans the EPO north of Point Conception, California (34°27' N latitude) to mid-Oregon (45° N latitude) and west to 129° W longitude. Drift gillnet fishing is prohibited annually within this conservation area from August 15 to November 15 to protect leatherback sea turtles. A smaller closure was implemented to protect Pacific loggerhead turtles from drift gillnet gear during a forecasted or occurring El Niño event, and is located south of Point Conception, California and west of 120° W longitude from January 1 through January 31, and from August 15 to August 31. Since 2000, the number of vessels participating in the swordfish fishery has decreased from 69 in 2001 to 38 in 2005. In 2005, 38 drift gillnet vessels landed 220 mt of swordfish compared to 35 vessels that landed 182 mt in 2004. Landings occurred at ports from San Diego to Monterey and the majority occurred from October to December. Over 85 percent of the reported effort occurred in the SCB. The ex-vessel revenue was $1.2 million in 2005 compared to $1.0 million in 2004. In 2007, 39 drift gillnet vessels landed 474 mt of swordfish compared to 38 vessels that landed 444 mt in 2006. The ex-vessel revenue was nearly $2.4 million in 2007 compared to about $2 million in 2006. Most of the swordfish landed in California supports domestic seafood restaurant businesses.

Commercial Longline Fishery

California prohibits pelagic longline fishing within the EEZ and the retention of striped marlin. Under regulations for the Pacific Highly Migratory Species FMP, West Coast based longline vessels are prohibited from making shallow sets to fish for swordfish in the EEZ as well as on the high seas. However, for the 2008 and 2009 fishing seasons, one experimental shallow-set fishing permit may be authorized by NMFS to fish within the EEZ off the U.S. West Coast. Vessels operating outside of the EEZ can land fish in California ports if the operator has a general resident or nonresident commercial fishing license and a current CDFG vessel registration. The operator must comply with the High Seas Fishing Compliance Act, which requires U.S. vessel operators to maintain logbooks if they fish beyond the EEZ. Additionally, the HMS FMP requires a federal permit with a pelagic longline gear endorsement for all U.S. vessels that pursue HMS on the high seas (seaward of the EEZ) and land their catch in California, Oregon, and Washington. In recent years, Federal regulations that were promulgated to protect endangered sea turtles east and west of 150° W longitude and north of the equator have impacted the number of landings of swordfish in California ports. In 2006, 3 longline vessels operating with Hawaii permits made swordfish landings (25 mt) compared to 20 vessels that landed 898 mt in 2004 (PFMC 2008).

Recreational fishery

The following on West Coast recreational swordfish catches has been freely adapted from the Billfish Newsletter (1996). Recreational anglers consider swordfish one of the finest of all trophy game fishes because of their size and strength. If spotted on the surface, anglers will try to entice them to strike. Swordfish typically feed at night in the surface waters on small pelagic fishes, hake and squid. They are also known to feed at depths of at least 300 meters. Most angling is done during the daytime from private boats targeting striped marlin, but some California anglers have develop specific techniques to target swordfish. Drifting at night with chemical light-sticks and squid bait has been conducted more recently but has been more popular on the East Coast. The California recreational fishery for swordfish and striped marlin developed about the turn of the century. Recreational catch records of swordfish are kept by the various sport-fishing clubs in California. The Balboa Angling Club, San Diego Marlin Club and the Tuna Club (Avalon) are three of the major clubs where anglers have their swordfish catches recorded and weighed. The number of swordfish weighed in at these clubs averaged three to four fish per year. During the period between 1969 and 1980, an average of 30.5 fish per year were caught, with a peak in 1978 of 127 swordfish reported (Figure 7). The increased catches during that period correspond to a similar increase in commercial landings. A generally higher abundance of their prey was also reported during the same period. There is some evidence that swordfish abundance may increase in the years following El Niño events.

More recently (Billfish Newsletter 2006) recreational landings of swordfish recorded at southern Californian swordfish clubs amounted to about six swordfish taken per year. The Commercial Passenger Fishing Vessel fleet submits logbooks on all fish caught. Reported catch is shown in the Pacific Council's HMS SAFE document (PFMC 2007) and indicates that three swordfish were caught by the fleet in 2006) recreational catches. A query of the Pacific States Marine

Fisheries Commission recreational database (RecFIN) found that since 1980, only one swordfish has been counted and that was caught in Oregon (Suzanne Kohin, NMFS SWFSC pers. comm. May 2008).

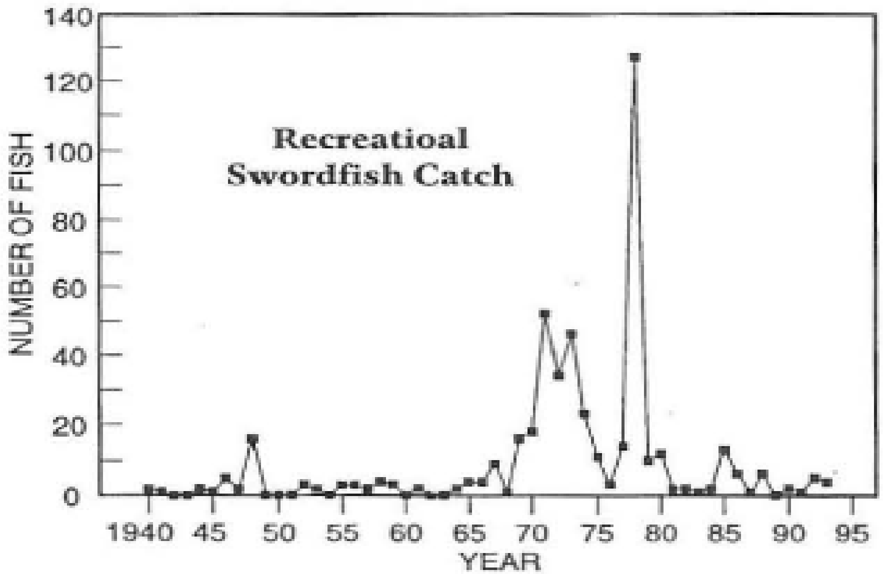

Figure 7: Southern California recreational swordfish catch, 1940-1994
Source: Billfish Newsletter (1996)

Non-U.S. Swordfish Catches in the North Pacific
In the North Pacific, there are directed swordfish fisheries that operate out of Japan and Taiwan. However, it is likely that most of the swordfish catch in the North Pacific is caught incidentally in tuna longline fisheries (e.g., bigeye, albacore fisheries) by countries such as Japan, Korea, China, and Taiwan (Table 6). In recent years, Spanish longline vessels have caught swordfish in the North Pacific (Figure 8).

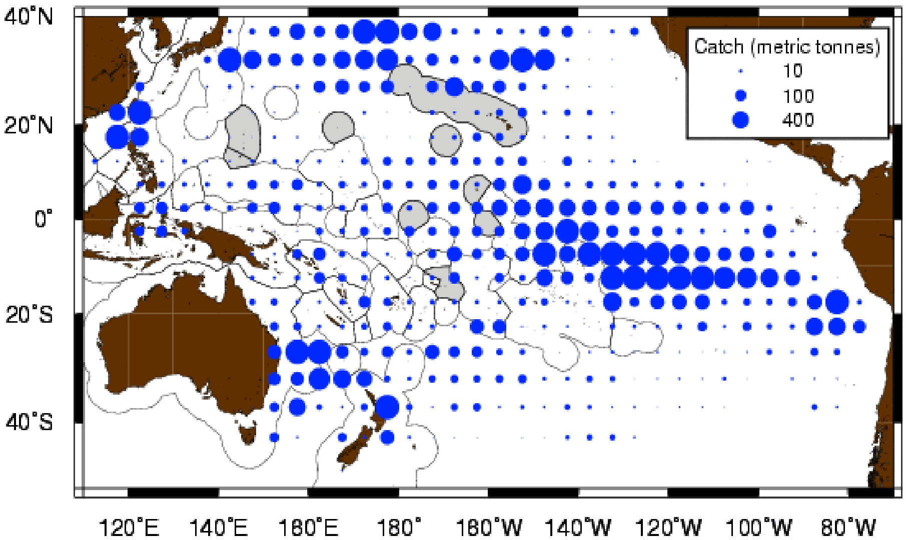

Figure 8: Pacific-wide swordfish catches
Source: 2006 WPRFM Annual Report

Table 6: Historical catches of swordfish in the North Pacific, 1952-2006

Source: International Science Committee (ISC) Billfish Working Group

	Japan								Chinese Taipei[5]				Korea	Mexico	United States[6]						
															Hawaii	California					
Year	Distant-water and Offshore Longline[2]	Coastal Longline	Driftnet	Harpoon[3]	Other Bait Fishing	Trapnet	Other[4]	Total	Distant-water Longline	Offshore Longline	Other	Total	Longline	All Gears	Longline	Longline	Gill Net	Harpoon	Unknown[7]	Total	Grand Total
1952	8,890	152	0	2,569	6	68	6	11,691	-	-		-	-	-	-	-	-	-	-	-	11,691
1953	10,796	77	0	1,407	20	21	87	12,408	-	-		-	-	-	-	-	-	-	-	-	12,408
1954	12,563	96	0	813	104	18	17	13,611	-	-		-	-	-	-	-	-	-	-	-	13,611
1955	13,064	29	0	821	119	37	41	14,111	-	-		-	-	-	-	-	-	-	-	-	14,111
1956	14,596	10	0	775	66	31	7	15,485	-	-		-	-	-	-	-	-	-	-	-	15,485
1957	14,268	37	0	858	59	18	11	15,251	-	-		-	-	-	-	-	-	-	-	-	15,251
1958	18,525	42	0	1,069	46	31	21	19,734	-	-		-	-	-	-	-	-	-	-	-	19,734
1959	17,236	66	0	891	34	31	10	18,268	-	-		-	-	-	-	-	-	-	-	-	18,268
1960	20,058	51	1	1,191	23	67	7	21,400	-	-		-	-	-	-	-	-	-	-	-	21,400
1961	19,715	51	2	1,335	19	15	11	21,147	-	-		-	-	-	-	-	-	-	-	-	21,147
1962	10,607	78	0	1,371	26	15	18	12,115	-	-		-	-	-	-	-	-	-	-	-	12,115
1963	10,322	98	0	747	43	17	16	11,243	-	-		-	-	-	-	-	-	-	-	-	11,243
1964	7,669	91	4	1,006	42	17	28	8,858	-	343	18	361	-	-	-	-	-	-	-	-	9,219
1965	8,742	119	0	1,908	26	14	182	10,991	-	358	10	368	-	-	-	-	-	-	-	-	11,359
1966	9,866	113	0	1,728	41	11	4	11,764	-	331	27	358	-	-	-	-	-	-	-	-	12,122
1967	10,883	184	0	891	33	12	5	12,008	-	646	35	681	-	-	-	-	-	-	-	-	12,689
1968	9,810	236	0	1,539	41	14	9	11,649	-	763	12	775	-	-	-	-	-	-	-	-	12,424
1969	9,416	296	0	1,557	42	11	5	11,327	0	843	7	850	-	-	-	-	-	-	-	-	12,177
1970	7,324	427	0	1,748	36	9	1	9,545	-	904	5	909	-	-	5	-	-	612	10	627	11,081
1971	7,037	350	1	473	17	37	0	7,915	-	992	3	995	-	-	1	-	-	99	3	103	9,013
1972	6,796	531	55	282	20	1	1	7,686	-	862	11	873	-	2	0	-	-	171	4	175	8,736
1973	7,123	414	720	121	27	23	2	8,430	-	860	119	979	-	4	0	-	-	399	4	403	9,816
1974	5,983	654	1,304	190	27	16	1	8,175	1	880	136	1,017	-	6	0	-	-	406	22	428	9,626
1975	7,031	620	2,672	205	58	18	2	10,606	29	899	153	1,081	-	-	0	-	-	557	13	570	12,257
1976	8,054	750	3,488	313	170	14	1	12,790	23	613	194	830	-	-	0	-	-	42	13	55	13,675
1977	8,383	880	2,344	201	71	7	1	11,887	36	542	141	719	-	-	17	-	-	318	19	354	12,960
1978	8,001	1,031	2,475	130	110	22	1	11,770	-	546	12	558	-	-	9	-	-	1,699	13	1,721	14,049
1979	8,602	1,038	983	161	45	15	1	10,845	7	661	33	701	-	7	7	-	-	329	57	393	11,946
1980	6,005	849	1,746	398	30	15	1	9,045	10	603	76	689	-	380	5	-	160	566	62	793	10,907
1981	7,039	727	1,848	129	59	10	0	9,812	2	656	25	683	-	1,575	3	1	461	267	20	752	12,822
1982	6,064	874	1,257	195	58	7	0	8,546	1	855	49	905	-	1,365	5	2	911	156	43	1,117	11,933
1983	7,692	999	1,033	166	30	9	2	9,931	0	783	166	949	-	120	5	1	1,321	58	378	1,763	12,763
1984	7,177	1,177	1,053	117	98	13	0	9,635	-	733	264	997	-	47	3	14	2,101	96	678	2,892	13,571
1985	9,335	999	1,133	191	69	10	0	11,737	-	566	259	825	-	18	2	46	2,368	211	792	3,419	15,999
1986	8,721	1,037	1,264	123	47	9	0	11,201	-	456	211	667	-	422	2	4	1,594	236	696	2,532	14,822
1987	9,495	860	1,051	87	45	11	0	11,549	3	1328	190	1,521	-	550	24	4	1,287	211	300	1,826	15,446
1988	8,574	678	1,234	173	19	8	0	10,686	-	777	263	1,040	-	613	24	19	1,092	180	344	1,659	13,998

MAR&SWOWG

Table 6: Historical catches of swordfish in the North Pacific, 1952-2006 (continued)
Source: ISC Billfish Working Group

	Japan								Chinese Taipei[5]				Korea	Mexico	United States[6]						
															Hawaii	California					
Year	Distant-water and Offshore Longline[2]	Coastal Longline	Driftnet	Harpoon[3]	Other Bait Fishing	Trapnet	Other[4]	Total	Distant-water Longline	Offshore Longline	Other	Total	Longline	All Gears	Longline	Longline	Gill Net	Harpoon	Unknown[7]	Total	Grand Total
1989	6,690	752	1,596	362	21	10	0	9,431	50	1,491	38	1,579	-	690	218	29	1,050	54	224	1,575	13,275
1990	5,833	690	1,074	128	13	4	0	7,742	143	1,309	154	1,606	-	2,650	2,436	18	1,028	50	137	3,669	15,667
1991	4,809	807	498	153	20	5	0	6,292	40	1,390	180	1,610	-	861	4,508	39	836	16	137	5,536	14,299
1992	7,234	1,181	887	381	16	6	0	9,705	21	1,473	243	1,737	-	1,160	5,700	95	1,332	74	44	7,245	19,847
1993	8,298	1,394	292	309	43	4	1	10,341	54	1,174	310	1,538	-	812	5,909	165	1,400	169	36	7,679	20,370
1994	7,366	1,357	421	308	37	4	0	9,493	-	1,155	219	1,374	-	581	3,176	740	799	153	8	4,876	16,324
1995	6,422	1,387	561	440	17	7	0	8,834	50	1,135	225	1,410	-	437	2,713	279	755	96	31	3,874	14,555
1996	6,916	1,067	428	633	9	4	0	9,057	9	701	31	741	12	439	2,502	347	752	81	10	3,692	13,941
1997	7,002	1,214	365	396	11	5	0	8,993	15	1,358	61	1,434	246	2,365	2,881	664	707	84	3	4,339	17,377
1998	6,233	1,190	471	535	9	2	0	8,441	20	1,178	41	1,239	123	3,603	3,263	422	924	48	13	4,670	18,076
1999	5,557	1,049	724	461	2	5	0	7,798	70	1,385	61	1,516	104	1,136	3,100	1,333	606	81	2	5,122	15,676
2000	6,180	1,121	808	539	7	5	1	8,661	325	1,531	86	1,942	161	2,216	2,949	1,908	646	90	9	5,602	18,582
2001	6,932	908	732	255	5	15	0	8,848	1,039	1,691	91	2,821	349	780	220	1,763	375	52	5	2,415	15,213
2002	6,230	965	1,164	222	8	11	0	8,600	1,633	1,557	27	3,217	350	465	204	1,320	302	90	3	1,919	14,551
2003	5,352	1,039	1,198	167	10	4	0	7,770	1,084	2,196	11	3,291	311	671	147	1,812	216	107	0	2,282	14,325
2004	(6165)	1,454	1,339	33	33	23	1	(9,048)	884	1,828	16	2,728	(350)	270.1	(213)	(898)	182	89	(37)	(1,419)	(14,883)
2005	(6972)							(6,972)	437	1,813	26	2,276	(407)	234.5	(1,360)	-	219	73	(0)	(1,652)	(13,506)
2006														347.2							

[1]Catch data are currently unavailable for Republic of Korea, Philippines, and some other countries catching swordfish in the North Pacific.

[2]Catches by gear for 1952-1970 were estimated roughly using FAO statistics and other data. Catches for 1971-2002 are more reliably estimated.

[3] Contains trolling and harpoon but majority of catch obtained by harpoon.

[4]For 1952-1970 "Other" refers to catches by other baitfishing methods, trap nets, and various upspecified gears.

[5]Offshore longline category includes some catches from harpoon and other fisheries but does not include catches unloaded in foreign ports.

[6]Estimated round weight of retained catch. Does not include discards.

[7] Unknown…(Al Coan to provide footnote)

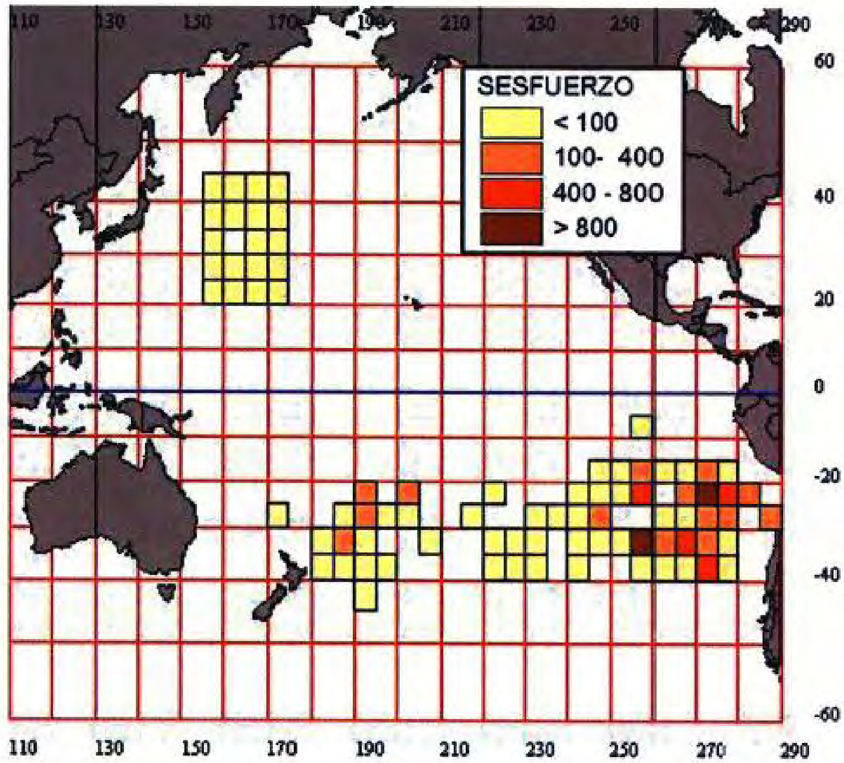

Figure 9: Area fished (number in thousand of hooks) by Spanish longline vessels targeting swordfish in the North Pacific, 2005
Source: Mejuto et al. 2007

3.2.1.3 Swordfish Stock Status

There is considerable debate concerning the stock structure of swordfish in the Pacific. For example, it is not known whether there is a single Pacific-wide stock or if there are separate stocks partitioned geographically (Ward and Elscot 2000). Swordfish are difficult fish to tag with either conventional or electronic archival or satellite tags. However, data from conventional tags does suggest some connectivity between North- and central Pacific swordfish and swordfish caught off the West Coast (Carol Reeb, Stanford University, pers. comm., May 2008). Alavarado et al. (1996) used genetics to examine the genetic population structure of Pacific swordfish. They found that genic and genotypic differentiation were significant, and so were the pair-wise comparisons between the south-eastern Pacific Ocean sample from Chile, and all other regions. In addition, the north-eastern Pacific Ocean (Ecuador to Mexico) population was different from the north-central Pacific Ocean (Hawaii), which in turn was different from the southwestern Pacific Ocean (pooled eastern and western Australia).

An alternative hypothesis by Reeb et al. (2000) supported significant genetic structuring among Pacific populations. Northern and southern populations in the western Pacific were significantly divergent, while populations in the east appeared to be genetically continuous. Regression analysis supported a correlation of genetic differentiation with geographic distance along a U-shaped corridor of gene flow. These results revealed a pelagic bio-geographic pattern heretofore unrecognized in the Pacific, that allowed researchers to reject the null hypothesis that Pacific populations of swordfish are unstructured and comprise only a single homogeneous stock. In light of differing opinions on stock structure, North Pacific swordfish are currently (and will likely be in the 2010 stock assessment by the ISC) considered one stock when assessed.

A stock assessment for North Pacific swordfish was undertaken by Kleiber and Yokawa (2004) using the Multifan-CL length-based, age-structured model. Results of this assessment suggest that the population in recent years is well above 50 percent of the unexploited biomass, implying that swordfish are not over-exploited, but are relatively stable at the current levels of fishing (WPRFMC 2004). Furthermore, Wang et al. (2007) found that the spawning stock biomass of swordfish in the North Pacific is currently at a fairly high fraction of its initial level and that the spawning stock biomass-per-recruit under current exploitation rates is higher than that corresponding to the MSY. Wang et al. (2007) note that recent stock assessments of swordfish in the North Pacific indicate that this stock is not over-exploited and that it has been relatively stable at current levels of exploitation, but that previous assessments ignored sexual dimorphism, and instead focused on the results of sex-aggregated analyses. The Wang et al. (2007) study indicates that when sex-structure is taken into account, the quantities related to the absolute measures, such as MSY, are substantially different. For example, Wang et al. (2007) estimate MSY for North Pacific swordfish to be 13,151 mt, whereas Kleiber and Yokawa estimate MSY to be 22,284 mt. However, the results of the models that take sexual dimorphism into account still suggest that the spawning stock biomass of swordfish in the North Pacific is currently at a fairly high fraction of its initial level and that the spawning stock biomass-per-recruit under current exploitation rates is higher than that corresponding to the MSY level (Wang et al. 2007).

Recent analyses of catch-per-unit-effort (CPUE) based on data from Japanese longline vessels show declining trends mainly driven by declines in CPUE in the northwest portion of the study area (north of 10° N and west of 170° E) (ISC 2004). Current swordfish landings in the North Pacific amount to about 14,500 metric tons (31.9 million pounds), which, according to a recent stock assessment, is about 65 percent of an estimated MSY of 22,284 metric tons (49 million pounds; Bigelow, PIFSC, pers. comm., Jan. 2008, based on Kleiber and Yokawa 2004). According to NMFS, the North Pacific swordfish stock is not subject to overfishing, not overfished, and not approaching either condition and with a B/Bmsy (or proxy) of 1.75.

3.2.2 Other Target Species

A suite of additional PMUS are managed under the Pelagics FMP (see Table 2). This section provides general information on the major species that are caught and landed by the shallow-set fishery while targeting swordfish. More detailed descriptions of bigeye and yellowfin tunas may be found in the Pelagics FMP Amendment 14 document dated August 2006 (WPRFMC 2006), and of other PMUS in the 2001 FEIS document (NMFS 2001). Tables 7-10 present major species caught by the shallow-set fishery each year between 2004 and 2007 as reported in federal logbooks.

Table 7: 2004 reported catches of major species by the Hawaii swordfish longline fishery

Number of sets made: 135			
Species	**Number caught**	**Number kept**	**Pounds kept**
Swordfish	1,438	1,359	225,594
Albacore	293	159	8,109
Bigeye Tuna	23	18	1,566
Moonfish	29	15	1,245
Oilfishes	66	36	612
Mahimahi	34	32	448
Striped Marlin	6	6	408
Pomfret	30	19	247
Mako Shark	255	1	177
Blue Marlin	1	1	163
Skipjack Tuna	2	1	16
Blue Shark	1,392	0	-
Shortbill Spearfish			-
Thresher Sharks	4	0	-
Wahoo	1	0	-
Yellowfin Tuna			-

Source: PIFSC 2008

Table 8: 2005 reported catches of major species by the Hawaii swordfish longline fishery

Number of sets made: 1,645			
Species	**Number caught**	**Number kept**	**Pounds kept**
Swordfish	21,260	19,046	3,161,636
Bigeye Tuna	2,043	1,871	162,777
Striped Marlin	1,600	1,354	92,072
Mahimahi	6,574	5,428	75,992
Blue Marlin	453	398	64,874
Albacore	1,237	830	42,330
Oilfishes	2,512	1,958	33,286
Mako Shark	966	148	26,196
Blue Shark	14,901	144	14,400
Yellowfin Tuna	187	171	10,944
Shortbill Spearfish	230	160	4,960
Wahoo	137	135	4,050
Moonfish	59	45	3,735
Thresher Sharks	55	10	1,980
Pomfret	132	102	1,326
Skipjack Tuna	86	68	1,088

Source: PIFSC 2008

Table 9: 2006 reported catches of major species by the Hawaii swordfish longline fishery

Number of sets made: 850			
Species	**Number caught**	**Number kept**	**Pounds kept**
Swordfish	13,437	12,585	2,089,110
Bigeye Tuna	1,200	1,153	100,311
Albacore	434	349	17,799
Mako Shark	575	48	8,496
Yellowfin Tuna	135	127	8,128
Striped Marlin	110	105	7,140
Mahimahi	465	434	6,076
Oilfishes	453	314	5,338
Moonfish	49	40	3,320
Blue Marlin	13	12	1,956
Pomfret	149	127	1,651
Skipjack Tuna	16	14	224
Wahoo	6	6	180
Shortbill Spearfish	4	4	124
Blue Shark	9,495	0	-
Thresher Sharks	15	0	-

Source: PIFSC 2008

Table 10: 2007 reported catches of major species by the Hawaii shallow-set longline fishery

Number of sets made:1,497			
Species	**Number caught**	**Number kept**	**Pounds kept**
Swordfish	20,843	18,769	3,115,654
Bigeye Tuna	1,350	1,167	101,529
Albacore	1,391	853	43,503
Oilfishes	2,392	1,890	32,130
Mahimahi	1,916	1,727	24,178
Striped Marlin	318	279	18,972
Mako Shark	832	104	18,408
Blue Marlin	51	48	7,824
Yellowfin Tuna	129	118	7,552
Moonfish	54	40	3,320
Wahoo	87	81	2,430
Shortbill Spearfish	71	61	1,891
Thresher Sharks	52	7	1,386
Pomfret	141	114	1,482
Blue Shark	15,475	9	900
Skipjack Tuna	35	27	432

Source: PIFSC 2008; NMFS PIFSC 4th Quarter Longline Report

3.2.2.1 Bigeye Tuna

Life History and Distribution
Bigeye tuna (BET) are believed to have recently evolved from a common parent stock of yellowfin tuna (YFT) (*Thunnus albacares*), remaining in a close phylogenetic position to yellowfin with similar larval form and development. Although the species shares a similar latitudinal distribution with YFT worldwide, BET have evolved to exploit cooler, deeper and more oxygen poor waters when compared to YFT in a classic example of adaptive niche partitioning. Several investigators have demonstrated that this has been accomplished through a combination of physiological and behavioral thermoregulation and other anatomical adaptations for foraging at depth such as respiratory adaptations and eye and brain heaters (Holland and Sibert 1994; Lowe et al. 2000; Fritsches and Warrant 2001). In this way, the species is considered to be intermediate between a tropical tuna (e.g., yellowfin, blackfin (*T. atlanticus*), longtail tuna (*T. tonggol)*) and the temperate water tunas (e.g., albacore (*T. alalunga*), the bluefin tunas). This combination of traits can be characterized by rapid growth during the juvenile stage, movements between temperate and tropical waters to feed and spawn, equatorial spawning with high fecundity -- combined with a preference for cool water foraging and a protracted maturity schedule, an extended life span and the potential for broad spatial movements. It is believed that BET are relatively long lived in comparison to YFT but not as long lived as the three bluefin tuna species.

Feeding is opportunistic at all life stages, with prey items consisting of crustaceans, cephalopods and fish (Calkins 1980). There is significant evidence that BET feed at greater depths than YFT, utilizing higher proportions of cephalopods, and mesopelagic fishes and crustaceans in their diet thus reducing niche competition (Whitelaw and Unnithan 1997).

Spawning spans broad areas of the Pacific and occurs throughout the year in tropical waters and seasonally at higher latitudes at water temperatures above 24° C (Kume 1967; Miyabe 1994). Hisada (1979) reported that BET require a mixed layer depth of at least 50 m with a sea surface temperature (SST) of at least 24° C. While spawning of bigeye tuna occurs across the Pacific, the highest reproductive potential was considered to be in the EPO based on size frequencies and catch per unit of effort inferred abundance (Kikawa 1966).

Basic environmental conditions favorable for survival include clean, clear oceanic waters between 13° C and 29° C. However, recent evidence from archival tags indicates that bigeye can make short excursions to depths in excess of 1,000 m and to ambient sea temperatures of less than 3° C (Schaefer and Fuller 2002). Juvenile BET in the smaller length classes occupy surface mixed layer waters with similar sized juvenile YFT. Larger bigeye frequent greater depths, cooler waters and areas of lower dissolved oxygen compared to skipjack and yellowfin. Hanamoto (1987) estimated optimum bigeye habitat to exist in water temperatures between 10° to 15° C at salinities ranging between 34.5‰ to 35.5‰ where dissolved oxygen concentrations remain above 1 ml/l. Recent data from archival tagging has largely corroborated these earlier findings while extending the actual habitat range of the species.

Determinations of age, growth and maturity schedules for BET are only now becoming better defined. BET are considerably longer lived, slower growing and, therefore, more vulnerable than the YFT. It is now considered that bigeye mature at 3 – 4 years of age after which growth slows considerably with fish capable of living well past ten years. Critical to the understanding of bigeye biology and management are better estimates of maturity schedules by area which are just now beginning to become available. Preliminary results indicate that earlier assessments may have utilized unrealistically low estimates of "size at maturity" for the species.

Larval and Juvenile Stages

The eggs of BET resemble those of several scombrid species and can not be differentiated by visual means. Therefore, the distribution of bigeye eggs has not been determined in the Pacific Ocean. However, the duration of the fertilized egg phase is very short, approximately one day, meaning egg distributions are roughly coincident with documented larval distributions. Eggs are epipelagic and buoyed at the surface by a single oil droplet until hatching occurs.

Bigeye larvae appear to be restricted to surface waters of the mixed layer well above the thermocline and at depths less than 50 to 60 m, with no clear consensus on diurnal preference by depth or patterns of vertical migration (Matsumoto 1961, Strasburg 1960, Ueyanagi 1969). Prey species inhabit this zone, consisting of crustacean zooplankton at early stages, shifting to fish larvae at the end of the larval phase and beginning of early juvenile stages. The diet of larval and juvenile BET is similar to that of YFT, consisting of a mix of crustaceans, cephalopods and fish (Uotani et al. 1981).

The age and growth of larval, post-larval and early juvenile BET is not well known or studied. Yasutake et al. (1973) recorded newly hatched larvae at 2.5 mm in total length, growing to 3.0 and 3.1 mm at 24 and 48 hours. The early post-larval stage was achieved at 86 hours after hatching. However, it is likely that the early development of bigeye tuna is similar to that of YFT which is the subject of laboratory studies by the IATTC (IATTC 1997). The larval stages of BET likely extend for approximately two to three weeks after hatching. The short duration of the larval stage suggests that the distribution of bigeye larvae is nearly coincident with the distribution of bigeye spawning and eggs. It has been suggested that areas of elevated productivity are necessary to support broad spawning events that are characteristic of skipjack, YFT and BET whose larvae would subsequently benefit from being in areas of high forage densities (Sund et al. 1981, Miller 1979, Boehlert and Mundy 1994; Itano 2000).

Juvenile tunas, including bigeye, aggregate strongly to floating objects or to large, slow-moving marine animals, such as whale sharks and manta rays (Calkins 1980, Hampton and Bailey 1993). This behavior has been exploited by surface fisheries to aggregate juvenile YFT and BET to anchored or drifting fish aggregation devices (FADs) (Sharp 1978, Hampton and Bailey 1993). Juvenile, sub-adult and adult BET are also known to aggregate near seamounts and submarine ridge features where they are exploited by pole-and-line, handline and purse-seine fisheries (Fonteneau 1991, Itano 1998, Hallier and Delgado de Molina 2000, Itano and Holland 2000).

Juvenile BET form mono-specific schools at or near the surface with similar-sized tuna or may form mixed aggregations with skipjack and/or juvenile YFT (Calkins 1980). Yuen (1963) has suggested that these mixed-species schools are actually separate single-species schools that temporarily aggregate to a common element such as food. Echo sounder, sonar data and test fishing strongly suggest a vertical separation of bigeye, yellowfin and skipjack schools that are aggregated to the same floating object. Circumstantial evidence supports species-specific vertical stratification of tuna on drifting objects, with BET being the deepest, YFT intermediate and skipjack closest the surface. Several studies have examined these issues using sonar and echo sounding equipment capable of measuring target strength readings of individual fish (Josse et al. 2000, Josse and Bertrand 2000). Species-specific remote sensing of tunas needs further study to substantiate initial findings. Such studies are complicated by BET behaviors including normal daytime deep diving behavior which becomes inconsistent when tuna are in association with drifting and anchored FADs where they tend to remain within the mixed layer (Schaefer and Fuller 2002, Musyl et al. 2003).

Juvenile BET are regularly taken as an incidental in surface fisheries, and occasionally as targeted catch, such as in the seamount and FAD-associated offshore handline fishery of Hawaii (Adam et al. 2003). Both juvenile and sub-adult BET are taken as an incidental catch in floating object sets in western Pacific purse seine fisheries. In the EPO, purse seine catches of sub-adult BET have been quite high in some years and should be considered as a retained component of the catch in the skipjack floating object fishery. Schaefer and Fuller (2002) from archival tag data noted that BET less than 110 cm spent a greater percentage of their time in association with drifting FADs in the EPO but that the larger bigeye still had an affinity for aggregating to floating objects. Very small BET are also taken in equatorial purse seine fisheries though may be discarded or poorly enumerated due to market demands and mixed reporting with juvenile YFT.

Juvenile and sub-adult BET of increasing size appear in higher latitude fisheries, suggesting portions of the population move away from equatorial spawning/nursery grounds to feed and grow, only to return later to spawn. The distribution of these juvenile and sub-adult tuna becomes better understood as they begin to enter catch statistics of temperate water fisheries.

Adult Stage

Adult BET are distributed across the tropical and temperate waters of the Pacific, between northern Japan and the North Island of New Zealand in the western Pacific, and from 40° N to 30° S in the eastern Pacific (Calkins 1980). Brill (1994) proposed a physiological basis to explain how BET are able to utilize oxygen in a highly efficient manner, thereby allowing them to forage in areas that are not utilized by other tuna species. He theorized that BET spend the majority of their time at depth, making short excursions to the surface to warm up. Lowe et al. (2000) demonstrate that the blood of BET has a significantly higher affinity for O2 compared to other tunas, thus explaining their ability to exploit O2 poor regions and depths.

This vertical movement pattern, which has been clearly demonstrated by sonic tracking experiments of BET, is exactly the opposite pattern demonstrated by skipjack and juvenile YFT (Holland et al. 1992). Sonic tracking and archival tagging of BET consistently indicate deep foraging during the daytime near or below the thermocline and shallow swimming behavior at night. Schaefer and Fuller (2002) noted that BET in the EPO spend most of the day at depths of 200 – 300 m and ambient temperatures of 13 - 14° C, although dives to below 1,500 m and ambient temperatures of < 3° C were noted.

Movement

Recent studies by scientists at PIFSC describe the fishing grounds near 30° N and the abundance of BET at this location during the summer months. They integrated fishery, biological, and oceanographic data to describe the area and used pop-up archival tags to determine BET movements. The tuna showed an apparent site fidelity to this area in the summer months. This area around 30° N is very stratified with no apparent nutrient inputs to the surface layers yet often has large phytoplankton blooms visible by satellites (PIFSC unpublished data).

Sibert et al. (2003) applied a Kalman filter statistical model to refine horizontal movement data from geolocating archival tags recovered from Hawaiian BET. Juvenile and sub-adult BET recoveries showed little real movement and a strong tendency to remain at the seamount and FADs where they had been tagged. The only large BET (131 cm) apparently remained associated with the coastal features and nearshore bathymetry of the island of Hawaii during 84 days at liberty. The authors suggest that large features, such as islands, may act as points of attraction and aggregation for BET. This is a commonly held belief of traditional handline fishermen in Polynesia who target deep swimming tunas at specific locations close to atolls and high islands. There are several of these traditional handline areas along the south shore of the Island of Hawaii that are known to hold BET and YFT (Rizutto 1983).

BET Stock Structure

The geographic distribution of BET is pan-Pacific with no physical or oceanographic barriers to movement within temperature extremes. Analyses of genetic variation in mitochondrial DNA and nuclear microsatellite loci have been conducted on BET otoliths from nine geographically scattered regions of the Pacific (Grewe and Hampton 1998). The study noted some evidence for restricted gene-flow between the most geographically distinct samples (Ecuador and the Philippines). However, the data otherwise failed to reject the null hypothesis of a single Pacific-wide population of BET. In other words, the study supported the possibility of some degree of population mixing throughout the basin. Grewe et al. (2000) however, found no evidence to suggest that BET samples from the Indian Ocean were genetically different from the Pacific Ocean samples examined in the earlier study. This suggests that the methodology currently used may be an inappropriate tool for determining the issue of stock structure.

Miyabe and Bayliff (1998) suggested that there is insufficient information currently available to definitively determine the stock structure of BET in the Pacific; therefore a single stock hypothesis is usually adopted for Pacific BET. However, consistent areas of low catch separate principal fishing grounds in the eastern and central/western regions (around 165 - 170° W) and there appears to be little mixing of tagged populations although the tagging data are quite limited. Due to these considerations and the existence of two major, geographically separated, fishing grounds and fisheries coupled with the possibility of ocean basin movements of Pacific

BET, stock assessments have been carried out on both a Pacific-wide basis and a two-stock hypothesis separating the central and western Pacific from the EPO.

The results of the genetic analyses are broadly consistent with SPC tagging experiments on BET whereby most stay close but some show extensive movement. BET tagged in locations throughout the western tropical Pacific have displayed eastward movements of up to 4,000 nm over periods of one to several years. The widespread distribution of BET spawning throughout the tropical Pacific and the greater longevity of BET relative to other tropical tunas, such as YFT (Hampton et al. 1998), are also consistent with a high potential for basin-scale gene flow. However, large-scale movements of BET > 1,000 nm have accounted for only a small percentage of returns, with most recaptures occurring within 200 nm of release. In addition, a significant degree of site fidelity of BET in some locations has been suggested, such as near large land masses, island-rich archipelagos, and possibly areas of high FAD densities.

Sibert and Hampton (2003) estimated median lifetime displacements of skipjack and yellowfin tuna in the order of some hundreds of nautical miles, rejecting the notion that these tropical tuna species are widely ranging by nature and “highly migratory”. These findings are consistent with the concept of “semi-discrete stocks” of YFT in the Pacific as proposed by Suzuki et al. (1978). BET, representing a unique blend of traits between a tropical and temperate tuna species with a protracted life span, may be expected to remain in a general area for extended periods of time and to also range further and have a higher potential for broader displacements throughout their extended life span.

Stock Status

Pacific-wide bigeye was determined by NMFS to be subject to overfishing in December 2004 (69 FR 78397). The stock was found not to be in an overfished state (i.e., $B_{current}$ was found to be greater than 0.8 B_{msy}). In that determination NMFS recognized that Pacific bigeye tuna occur in the waters of multiple nations, on the high seas, and is fished by the fleets of other nations in addition to those of the U.S. Thus the capacity for unilateral action by the U.S., as required under the Magnuson-Stevens Act, is limited, as is the capacity for action taken by Councils to end overfishing. Multilateral action is essential to ensure that overfishing of bigeye tuna in the Pacific Ocean ends. This assessment was based on the fact that bigeye harvests by U.S. fisheries comprise a very small portion of Pacific-wide bigeye tuna harvests (less than three percent in 2004). Given the above, in 2007 NMFS approved the Council’s recommendation to develop, support and implement recommendations made by international regional fishery management organizations (RFMOs such as the Western and Central Pacific Fisheries Commission and the Inter-American Tropical Tuna Commission) to address overfishing of bigeye tuna.

The 2006 Western and Central Pacific Fisheries Commission’s (WCPFC) assessment of WCPO BET conducted by the Secretariat of the Pacific Community (SPC) used a six-region model, which indicated that there is a high probability that overfishing (i.e., $F_{current}$ was found to be greater than F_{msy}) of bigeye has been occurring in the WCPO since 1997. A 2008 WCPO assessment found that overfishing of bigeye in the WCPO is occurring with high probability (F/F_{msy} (1.43) and that while not yet overfished (i.e., smaller than the level associated with

MSY), both the adult and total biomass are predicted to drop below that level at 2003-2006 levels of fishing mortality and long term average levels of recruitment (Langley et al. 2008). The latest estimate of MSY for bigeye in WCPO is 64,600 mt (Langley et al. 2008) and 81,350 mt for the EPO (Aires de Silva and Maunder 2008). The greatest fishery impact to the WCPO stock is in the equatorial region, while the temperate regions are estimated to be moderately exploited. Furthermore, the attribution of depletion to various fisheries or groups of fisheries indicates that the longline fishery has a major impact; the purse-seine fishery operating on associated sets has a lesser, but still substantial effect, particularly in the equatorial regions.

3.2.2.2 Yellowfin Tuna

Several studies on the taxonomy, biology, population dynamics and exploitation of yellowfin tuna *(Thunnus albacares*) have been carried out. However in recent years, directed research and management attention has tended to concentrate on BET, limiting to some extent the amount of recent information available on YFT. Cole (1980) and Collette and Nauen (1983) provided general descriptions of the species and fisheries that were updated fourteen years later by Wild (1994) for eastern Pacific YFT, and Suzuki (1994) for western and central Pacific YFT.

Specific information on the status of YFT fisheries and stocks in the Pacific Ocean are contained in the collective research and publications of the IATTC for the EPO. Information on YFT of the WCPO can be found in the proceedings of seventeen years of annual meetings of the Standing Committee on Tuna and Billfish (SCTB) and the Scientific Committee (SC) of the WCPFC. The information contained in this review relies heavily on these sources that represent the most recent information available on the biology, ecology, physiology and fisheries for YFT in the Pacific Ocean. More detailed information on life history characteristics of YFT may be found in the Council’s Pelagics FMP Amendment 14 (WPRFMC 2006).

Life History and Distribution

YFT are placed in the subgenera *Neothunnus* with the Atlantic blackfin tuna (*Thunnus atlanticus*) and Indo-Pacific longtail tuna (*T. tonggol*) by Collette (1979, 1999) based on various morphological adaptations to endothermy (e.g., heat exchanger and liver morphology). This separation characterizes yellowfin tuna as “tropical” tuna vs. the “cold-water” subgenera *Thunnus* that consists of the bluefins, albacore and to some extent the bigeye tuna. However, YFT and BET share important morphological characters and BET appears to cluster weakly with the tropical tunas based on some genetic evidence (Chow and Kishino 1995; Alvarado Bremer et al. 1996).

While these observations suggest the BET is somehow intermediate between the tropical and “cold water” tunas, the YFT is clearly a tropical species, occupying the surface waters of all warm oceans. Yellowfin and bigeye tuna share a great deal of latitudinal distribution across the world oceans with yellowfin tending to occupy shallower and warmer depth strata within the upper mixed layer, i.e. the epipelagic zone.

Within the Pacific, YFT are widely distributed from around 35° N - 33° S in the EPO and 40° N - 35° S in the WCPO (Blackburn 1965). Basic environmental conditions favorable for survival include clean oceanic waters between 18° C and 31° C, within salinity ranges normal for the pelagic environment, and with DO concentrations greater than 1.4 to 2.0 ml/L, which are higher than those required by BET (Blackburn 1965; Sund et al. 1981). Larval and juvenile YFT occupy surface waters with adults increasingly utilizing greater depth strata while remaining within the mixed layer, *i.e.* generally above the thermocline (Suzuki et al. 1978). However, these habitat preferences are not strict or exclusive as juveniles of both species occupy surface waters, and recent evidence suggests adults may spend some time at significant depths below the thermocline.

Feeding is opportunistic at all life stages, with prey items consisting of crustaceans, cephalopods and fish (Reintjes and King 1953; Cole 1980). A large number of age and growth studies have been carried out for Pacific yellowfin tuna as reviewed by Suzuki (1994). Studies have examined length or weight frequencies, tagging data, scales, otoliths or other hard parts such as dorsal spines. Results have been inconsistent with some suggestion that the examination of hard parts yields superior results to length or weight frequency analyses or tagging data in growth determination studies. Growth is considered very rapid, with individuals reaching approximately 55 cm in fork length at age one and over 90 cm at age two. YFT are not considered long-lived in comparison to the bluefin tunas or albacore with tagging data suggesting a maximum age of around 6 - 7 years.

Spawning occurs over broad areas of the Pacific, occurring throughout the year in tropical waters and seasonally at higher latitudes at water temperatures above 24° C (Suzuki 1994; Schaefer 1998; Itano 2000). YFT are serial spawners, capable of repeated spawning at near daily intervals with batch fecundities of millions of ova per spawning event (June 1953; Nikaido 1988; McPherson 1991; Schaefer 1996, Itano 2000). It is believed maturity is reached very quickly at around two years of age with some regional variability.

YFT appear to move freely within broad regions of favorable water temperature and are known to make annual excursions to higher latitudes as water temperatures increase with season. However, the extent to which these are directed movements is unknown and the nature or existence of YFT “migration” in the central and western Pacific remains unclear (Suzuki 1994). YFT are clearly capable of large-scale movements which have been documented by tag and recapture programs, but many tag recaptures occur within a relatively short distance of release.

YFT are known to aggregate to drifting flotsam, large marine animals and in regions of elevated productivity, such as near seamounts and regions of localized upwelling (Blackburn 1969; Wild 1994; Suzuki, 1994). Aggregation to floating objects is particularly pronounced for juvenile stages. Major surface fisheries for YFT exploit these behaviors either by utilizing artificial FADs or by targeting productive areas with vulnerable concentrations of tuna (Sharp 1978; Hampton and Bailey 1993).

The combination of these biological and behavioral traits identify YFT as a classic “tropical” tuna species with rapid growth and maturity, high fecundity, relatively short life span and inhabiting broad expanses of warm, surface waters. In a simplified way, yellowfin and bigeye tuna may be considered as shallow and deeper-dwelling cousins with similar worldwide (horizontal) distributions but adapted to exploit different, vertically stratified food sources.

Larval and Juvenile Stage

The eggs of YFT, like BET, resemble those of several scombrid species and can not be differentiated by visual means (Cole 1980). Therefore, the distribution of YFT eggs has not been absolutely determined in the Pacific. However, the duration of the fertilized egg phase is very short (approximately 24 hours); therefore, egg distributions can be assumed to be roughly coincident with documented YFT larval distributions. The eggs are epipelagic, suspended at the surface by a single oil droplet until hatching. The observation of YFT spawning and the development of egg and early larval stages is now possible at shore based facilities where spawning was first observed during late 1996 (IATTC 1997).

YFT larvae are trans-Pacific in distribution and found throughout the year in tropical waters but are restricted to summer months in sub-tropical regions. For example, peak larval abundance occurs in the Kuroshio Current during May and June and in the East Australian Current during the austral fall and summer (November to December). YFT larvae have been reported close to the main Hawaiian Islands in June and September but were not found in December and April (Beohlert and Mundy 1994). The distribution of yellowfin larvae has been linked to areas of high productivity and islands, but how essential these areas are to the life history of the species is not known. *Thunnus* larvae (most likely YFT due to spawning distributions) have been noted to be relatively abundant near the Hawaiian Islands compared to offshore areas (Miller 1979, Boehlert and Mundy 1994).

The distribution of juvenile tuna less than 35 cm fork length has not been well documented but is assumed to be similar to that of larval YFT. These small juvenile stage yellowfin occupy warm oceanic surface waters above the thermocline and are found throughout the year in tropical waters. Published accounts on the capture of juvenile tuna have been summarized by Higgins (1967). Juveniles have been reported in the western Pacific between 31° N near the east coast of Japan to 23° S and 23° N near the Hawaiian Islands to 23° S in the central Pacific region. Juvenile YFT form mono-specific schools at or near the surface of similar sized fish or may be mixed with other tuna species such as skipjack or juvenile BET. Yuen (1963) has suggested that the mixed-species schools are actually separate single-species schools that temporarily aggregate to a common factor such as food. Juvenile fish will aggregate beneath drifting objects or with large, slow moving animals such as whale sharks and manta rays (Hampton and Bailey 1993). This characteristic has been exploited by surface fisheries to aggregate and exploit YFT, most of which are juvenile fish, to anchored or drifting artificial FADs. Juvenile YFT are also known to aggregate near seamounts and submarine ridge features and areas of elevated productivity (Fonteneau 1991, Itano and Holland 2000).

Juvenile YFT feed primarily during the day and are opportunistic feeders on a wide variety of forage organisms, including various species of crustaceans, cephalopods and fish (Reintjes and King 1953, Watanabe 1958). Prey items include epipelagic or mesopelagic members of the oceanic community or pelagic post-larval or pre-juvenile stages of island, reef or benthic associated organisms. Significant differences in the composition of prey species of FAD and non-FAD associated yellowfin have been noted in Hawaii (Brock 1985), American Samoa (Buckley and Miller 1994) and the southern Philippines (Yesaki 1983).

Recent work in Hawaiian waters found that juvenile yellowfin and bigeye tuna in a size range of 40 – 80 cm exploited similar broad groups of prey but significantly different species (Grubbs et al. 2002). YFT were noted to feed almost exclusively on epipelagic crustaceans and fish or mesopelagic species that vertically migrate into the shallow mixed layer at night. Bigeye tuna of the same size and in the same aggregations fed primarily on a deeper dwelling complex of mesopelagic crustaceans, cephalopods and fish.

Adult Stage

The habitat of adult YFT can be characterized as warm oceanic waters of low turbidity with a chemical and saline composition typical of tropical and sub-tropical oceanic environments. Adult YFT are clearly trans-Pacific in distribution and range to higher latitudes compared to juvenile fish. Sea surface temperatures play a primary role in their horizontal and vertical distribution, particularly at higher latitudes. Blackburn (1965) suggested the range of YFT distribution was bounded water temperatures between 18° C and 31° C with commercial concentrations occurring between 20° C and 30° C. Salinity does not appear to play as important a role in distribution in comparison to water temperature and clarity.

Adult YFT are opportunistic feeders, relying primarily on crustaceans, cephalopods and fish as has been described for juveniles. However, the larger size of adult fish allows the exploitation of larger prey items, with large squid and fish species becoming more important diet items. Yesaki (1983) noted a high degree of cannibalism of large FAD-associated YFT on juvenile tunas in the southern Philippines. The baiting of longlines with saury, mackerel and large squid also implies that mature fish will take large prey items if available. YFT are also known to aggregate to large near surface concentrations of forage, such as the spawning aggregations of lanternfish (*Diaphus* sp.) that occur seasonally in the Australian Coral Sea (Hisada 1973, McPherson 1991b).

Juvenile and adult YFT aggregate to drifting flotsam, anchored buoys and large marine animals, while adult yellowfin are known to associate with herds of porpoises (Hampton and Bailey 1993). Adults also aggregate in regions of elevated productivity and high zooplankton density, such as near seamounts and regions of upwelling and convergence of surface waters of different densities, presumably to capitalize on the elevated forage available (Blackburn 1969, Cole 1980, Wild 1994, Suzuki 1994).

The use of sonic and archival tagging technologies has greatly expanded our knowledge of tuna behavior and habitat selection. Electronic evidence supports the belief that YFT spend most of their time in the mixed layer above 100 m depth, above or just below the thermocline.

Longevity for the species has not been defined but a maximum age of six to seven years appears likely based on growth estimates and tag-recapture data. Maximum size exceeds 200 cm. The current International Game Fish Association all tackle record was caught in the eastern Pacific in 1977 for a YFT of 176.4 kg that measured 208 cm (Collette and Nauen 1983).

Most estimates suggest that the majority of YFT reach maturity between two and three years of age on the basis of length-age estimates for the species (Ueyanagi 1966). A length at maturity estimate by Itano (2000) was 112.5 cm for yellowfin from the Hawaii region, the northern-most area examined. Schaefer (1998) using the same methodology estimated the length at 50% maturity for yellowfin in the eastern Pacific Ocean at 92.1 cm, considerably lower than WCPO estimates. This significantly lower estimate may reflect the higher productivity of the EPO resulting in shortened maturity schedules.

YFT spawn in sea surface temperatures above 24 - 25° C in pelagic environments across the Pacific with some evidence suggesting some preference for leeward coasts of oceanic islands and archipelagos. Spawning takes place at night, peaking between 2200 – 0300 and is believed to take place close to the surface although wild spawning has not been witnessed (Schaefer 1998, Itano 2000). YFT are serial spawners, releasing millions of eggs during each spawning event and capable of repeated spawning at daily or near daily intervals during extended spawning.

Mature yellowfin in Hawaii were sampled during the spawning season (April – September) and the non-spawning season (October – March) and analyzed for spawning frequency and fecundity (Itano 2000). During the Hawaii spawning season, the spawning rates were very high from all surface fisheries, ranging from 1.02 d to 1.07 d indicating a near-daily spawning pattern. Yellowfin taken by deep-set longline gear during this time indicated a lower average spawning frequency resulting from a higher percentage of mature, non spawning fish. Spawning activity ceased completely in the fall season, resuming in early spring.

YFT are highly fecund, releasing hundreds of thousands to some millions of eggs during each spawning event. Batch fecundity increases significantly with weight but can be highly variable between fish of similar sizes (Schaefer 1998). Spawning occurs throughout the year in tropical waters at least within 10 degrees of the equator and seasonally at higher latitudes when sea surface temperatures rise above 24° C (Suzuki 1994). Several different areas and seasons of peak spawning for yellowfin have been proposed for the central and western equatorial Pacific.

The total catch of yellowfin tuna has increased steadily since 1980 in the Pacific Ocean, driven for the most part by increases in purse seine landings (Williams and Reid 2005). Pole-and-line catches have remained relatively stable during this time period in the WCPO while declining significantly in the EPO in recent years. Longline catches in both areas have been generally stable while there have been significant increases in yellowfin landings in the WCPO Mixed gear types fishery that primarily consist of unclassified gear types of Indonesia and Philippine handline catches (WCPFC 2005).

Juvenile YFT form a major component of surface landings in the WCPO and form an economically and socially important component of domestic, artisanal and subsistence fisheries in the Pacific, particularly in small-island and coastal states. In particular, small scale troll and surface handline fisheries generally take juveniles less than 100 cm. Juvenile YFT are also regularly taken as an incidental byproduct in skipjack pole and line fisheries, especially when floating objects or FADs are utilized. Juveniles of very small sizes are taken in the Philippine ringnet, gillnet and small purse seine fisheries or by a mixture of hook and line gears. These fisheries are based on anchored FADs, taking advantage of the strong tendency of juvenile tuna to aggregate to floating objects.

Large, mature-sized YFT are caught by higher value sub-surface fisheries, primarily longline fleets landing sashimi grade product. Adult YFT aggregate to drifting flotsam and anchored buoys, though to a lesser degree than juvenile fish. Large fish also aggregate over deep seamount and ridge features where they are targeted by some longline and handline fisheries.

A general perception is that adult YFT are taken by longline gear and in unassociated purse seine sets, while juvenile yellowfin are taken during purse seine sets on floating objects (e.g., logs, and anchored or drifting FADs). In reality, considerable overlap exists in longline and purse seine fisheries. It appears that juvenile YFT recruit to and are potentially vulnerable to longline gear from around 55 cm and may be retained or discarded depending on the market characteristics of the fishery. Purse seine sets on floating objects definitely harvest mainly juvenile-sized YFT but a small proportion of mature tuna are also taken. Examples of fishing gears or methods that really concentrate on mature-sized YFT include dolphin-associated purse seine fishing in the EPO and deep handline fisheries of the Philippines and Indonesia.

Movement

The migration or movement of YFT has been inferred from seasonal displacements to higher latitudes with warming SST and returning to lower latitudes during the cooler seasons (Suzuki et al. 1978). Examples of these situations can be seen off Japan with yellowfin in the Kuroshio Current, movements of yellowfin in the East Australian Current, or the seasonal appearance of YFT in California and New Zealand coastal waters. However, the extent to which these are migrations or simply habitat extensions with warming water is unknown.

YFT appear to be free to move throughout broad regions of favorable water temperature (18 - 31° C), salinity and DO values; and are capable of large, basin-scale movements as documented by tag recoveries. However, large, basin-scale movements that are typical for bluefin and albacore tuna appear to be very rare for yellowfin, with most tag recaptures occurring within 200 miles of release. Movement parameters for YFT may also be influenced by geography or bathymetry, with greater retention around islands, seamounts and banks.

A relatively large body of literature exists on sonic tracking of YFT in comparison to other tuna species (Block et al. 1997, Brill et al. 1999, Cayré 1991, Holland et al. 1990, Marsac and Cayré 1998). These studies generally support the assumption that YFT spend most of their time in the surface mixed layer of the ocean or near the thermocline. Juvenile YFT in Hawaii were observed to remain in the mixed layer or just above the thermocline (Holland et al. 1990) while large, adult size YFT in the same region were observed by sonic tracking to spend ~60 to 80% of their time in or immediately below the mixed layer and above 100 m (Brill et al. 1999). On the basis of these observations, Brill et al. (1999) proposed that yellowfin depth range was determined by a temperature differential based on the ambient surface temperature rather than any absolute temperature *per se*. In the case of Hawaiian YFT, they hypothesized that vertical diving was limited to water temperatures 8° C colder than surface waters due to the impact of cold water on heart function.

However, yellowfin have been observed (via acoustic telemetry) to make deeper dives to very cold water temperatures, generally for brief periods. Carey and Olsen (1982) report a yellowfin tuna diving to 464 m, the deepest diving record for a yellowfin yet published. Research is being conducted in Hawaii to examine the vertical behavior of YFT and BET found in association with anchored FADs (Itano et al. 2005). Anchored FADs have been equipped with underwater sonic receivers while tuna, billfish and oceanic sharks have been equipped with sonic transmitters that send presence/absence and depth data to the FAD receivers at a fine temporal scale. This work is ongoing but will document diurnal vertical behavior of these species in the presence of FADs.

YFT Stock Structure

YFT is an epipelagic species with worldwide distribution and there appear to be no physical or physiological barriers that prevent YFT from mixing throughout the Pacific basin. However, the question of stock structure of yellowfin in the Pacific continues to challenge management and several theories on stock heterogeneity exist.

Wild (1994) and Suzuki (1994) review the body of research on the stock structure of YFT in the EPO and WCPO. Several indirect stock identification procedures or methodologies have been employed that include morphometric and meristic variability, length frequency and catch-and-effort analyses, analyses of tagging data and spawning/reproductive studies (Cole 1980). Recently, genetic studies and the analyses of microconstituents in hard parts have attempted to develop more direct methods to discriminate yellowfin subpopulations. Results from indirect and direct methods have not always been complementary and the existence of sub-populations of YFT in the Pacific has yet to be proven (Wild 1994).

Tagging data suggest that YFT move throughout the western and central Pacific Ocean, at least within the equatorial latitudes, but generally do not move more than a few hundred miles (Sibert and Hampton 2003). Movement to higher latitudes may be more restricted in nature, but further research and tagging is needed. However, tagging data strongly suggest that movement between the EPO and the WCPO is fairly restricted for the species. Morphometric studies also support the possibility of restricted gene flow between the EPO and WCPO and even between northern and southern groups of YFT within the EPO (Schaefer 1989, 1991). The existence of semi-discrete equatorial populations of YFT in the eastern, central and western Pacific have also been supported by length frequency and catch composition data (Kamimura and Honma 1963, Suzuki et al. 1978). Analyses of otolith microchemistry have also suggested some geographic variation between central and western Pacific YFT (Gunn and Ward 1994).

Genetic studies for the most part have not been able to demonstrate population structure within the Pacific. Appleyard et al. (2001) examined five microsatellite loci from EPO and WCPO YFT and found very limited, but significant differentiation between some areas. However, the Appleyard et al. (2001) study concluded that population structure of a species like YFT that have the ability to mix genes across wide areas needs to be examined using a mixture of genetic and other data, e.g., tagging, morphology and analyses of otolith microchemistry.

Stock Status

Western and Central Pacific yellowfin tuna were determined by NMFS to be subject to overfishing in 2006 (71 FR 14837), however, based on recent stock assessments, they are no longer considered to be subject to overfishing. In 2004, U.S. fisheries were estimated to be responsible for less than four percent of all Western and Central Pacific Ocean yellowfin harvests, with the majority of these made by purse seine vessels. Given the above, in 2007, NMFS approved the Council's recommendation to develop, support and implement recommendations made by international regional fishery management organizations (RFMOs such as the Western and Central Pacific Tuna Fisheries Commission and the Inter-American Tropical Tunas Commission) to address overfishing of yellowfin tuna.

As described in the report of the third meeting of the Science Committee of the WCPFC, the 2007 stock assessment conclusions for yellowfin differ slightly from the 2006 assessment, particularly in relation to the ratio of the current estimate of fishing mortality compared with the fishing mortality at maximum sustainable yield (F/FMSY), with this indicator in the 2007 assessment being slightly more optimistic than that in the 2006 assessment. While the point estimate of F/FMSY remains slightly less than 1.0 (0.95), the probability distribution associated with the fishing mortality-based reference point indicates that there is almost an equal probability that the value of F/FMSY is less than or greater than the reference point. Therefore, the possibility of yellowfin overfishing is still relatively high (47%). The reference points that predict the status of the stock under equilibrium conditions are B/BMSY (1.10) and SB/SBMSY (1.12), which indicate that the long-term average biomass will remain slightly above the level capable of producing MSY at the 2002−2005 average fishing mortality. Overall, current biomass exceeds the estimated biomass at MSY (B/BMSY >1.0) indicating that the yellowfin stock in the WCPO is not in an overfished state, although there is a small probability (6.2%) that it is in an overfished state (WCPFC 2007). The MSY for WCPO yellowfin is estimated at 329,680 - 388,120 mt (Hampton et al. 2006) and 287,377 mt for the EPO (Hoyle and Maunder 2006).

3.2.2.3 Albacore Tuna

Life History and Distribution

Separate northern and southern stocks of albacore (*Thunnus alalunga*), with separate spawning areas and seasons, are believed to exist in the Pacific. In the North Pacific there may be two sub-stocks, separated due to the influence of bathymetric features on water masses (Laurs and Lynn 1991). Growth rates and migration patterns differ between populations north and south of 40° N. (Laurs and Wetherall 1981, Laurs and Lynn 1991).

In the North Pacific, albacore are distributed in a swath centered on 35° N and range as far as 50°N at the western end of their range. In the central South Pacific (150° E to 120° W) they are concentrated between 10° S and 30° S; in the west they may be found as far as 50º S. They are absent from the equatorial eastern Pacific. Hawaii appears to be at the southern edge of their range.

Temperature is recognized as the major determinant of albacore distribution. Albacore are both surface dwelling and deep-swimming. Deep-swimming albacore tuna are generally more concentrated in the western Pacific but with eastward extensions along 30° N and 10° S (Foreman 1980). The 15.6° to 19.4° C SST isotherms mark the limits of abundant distribution although deep-swimming albacore tuna have been found in waters between 13.5° and 25.2° C (Saito 1973). Laurs and Lynn (1991) describe North Pacific albacore tuna distribution in terms of the North Pacific Transition Zone, which lies between the cold, low salinity waters north of the sub-arctic front and the warm, high salinity waters south of the sub-tropical front. This band of water, roughly between 40° and 30-35° N (the Transition Zone is not a stable feature) also helps to determine migration routes.

Telemetry experiments demonstrate that albacore will enter water as cold as 9.5° C for short periods of time. Laurs and Lynn (1991) argue that acoustic tracking demonstrates that albacore tuna have a wider temperature range than stated previously and that their normal habitat is 10°-20° C with a dissolved oxygen saturation level greater than 60 percent.

The overall thermal structure of water masses, rather than just SST, has to be taken into account in describing total range because depth distribution is governed by vertical thermal structure. Albacore are found to a depth of at least 380 m and will move into water as cold as 9° C at depths of 200 m. They can move through temperature gradients of up to 10° C within 20 minutes. This reflects the many advanced adaptations of this fish; it is a thermoregulating endotherm with a high metabolic rate and advanced cardiovascular system. Generally, albacore have different temperature preferences according to size, with larger fish preferring cooler water, although the opposite is true in the northeast Pacific. They are considered epi- and mesopelagic in depth range.

The main albacore fisheries in the Pacific may be distinguished as either surface or deep water. The surface fisheries are trolling operations off the American coast from Baja to Canada, baitboat operations south of Japan at the Kuroshio Front and a fishery in New Zealand waters. A troll fishery has also developed south of Tahiti. Purse seine fishing is also considered a surface method but is currently of minor importance in the albacore fishery. Albacore are occasionally taken as bycatch in other tuna fisheries. Elsewhere, mainly in the northwest and South Pacific, longline gear is used to capture deep-swimming fish. Taiwanese and Japanese high seas drift gillnetters rapidly expanded effort in the South Pacific after 1988, targeting albacore tuna. A number of regional and international initiatives were put forward to limit or ban this fishery, and by 1990 operations had ceased (Wright and Doulman 1991). Generally, surface fisheries occur in cooler waters and target immature fish; the longline fishery, targeting deep-swimming fish, occurs closer to the equator.

Larval and Juvenile Stage
Davis et al. (1990) studied diel distribution of tuna larvae, including albacore tuna in the Indian Ocean off of northwest Australia. They found that albacore tuna migrate to the surface in the day and are deeper at night. This diel pattern was much more marked in albacore tuna than southern bluefin tuna (*Thunnus maccoyii*) larvae. Total vertical range was limited by pycnocline depth, which was 16-22 m in the study area. They concluded that the pycnocline acts as a physical barrier to movement. Albacore tuna may forage during daylight hours and simply sink to neutral depth at night when they cease swimming. Other studies indicate that the top boundary of the pycnocline can be an area of concentration for larvae.

Young and Davis (1990) report on larval feeding of albacore tuna in the Indian Ocean. They found *Corycaeus spp*., *Farranula gibbula* (Cyclopoida) and *Calanoid nauplii* to be major prey items. Diet breadth was greatest for larvae less than 5.5 mm. Leis et al. (1991) found high concentrations of tuna larvae, including albacore tuna, at sample sites near coral reefs on three islands in French Polynesia. They note that tuna larvae are sparsely distributed in the open ocean, possibly because they congregate near islands. Their findings are similar to Miller's (1979) findings around Oahu, Hawaii.

Small juvenile albacore tuna range from 12 to 300 mm in length and have been found in coastal waters from a number of areas in the western Pacific, including the Mariana Islands, Japanese coastal waters, Fiji, waters east of Australia, and Tuvalu. They have also been reported from Hawaiian waters. Albacore tuna are not mature until about five years old. Off the west coast of North America, young albacore congregate in large, loosely aggregated schools. Larger fish are observed to form more compact schools, but the dense schools common to yellowfin tuna and skipjack tuna are not generally formed by albacore.

Adult Stage
Albacore spawn in the summer in subtropical waters. There is also some evidence of multiple spawning (Otsu and Uchida 1959). Foreman (1980) provides a map showing distribution of spawning areas. In the North Pacific the area centers on 25° N and 160° E and does not extend east of about 150° W. The same map in Foreman shows larval distribution, which is more restricted in extent than estimates of total spawning area. Fecundity is estimated at 0.8-2.6 million eggs per spawning. Based on age groups it is believed that maximum longevity is around ten years. Female albacore tuna reach maturity by about 90 cm, while mature males are somewhat larger. Ueyanagi (1957) postulated that males reach maturity at 97 cm. This length would accord with ages between five and seven years, based on length-at-age estimates.

Movement
Albacore are noted for their tendency to concentrate along thermal fronts, particularly the Kuroshio front east of Japan and the North Pacific Transition Zone. Laurs and Lynn (1991) note that they tend to aggregate on the warm side of upwelling fronts. Near continental areas they prefer warm, clear oceanic waters adjacent to fronts with cool turbid coastal water masses. It is not understood why they do not cross these fronts, especially given that they are able to

thermoregulate, but it may be because of water clarity since they are sight-dependent foragers. Further offshore, fishing success correlates with biological productivity.

Albacore have a complex migration pattern with the North and South Pacific stocks having their own patterns. Most migration is undertaken by pre-adults, two to five years old. A further sub-division of the northern stock, each with separate migration, is also suggested. The model suggested by Otsu and Uchida (1963) shows a trans-Pacific migration by year class. Generally speaking, a given year class migrates east to west and then east again in a band between 30° N and 45° N, leaving the northeast Pacific in September-October, reaching waters off Japan the following summer and returning to the east in the summer of the following year. Four- to six-year old albacore enter sub-tropical waters south of 30° N and west of Hawaii (Kimura et al. 1997) where they spawn. Migration may also be influenced by large-scale climate events that affect the Kuroshio Current regime (Kimura et al. 1997). Albacore may migrate to the eastern Pacific when the Kuroshio takes a large meandering path. This also affects the southward extension of the Oyashio Current and may reduce the availability of forage, primarily saury, in the western Pacific.

The aforementioned sub-stocks apparently divide along 40° N. Albacore tagged off the U.S. West coast north of 40º N apparently undertake more westward migration (58 percent of tag returns come from the western Pacific west of 180°) versus those tagged to the south (only ten percent were recovered in the western Pacific, 78 percent from the tagging area) (Laurs and Lynn 1991).

Stock Status

A North Pacific albacore stock assessment conducted in 2006 by the International Scientific Committee on Tunas and Tuna-Like Species in the North Pacific Ocean (ISC) indicated that spawning stock biomass (SSB) increased from 2002 (73,500 mt) to 2006 (153,300 mt) and was projected to increase to 165,800 mt in 2007. The increase is attributable to strong year classes in 2001 and 2003. Projections (2007−2020), using an average productivity of 27.75 million fish and F equal to 0.75, indicate that the SSB will reach equilibrium by 2015 at 92,600 mt. The conservation advice provided by the ISC for North Pacific albacore is as follows: “Due to updating, and improvements and refinements in data and models used in the 2006 stock assessment, it is now recognized that $F_{current}$ (0.75) is high relative to most of the F reference points. On the other hand, the same analysis indicates that the current estimate of the SSB is the second highest in history but that keeping the current F would gradually reduce the SSB to the long-term average by the mid 2010s. Therefore, the recommendation of not increasing F from current level (Fcurrent =0.75) is still valid. However, with the projection based on the continued current high F the fishing mortality rate will have to be reduced” (WCPFC 2007).

3.2.2.4 Blue Marlin

The blue marlin (*Makaira nigricans*) is the most tropical of all marlins. It has been variously described as a single pan-tropical species (Rivas 1974) or two distinct species, *Makaira nigricans* in the Atlantic and *Makaira mazara* in the Pacific (Nakamura 1983). Using mitochondrial DNA (mtDNA) techniques, Graves and McDowell (1995) found that "[t]he lack of significant genetic differentiation between Atlantic and Indo-Pacific samples of blue marlin [and sailfish] does not support…recognition of distinct Atlantic and Indo-Pacific species." The current assumption is that there is a single Pacific-wide stock. This conclusion is supported by genetic studies that suggest a single Pacific-wide cytochrome b DNA haplotype (Finnerty and Block 1992).

Important fishing areas include the northwest Pacific and most of the blue marlin are caught in the longline fishery. Blue marlins are extremely important to the sport fishing sectors within the management plan area. In Hawaii, Guam and the Northern Mariana Islands, blue marlin are caught by recreational small-boat trollers and charter boats.

Based on a long-term study of reproductive condition of blue marlin caught in Hawaii billfish tournaments, Hopper (1990) argues that these fish congregate around the Hawaiian Islands during summer months in order to spawn. Hopper contends that they migrate from more southerly latitudes, and "Hawaii may be a focus for blue marlin spawning in the northern central Pacific because oceanographic conditions are favorable to survival of marlin larvae and juveniles." Other researchers (Nishikawa et al.1985) note that areas where larvae occur more frequently correspond to the best summer fishing grounds. It has also been suggested that marlin spawn year-round in tropical waters.

Tracking experiments (Holland et al. 1990b, Block et al. 1992a) show that blue marlin in Hawaiian waters spend virtually all of their time within the mixed layer, frequently moving between the surface and the top of the thermocline which, in Hawai‘i, is usually at a depth of between 80 and 100 meters. Dives through the thermocline are uncommon and are to relatively shallow depths; Block et al. (1992b) recorded a maximum dive depth of 209 meters in one tracked marlin. There is a north-south seasonal migration of fish that corresponds to warmer waters. These migrations may be more northwesterly and southeasterly so that northward moving groups pass the equator around 150° E -180° and southward migrants pass the equator between 160° E -180° (Au 1991). If there is a single Pacific-wide stock, these data suggest that there may be a seasonal clockwise gyral pattern of migration.

Stock Status

Klieber et al. (2003) found that in their most conservative result of their stock assessment that recent catches of blue marlin are close to MSY; however, the actual situation may be more optimistic with effort levels well below those that would produce MSY. The stock is not considered to be overfished nor is overfishing thought to be occurring. The MSY for Pacific blue marlin is estimated to be 13,056 mt (Kleiber et al. 2003).

3.2.2.5 Striped Marlin

In the Pacific, the striped marlin (*Tetrapturus audax*) is distributed in two supra-equatorial bands that join at the eastern tropical margin. This has led some researchers to divide the population into two separate stocks, at least for management purposes. This interpretation is supported by genetic analysis (mitochondrial DNA) that suggests a corresponding spatial partitioning in genotypes (Graves and McDowell 1994). The authors suggest that this differentiation may be due to spawning site fidelity.

In contrast to the blue marlin, there is no significant sexual size dimorphism in this species. Region-wide major catches of striped marlin are made by Japan and Korea. Important fishing areas include FAO Fishing Area 61 (northwest Pacific) where about 50 percent of the catch is made. Most of the catch is made by surface longlining that targets tunas (Nakamura 1985).

Distribution of eggs is unknown. Larvae are reportedly found between 10°-30° N and 10°-30° S Peak abundance is in May-June in the northwestern Pacific (Ueyanagi and Wares 1975). This corresponds to the spawning ground described by Squire and Suzuki (1990). Thus, spawning is probably seasonal and confined to the early summer months in both hemispheres, and there is probably a separate spawning ground in the southwest Pacific. Like other billfish, striped marlins are generally confined to pelagic surface waters; the larvae may make diurnal vertical migrations in the top 50 m of the water column. Little is known about time of first feeding or food preferences. Females are reported to reach first maturity at 50-80 lb; it is not possible to determine onset of sexual maturity in males because change in the size of testes is slight.

Acoustic tracking of adult striped marlin in Hawaiian waters and off California (Brill et al. 1993, Holts and Bedford 1990) demonstrated that they spent virtually all their time in the mixed layer. The authors conclude that depth preference is governed by temperature stratification; the fish they tracked spent the vast majority of time in waters within 2° C of the mixed layer temperature and never ventured into waters 8° C colder than the mixed layer temperature. Squire and Suzuki (1990) argued that striped marlin make long-term migrations between spawning and feeding areas. The spawning areas are in the northwest and to a lesser extent the southwest Pacific. Young fish migrate eastward to feeding areas off the Central American coast and subsequently return westward as adults.

Stock Status

According to a recent stock assessment for the North Pacific striped marlin conducted by the ISC, striped marlin spawning biomass has declined from around 40,000 mt in the early 1970s to about 5,000 mt in the early 2000s. The latest status determinations are that striped marlin is not subject to overfishing, not overfished, and not approaching either condition in the EPO. However, for the WCPO stock its status with respect to overfishing and overfished conditions is unknown at this time. The IATTC is planning on conducting a separate stock assessment by 2009. Nonetheless, the ISC assessment suggests that spawning biomass in 2003 was estimated to be 14−15% of the 1970 level, depending on the model scenario used and that stock projections from 2004 through 2009 indicate that both spawning biomass and landings will continue to decline if the current fishing mortality rate is maintained (WCPFC 2007). MSY has not been estimated for this stock.

3.2.2.6 Shortbill Spearfish

The shortbill spearfish (*Tetrapturus angustirostris*) is an Istiophorid billfish and shares the genus with five other species. Kikawa (1975), summarizing various works, describes the total distribution as sporadic between 10° N and 10° S with possible range extent to 30° N and 30° S, based on longline catch data. Nakamura (1985) gave a range of 40° N to 35° S for the Pacific with a low density throughout its range. Nakamura further stated that the shortbill spearfish "is an oceanic pelagic fish which does not generally occur in coastal or enclosed waters but is found well offshore. Boggs (1992), conducting research in 1989 on longline capture depth, obtained the highest catch rates at 120-360 m with a few fish caught as deep as 280-360 m. This distribution is described as "the middle of the thermocline" that begins at 120 m and 20° C. In another survey in 1990, the highest catch rates were shallower (40-80 m) with no catch below 200 m.

Nakano et al. (1997), analyzing catch depth data from research cruises in the mid-Pacific, classes shortbill spearfish among fish for which catch rate declines with depth. The hypothetical habitat for this fish may be described as open ocean epipelagic and mesopelagic waters from the surface to 1,000 meters in the tropics and subtropics.

Spearfish are heterosexual and no sexual dimorphism is reported. Shortbill spearfish apparently spawn in winter months in tropical and subtropical waters between 25° N and 25° S. Kikawa (1975) noted that unlike other billfish spawning does not "take place in large groups over a very short period of time, but probably is continuous over a long period and over broad areas of the sea."

There is no special fishery for spearfish; they are caught incidentally by longliners and occasionally by surface troll.

Stock Status
There is currently no available stock assessment for shortbill spearfish.

3.2.2.7 Mahimahi

Mahimahi or dolphinfish (*Coryphaena hippurus*) is one of two species in the Coryphaenidae family. They are distributed worldwide in tropical and subtropical waters. Their larvae occur in the tropical regions of all oceans. They grow rapidly throughout their life and have a maximum life span of about four years (Palko and Beardsley 1982). Large aggregations of mahimahi are common around flotsam drifting at sea and off fish aggregation buoys. They are top level predators capable of taking fast-moving prey such as smaller fishes located beneath floating objects. Mahimahi have an extended spawning season, a very early age at maturity, a voracious appetite, a cosmopolitan diet, and a short life span (Palko and Beardsley 1982).

In Hawaii, the supply of locally-caught mahimahi is extremely limited and seasonal considering the high demand for this species. Although available for most of the year, mahimahi catches usually peak in March-May and September-November. Most of the fish are between 8 and 25 pounds, but larger fish are caught by trollers and smaller fish by the pole-and-line skipjack tuna fleet.[11] About 80 percent of the commercial mahimahi landings in Hawaii are by trollers. The remainder is caught on longline gear or by aku fishermen using live bait in the pole-and-line fishery. Since the reopening of the Hawaii-based shallow-set fishery in 2004, 9,712 mahimahi have been caught by this sector, the majority of which (83 percent) were kept.

Stock Status

There is currently no available stock assessment for mahimahi. The Council is working on an ecological risk model that is expected to evaluate the vulnerability of mahimahi stocks.

3.2.2.8 Blue shark

The blue shark (*Prionace glauca*) is a wide ranging oceanic shark found worldwide from tropical to temperate waters. The most abundant pelagic shark species, large numbers of blue sharks are caught by the world's pelagic fisheries - usually as by-catch incidental to various target species. In the North Pacific, blue sharks are found from the equator to waters north of 57° N and into the Gulf of Alaska during the summer (Strasburg 1958, Neave and Hanavan 1960). The species is frequently caught by pelagic fisheries and is the most common shark species taken by longline fisheries.

In terms of depth distribution, Strasburg (1958) examined blue shark relative abundance by depth using commercial longline hooking rates. He determined that above 30° N, sharks were mainly taken on shallower hooks, but no evidence of depth effect could be identified between the equator and 30° N, and catch rates increased in deeper water between the equator and 10° S. On the other hand, Nakano et al. (1997) failed to find a difference in blue shark catch rates with depth. Strasburg (1958) reported 99 percent of blue sharks were caught in water temperatures ranging from 45° to 69° F (5.6° to 18.9° C) and 86 percent were in or below the thermocline. Depth of highest catches also became shallower following the shoaling of the thermocline to the north. Nakano (1994) reported that blue sharks were caught in the SST range of 10°-25° C and 10°-22° C by the salmon research and large mesh driftnet gears respectively. Most catches were made at 16°-18° C and 14°-17° C of sea surface temperature respectively.

The blue shark has relatively high fecundity among Carcharhiniformes (Pratt and Casey, 1990). Segregation by sex and size are well-known characteristics exhibited by elasmobranchs (Springer, 1967). Using commercial longline catch data from the western North Pacific, Suda (1953) deduced increasing size of blue sharks to the south, and the occurrence of smaller sharks less than 134 cm in the waters north of 30° N. near Japan. There was also lower occurrence of females in September-November around 30°-40° N and March-May between 20° and 30° N, and dominance of females during summer near 0-10° N. Comparison of length distributions from the driftnet fishery off California and the longline swordfish fishery operating north of Hawaii indicates that sub-adult blues move out from coastal waters to join the oceanic, adult portion of their population as they approach sexual maturity.

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[11] See http://www.hawaii-seafood.org/mahimahi.html, accessed July 2008.

Sharks are caught more frequently in the shallow-set swordfish longline fishery than in the deep-set tuna longline fishery, with an average of 25 and 9.5 sharks per a typical set and an average cost of damaged gear of $50 and $19, respectively (Gilman et al. 2006). Most tuna vessels, unlike swordfish vessels, use wire traces (leaders) on their gear at the end of branch lines causing sharks to be retained on the line in the tuna fishery much more frequently than in the swordfish fishery. About 66% of caught sharks are reported to be released by crew cutting the branch line which likely results in a high degree of survivorship. Other small sharks may be hauled aboard and hooks removed; however, dehookers are reported to be ineffective and risky to use with sharks (Gilman et al. 2006).

Other information which was reported by Gilman et al. (2006) from their longliner survey is that most (66%) only occasionally retain a shark, few (25%) never retain a shark, and of those that do retain a shark only do so at the end of a trip with space available because of shark's low market value and ability to contaminate a catch with urea. They also reported that they attempt to avoid shark interactions and capture by adjusting their fishing location and staying out of areas of known high shark abundance. Most respondents in Gilman's (2006) survey believe that high shark catches are directly correlated with shallower gear sets, proximity to submarine topographic features such as seamounts, and proximity to oceanographic fronts.

Stock Status
Pelagic shark stock assessment work was initiated in the year 2000 as a collaborative effort with scientists at the National Research Institute for Far Seas Fisheries. A report was produced by Kleiber et al. (2001) which calculated MSY of 318,500 mt for blue sharks in the North Pacific (Southwest Fisheries Science Center, Admin. Rep. H-01-02). The most recent estimate of the MSY for North Pacific blue sharks is about 60,000 metric tons or 132 million pounds (Kleiber et al. 2007).

3.2.2.9 Family Alopiidae (thresher sharks)

Distribution
Three species of thresher shark are caught in Pacific fisheries. These are the bigeye thresher, *Alopias superciliosus*, the pelagic thresher, *Alopias pelagicus*, and the common thresher, *Alopias vulpinus.* They are found virtually circumglobally in warm seas. The pelagic thresher, bigeye thresher, and common thresher range in depth from the surface to at least 150 m, 500 m, and 366 m, respectively (Compagno 1984). Based on differences in structure, feeding habits, and spatial distribution, Compagno speculated the three species reduce interspecific competition through niche partitioning.

Biology and life history
All thresher sharks are characterized by a long asymmetrical caudal fin with a dorsal lobe comparable in length to the rest of the body. The bigeye thresher is easily distinguished by large eyes and a well-pronounced horizontal groove on the head. The pelagic thresher is easily distinguishable from the common thresher by coloration. The white color of the abdomen does

not extend over the pectoral fin bases of the pelagic thresher, while the common thresher has white color extending over the pectoral fin bases (Compagno 1984).

Maximum total length of pelagic thresher, bigeye thresher, and common threshers is 330 cm, 461 cm, and 549 cm, respectively. Male pelagic thresher, male bigeye thresher, and male common threshers mature at 276 cm, 270 cm, and 319 cm, respectively. Female pelagic thresher, female bigeye thresher, and female common threshers mature at 264 cm, 355 cm, and 376 cm, respectively. Von Bertalanffy growth parameters are *A. superciliosus* – L_∞ =224.6 cm, k=0.092, t0= -4.21 (Liu et al. 1998); *A. pelagicus* – L t=197.2 cm, k=0.085, t0= -7.67 for females and L t=182.2 cm, k=0.118, t0= -5.48 for males (Liu et al. 1999). All thresher sharks are ovoviviparous with uterine cannibalism. Broods consist of two young, one in each uterus that measure 135-140 cm at birth for *A. superciliosus* (Chen et al. 1997), two young measuring 158-190 cm TL at birth for *A. pelagicus* (Liu et al. 1999), and four to six young that measure 137-155 cm at birth for *A. vulpinus* (Castro 1983). Size at birth of pelagic thresher, bigeye thresher, and common threshers is 96 cm, 105 cm, and 114-150 cm, respectively (Compagno 1984).

The morphologically unique caudal lobe of thresher shark tails is highly specialized for feeding. Thresher sharks feed by circling schools of prey and schooling them together before using their tail to whip prey, either stunning them or outright killing them. Thresher sharks are usually hooked by the tail in longline fisheries after striking the bait with their tail (Compagno 1984).

Trophic relationships

Thresher sharks eat small to moderately large fish, squid, and pelagic crustaceans. Bigeye threshers take larger pelagic fishes and bottom fishes while the pelagic and common threshers feed on smaller fishes and squids (Compagno 1984).

Stock Status

In California, 94 percent of the total thresher shark commercial landings is 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). CPUE has also declined from initial levels.

Declines in CPUE indicate a reduction in the thresher shark population (Holts, 1998). However, 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. The thresher shark populations are managed under the HMS FMP utilizing a harvest guideline based on OY, rather than MSY.

3.2.2.10 Family Lamnidae (mako sharks)

Distribution
There are two species of mako sharks, shortfin mako (*Isurus oxyrinchus*) and longfin mako (*Isurus paucus*). The shortfin mako is found worldwide in coastal and oceanic, temperate and tropical seas. The longfin mako is oceanic and tropical, and thus is more restricted in distribution. The shortfin mako can be found from the surface to at least 150 m. Mako sharks are seldom found in water temperatures less than 16° C. The Southern California Bight (SCB) is evidently an important nursery and feeding area for immature stages (Hanan et al. 1993). The shortfin mako has a tendency to follow warm water currents towards the poles during the summer (Compagno 1984).

Biology and life history
Mako sharks are slender with conical snouts. The two species can be distinguished by several characteristics; the shortfin mako has an acutely pointed snout while that of the longfin mako is bluntly pointed, and the pectoral fins of the shortfin mako are shorter than the head while those of the longfin mako are longer than the head. Pratt and Casey (1983) provide growth and age estimates for *I. oxyrinchus* based on specimens captured in the northeast Atlantic. Growth is considered fast but the species exhibits low fecundity. Size at birth is about 60 cm. Males mature at about 180 cm or 2.5 years, and females, 260 cm or six to seven years. Theoretical maximum size, based on the von Bertalanffy growth curve is 302 cm for males and 345 cm for females, suggesting a maximum age in excess of 15 years. Size dimorphism between sexes, with females being larger, is common in many shark species.

Shortfin mako sharks are ovoviviparous and uterine cannibals with a litter size of 4-16. Longfin mako sharks are also ovoviviparous and uterine cannibals but have a litter size of two, with the pups generally being larger than those of shortfin mako. Pratt and Casey (1983) estimate a one-year gestation period. Mako sharks are fast-swimming species capable of swift dashes and spectacular jumps when chasing their prey. Mako sharks have a modified circulatory system that enables them to retain a body temperature warmer than the surrounding water. This permits a higher level of activity and increases the power of their muscles. They feed on a wide variety of bony fishes, other sharks, rays, marine birds and reptiles, marine mammals, squids, bottom crustaceans and carrion (Compagno 1984). The longfin mako is slower and less active than the shortfin mako (Compagno 1984).

Trophic relationships
The shortfin mako is piscivorus and its diet includes a wide variety of pelagic species. It is known to eat squid, turtles, and dolphins. The diet of the longfin mako is less known but presumably includes schooling fish and pelagic cephalopods (Compagno 1984).

Stock status
Approximately 10 mt/yr of mako shark are caught in the HI-based shallow-set fishery.
This species is also taken by the California driftnet fishery for swordfish. Although current catches are only about 80 mt/yr in the California fishery, the mako shark is a 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 were also taken in smaller amounts (<10 mt/yr) by California-based longliners operating beyond the EEZ in the late 1990s (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 distribution. There have been no assessments completed to date on the North Pacific short- or longfin mako stocks. The status determinations for the two species are currently listed as unknown for both overfishing and overfished conditions

3.2.2.11 Hawaii Commercial Pelagic Fisheries Statistics

Table 11 and Figures 10, 11, and 12 provide information on Hawaii commercial pelagic fisheries. The Hawaii longline fishery is the State's largest commercial fishery in terms of landings and economic value. Other significant pelagic fisheries include troll and handline methods.

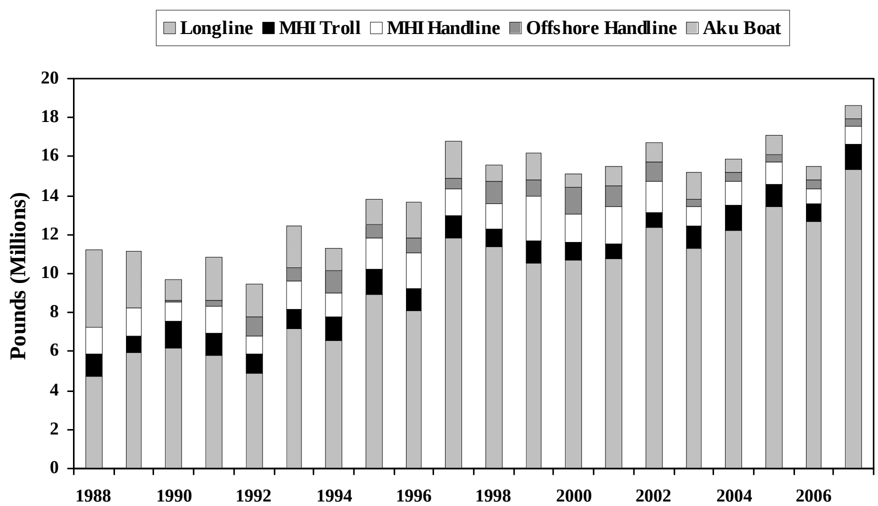

Figure 10: Hawaii commercial tuna landings by gear type, 1988-2007
Source: 2007 WPRFMC Pelagics Annual Report

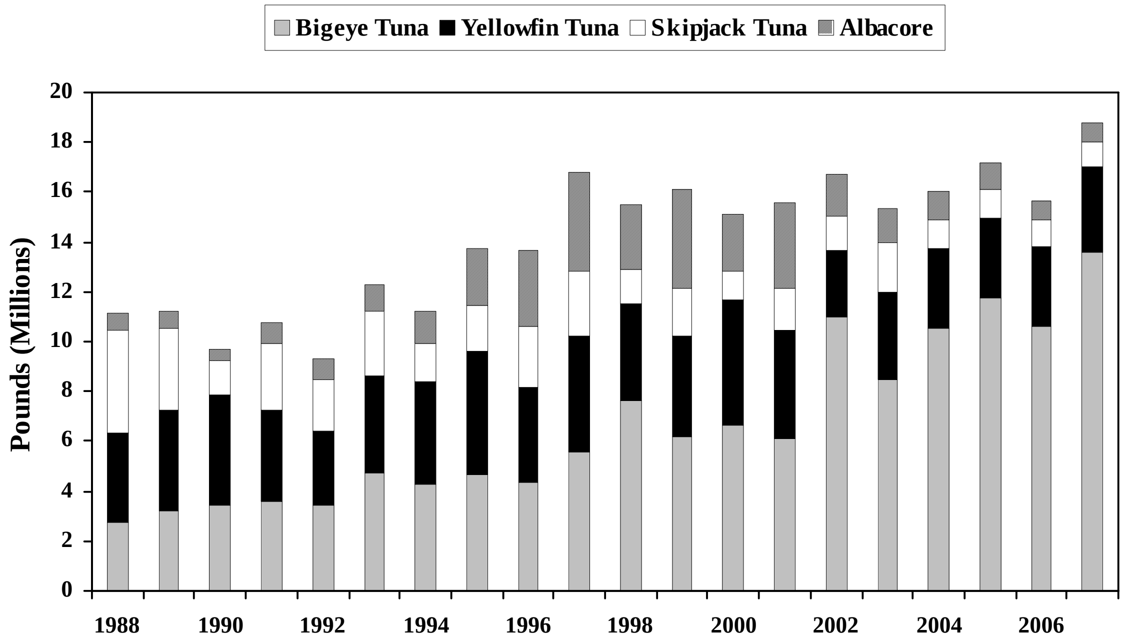

Figure 11: Species composition of the tuna landings, 1988-2007
Source: 2007 WPRFMC Pelagics Annual Report

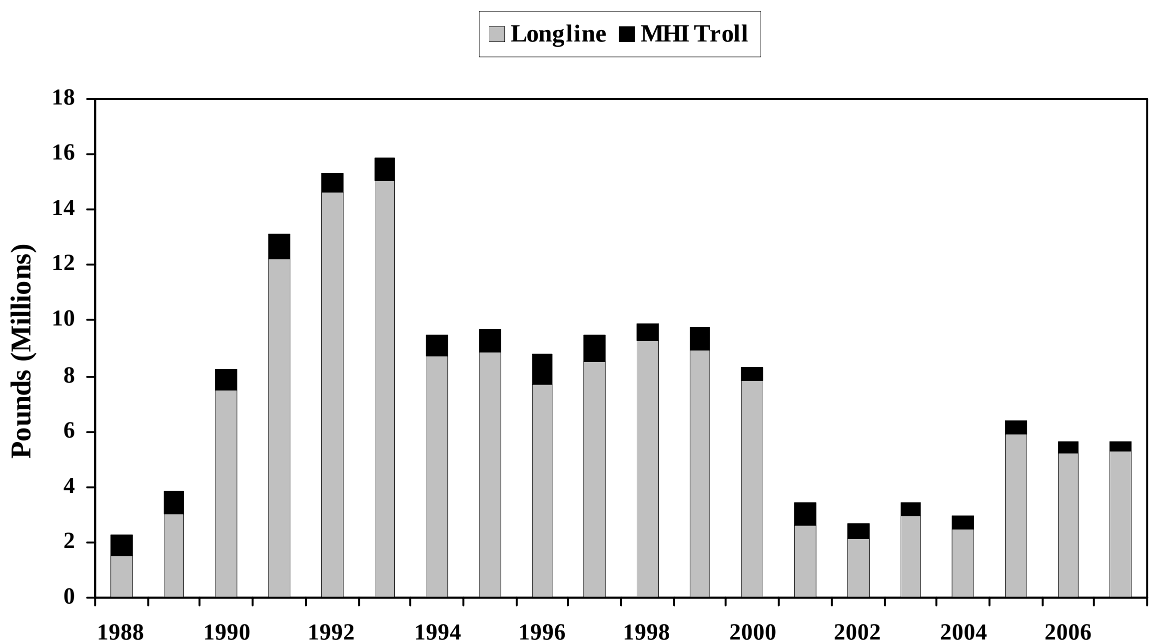

Figure 12: Hawaii commercial billfish landings by gear type, 1988-2007
Source: 2007 WPRFMC Pelagics Annual Report

Table 11: Hawaii commercial billfish landings by gear type, 1988-2007

	Hawaii Billfish Landings (1000 Pounds)			
Year	Longline	MHI Troll	MHI Handline	All Gear
1988	1,537	736	28	2,301
1989	3,043	805	32	3,880
1990	7,519	732	27	8,278
1991	12,208	890	31	13,129
1992	14,656	683	16	15,355
1993	15,034	870	24	15,928
1994	8,737	770	19	9,526
1995	8,837	856	30	9,723
1996	7,723	1,042	31	8,796
1997	8,517	935	40	9,492
1998	9,277	626	20	9,923
1999	8,958	769	31	9,758
2000	7,817	506	201	8,535
2001	2,630	780	51	3,469
2002	2,160	535	26	2,728
2003	2,951	492	25	3,477
2004	2,471	480	23	3,019
2005	5,909	471	17	6,400
2006	5,246	395	14	5,659
2007	5,322	302	14	5,643
Average	**7,028**	**684**	**35**	**7,751**
Std. Dev.	**3,882**	**194**	**39**	**3,962**

Source: 2007 WPRFMC Pelagics Annual Report

3.2.2.12 Hawaii Recreational Pelagic Fisheries Statistics

Currently, there are no Federal or State recreational permit and reporting requirements for recreational pelagic fishers in Hawaii. The figures below present catch data that are extrapolated from shore-based creel surveys, therefore accurate catch estimates are difficult to ascertain. It is noted that that according to the available information, the primary fish caught in Hawaii recreational pelagic fisheries by number is skipjack tuna, In terms of weight, however, yellowfin tuna catches are highest, followed by blue marlin and mahimahi catches and these make up the top three species landed, by weight.

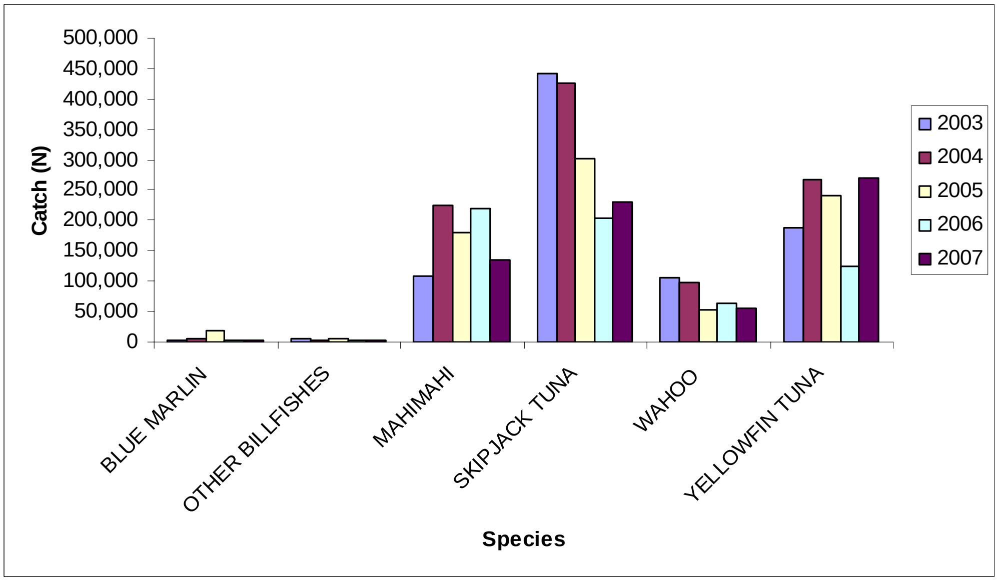

Figure 13: Estimated Hawaii recreational pelagic landings (number of fish), 2003-2007
Source: Hawaii MRFSS web data

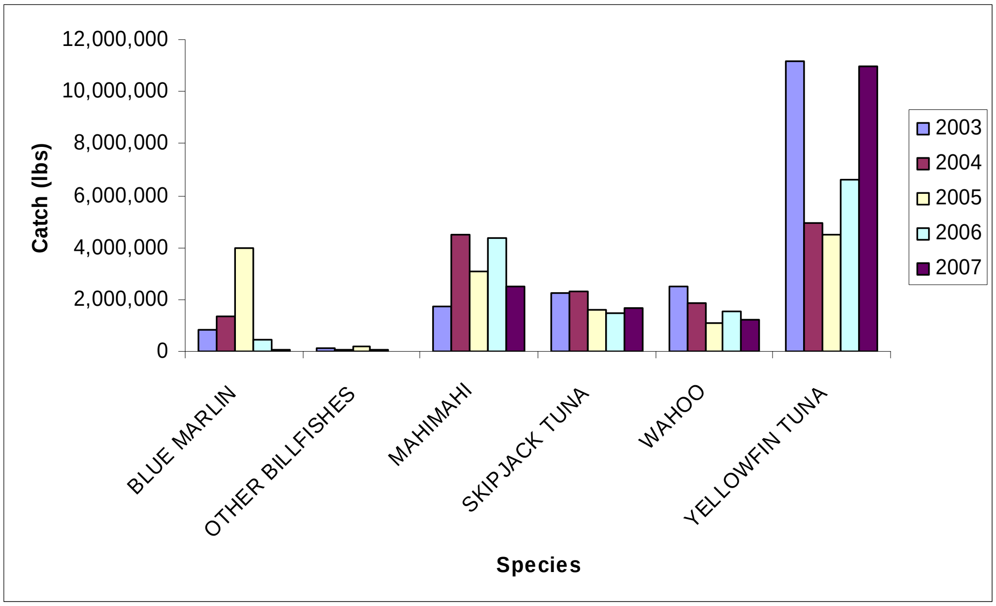

Figure 14: Estimated Hawaii recreational pelagic landings (by weight), 2003-2007
Source: Hawaii MRFSS web data

3.2.3 Non-Target Species

Non-target species are those which are normally discarded, either due to low commercial value or by regulations regarding retention. Because non-target species are typically caught in low numbers, and perhaps because they have little to no economic value to fishery participants, logbooks have been found to misstate some non-target species. Thus data collected by Federal observers is used to characterize and analyze catches and discards of these species. Observer data are also used to characterize the condition of all discarded fish at their time of release (i.e. alive vs. dead).

Table 12 provides total observed fish catches, discard rates, and discard conditions in the Hawaii-based shallow-set fishery from years 2004-2007 (all years combined through 3rd quarter of 2007).

Table 12: Observed finfish catches, discard rates and discard conditions in the Hawaii-based shallow-set fishery, 2004-2007

Species	Total number caught 2004-2007	Percent discarded	Percent discarded alive	Average percent discarded dead
Swordfish	57,769	10.80%	33.64%	66.36%
Blue Shark	42,856	99.99%	94.09%	5.91%
Mahimahi	9,712	17.34%	83.97%	16.03%
Escolar	6,264	28.94%	60.01%	39.99%
Longnose Lancetfish	5,683	100.00%	6.86%	93.14%
Bigeye Tuna	4,723	8.17%	64.25%	35.75%
Albacore	3,827	37.16%	56.96%	43.04%
Shortfin Mako (Mackerel Shark)	2,902	89.18%	78.90%	21.10%
Striped Marlin	2,144	14.93%	76.88%	23.13%
Snake Mackerel	1,086	88.86%	38.34%	61.66%
Remora	923	99.24%	90.61%	9.39%
Oilfish	783	89.53%	73.75%	26.25%
Yellowfin Tuna	493	8.32%	63.41%	36.59%
Oceanic Whitetip Shark	450	98.00%	93.20%	6.80%
Indo-Pacific Blue Marlin	440	15.68%	75.36%	24.64%
Sickle Pomfret	389	6.68%	46.15%	53.85%
Cartilaginous Fishes	360	100.00%	84.17%	15.83%
Pelagic Stingray	303	87.46%	69.06%	30.94%
Shortbill Spearfish	301	33.89%	54.90%	45.10%
Opah (Moonfish)	253	35.97%	73.63%	26.37%
Wahoo	250	3.60%	22.22%	77.78%
Brama Pomfrets Nei	229	49.34%	43.36%	56.64%
Skipjack Tuna	189	12.70%	20.83%	79.17%
Mako Sharks	125	100.00%	76.80%	23.20%
Bigeye Thresher Shark	95	84.21%	76.25%	23.75%
Bony Fishes Nei	73	94.52%	42.03%	57.97%
Sandbar Shark	51	96.08%	97.96%	2.04%

Species	Total number caught 2004-2007	Percent discarded	Percent discarded alive	Average percent discarded dead
Billfishes	43	97.67%	71.43%	28.57%
Silky Shark	42	97.62%	90.24%	9.76%
Tunas And Mackerels	41	97.56%	22.50%	77.50%
Ocean Sunfish (Common Mola)	38	100.00%	97.37%	2.63%
Knifetail Pomfret	26	96.15%	56.00%	44.00%
Pelagic Puffer	25	100.00%	84.00%	16.00%
Crocodile Shark	23	100.00%	78.26%	21.74%
Salmon Shark	22	100.00%	18.18%	81.82%
Brilliant Pomfret	19	63.16%	41.67%	58.33%
Thresher Sharks	16	100.00%	81.25%	18.75%
Great Barracuda	15	20.00%	66.67%	33.33%
Longfin Mako	13	92.31%	83.33%	16.67%
Tiger Shark	11	100.00%	90.91%	9.09%
Thresher Shark	10	90.00%	77.78%	22.22%
Cookie Cutter Shark	8	62.50%	40.00%	60.00%
Galapagos Shark	6	100.00%	83.33%	16.67%
Pelagic Thresher Shark	6	100.00%	66.67%	33.33%
Smooth Hammerhead Shark	6	100.00%	33.33%	66.67%
Mobulas Nei	5	60.00%	100.00%	0.00%
Manta	5	100.00%	60.00%	40.00%
Omosudid (Hammerjaw)	5	100.00%	20.00%	80.00%
Tapertail Ribbonfish	4	75.00%	33.33%	66.67%
Roudi Escolar	3	100.00%	33.33%	66.67%
Driftfish	3	66.67%	0.00%	100.00%
Louvar	2	50.00%	100.00%	0.00%
Pacific Bluefin Tuna	2	0.00%	0.00%	0.00%
Bignose Shark	1	100.00%	100.00%	0.00%
Black Mackerel	1	100.00%	100.00%	0.00%
Slender Mola	1	100.00%	100.00%	0.00%
White Shark	1	100.00%	100.00%	0.00%
Black Marlin	1	0.00%	0.00%	0.00%

Source: PIFSC 2008

Note: “Thresher sharks” and “thresher shark” appear in the above table because NMFS observers are sometimes unable to identify the correct species, and thus catches are on occasion categorized generally as “thresher sharks”.

3.3 Protected Species

The Hawaii-based shallow-set fishery has the potential to interact with a range of protected species. The following sections provide general information on these species. Table 13 presents species listed as endangered or threatened under the ESA that have the potential to interact with the shallow-set fishery. NMFS' Observer Program and this document define an "interaction" to be a hooking or entanglement and categorize condition at release as injured, unknown, or dead.

Table 13: ESA-listed species with the potential to interact with the shallow-set fishery

Species	ESA status
Leatherback turtle	Endangered
Loggerhead turtle	Threatened
Olive ridley turtle	Threatened, except for Mexico's nesting population which is Endangered
Green turtle	Threatened, except for Mexico's Pacific coast nesting population which is Endangered
Hawksbill turtle	Endangered
Hawaiian monk seal	Endangered
Humpback whale	Endangered
Sperm whale	Endangered
Blue whale	Endangered
Fin whale	Endangered
North Pacific right whale	Endangered
Sei whale	Endangered
Short-tailed Albatross	Endangered

3.3.1 Sea Turtles: Description of Affected Populations and Conservation Issues

This section provides a brief summary of information on the biology, status and trends of potentially affected sea turtles and focuses primarily on Pacific populations of leatherback and loggerhead sea turtles, which are most likely to be affected by the proposed action. Information on green, hawksbill, and olive ridley sea turtles is also provided. Much of the enclosed information is from NMFS 2004 and 2005 BiOps (NMFS 2004, 2005) and current NOAA Fishery Service ESA 5-year reviews, with additional information incorporated where appropriate. Table 14 presents information on shallow-set fishery interactions between 2004 and the 1st quarter of 2008.

Table 14: Number of shallow-set fishery/sea turtle interactions, 2004-2008

Species	**2004**	**2005**	**2006**	**2007**	**2008***
Number of sets made:	135	1,645	850	1,497	619
Leatherbacks: released injured	1	8	2	5	1
Loggerheads: released injured	1	12	17	15	0
Olive ridleys: released injured	0	0	0	1	1

Green turtles: released injured	0	0	0	0	1
Hawksbill turtles: released injured	0	0	0	0	0

Source: NMFS PIRO Observer Program
* Includes 2008 Q1 only

This section also describes the Council's sea turtle conservation projects that have been implemented to offset impacts of the Hawaii-based longline fishery on sea turtles and to bolster population recovery. The Council's nesting beach conservation projects are protecting eggs and hatchlings that otherwise would not have survived due to various impacts such as predation and erosion. Moreover, current leatherback nesting beach conservation projects in Papua, Indonesia have been found to be over 10 times more cost effective in producing adult turtles than the Hawaii shallow-set regulations are in protecting adult turtles, and over 100 times more cost effective than the California drift gillnet time area closure is in protecting adult turtles (Gjertsen 2008).

The Council's five conservation projects were identified by the Council's Turtle Advisory Committee (TAC) — an international group of eight sea turtle experts — and are consistent with the U.S. Sea Turtle Recovery Plans (NMFS and USFWS 1998a, NMFS and USFWS 1998b) and implement actions that: 1) reduce turtle and egg harvest; 2) reduce nest predation by domestic and feral animals; 3) protect nests from erosion and human disturbance; 4) collect biological, ecological and reproductive information on populations; 5) monitor population trends; and 6) educate local communities on the value of conserving sea turtles. The existing conservation projects are focused at key turtle habitats, nesting beaches and coastal foraging grounds of Western Pacific leatherback turtles and North Pacific loggerheads due to their population status as well as their potential to interact with the Hawaii-based longline fishery.

3.3.1.1 Leatherback Sea Turtles

General Distribution

Leatherback turtles are widely distributed throughout the oceans of the world. The species is found in four main regions of the world: 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 regional areas may further be 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, Vanuatu, 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, Puerto Rico, and Costa Rica. In the Indian Ocean, leatherback nesting aggregations are reported in India and Sri Lanka.

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 1999). Leatherbacks have the widest distribution of sea turtles, nesting on beaches in the tropics and sub-tropics and foraging into higher-latitude sub-polar waters. They have evolved physiological and anatomical adaptations (Frair et al. 1972, Greer et al. 1973) that allow them to exploit waters far colder than any other sea turtle species would be capable of surviving. In the Pacific, they extend from the waters of British Columbia (McAlpine et al. 2004) and the Gulf of Alaska (Hodge and Wing 2000) to the waters of Chile and South Island (New Zealand), and nesting occurs in both the eastern and western Pacific (Marquez 1990, Gill 1997, Brito M. 1998). Leatherbacks undergo extensive migrations to and from their tropical nesting beaches. In a single year, a leatherback may swim more than 10,000 kilometers (Eckert 1998).

Saba et al. (2007) summarized that satellite tracking studies of post-nesting females at Las Baulas, Costa Rica suggest that the turtles follow a southwestern migration corridor along the Cocos Ridge towards the Galapagos Islands (Morreale et al. 1996, Shillinger et al. 2006), followed by an open migration through the eastern equatorial Pacific, the Chile-Peru Humboldt Current System, and the far off-shore waters of Peru and Chile (Shillinger et al. 2006).

In the western Pacific, satellite telemetry work has demonstrated migrations of leatherbacks nesting in Papua, Indonesia, to the waters of the Philippines and Malaysia, into the Sea of Japan, and across the equatorial Pacific to temperate waters off North America (Benson et al. 2007). The prevailing southward current suggests that the Raja Ampat archipelago is an important migratory corridor and/or inter-nesting habitat for Papuan leatherback breeding populations (Hitipeuw et al. 2007). Leatherbacks from Papua New Guinea beaches headed into the high latitude waters of the southern Pacific (Benson et al. 2007a). The north Pacific foraging grounds have animals from both the eastern and western Pacific rookeries (Dutton et al. 1998, 2000; Dutton 2005, 2006), although leatherbacks from the eastern Pacific generally forage in the southern hemisphere in the waters of Peru and Chile (Dutton 2005, 2006). Four of 14 leatherbacks from the western Pacific have also been reported from Chile (Donoso et al. 2000, Dutton 2005, 2006). Based on stable isotope analysis, Paddock et al. (2007) suggested that leatherbacks nesting in Papua, Indonesia, and Papua New Guinea forage in the western Pacific and the eastern Pacific. Leatherbacks tracked from Monterey Bay, California, moved southwest, and one turtle was tracked across the Pacific to north of Papua, Indonesia (Eckert and Dutton 2001, Dutton et al. 2006).

Size and Identification

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 1998a). The leatherback is morphologically and physiologically distinct from other sea turtles. It has a streamlined body, with a smooth, dermis-sheathed carapace and dorso-longitudinal ridges which 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 1998a), while adult female leatherback turtles nesting in eastern Australia averaged 162 cm CCL (Limpus, et al., 1984, in NMFS and USFWS 1998a). 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 1998a).

Age at Maturity

Recent studies (skeletochronological data based on scleral ossicles) suggest that leatherbacks in the western North Atlantic may not reach maturity until 29 years of age (Avens and Goshe 2007). This new data may contradict earlier leatherback age at maturity estimates. Pritchard and Trebbau (1984) estimated 2-3 years, Rhodin (1985) estimated 3-6 years, Zug and Parham (1996) estimated average maturity at 13-14 years for Western Pacific leatherback females, and Dutton et al. (2005) estimated 12-14 years for leatherbacks nesting in the U.S. Virgin Islands. Age at maturity remains a very important parameter to be confirmed as it has significant implications for management and recovery of leatherback populations.

Survivorship

Reliable estimates of survival or mortality at different life history stages for leatherbacks are not easily obtained. The annual survival rate for leatherbacks that nested at Playa Grande, Costa Rica, was estimated to be 0.654 for 1993-1994 and 0.65 for those that nested in 1994-1995 (Spotila et al. 2000). Rivalan et al. (2005) estimated the mean annual survival rate of leatherbacks in French Guiana to be 0.91. The annual survival rate was approximately 0.893 (confidence interval = 0.87-0.92) for female leatherbacks at St. Croix (Dutton et al. 2005). For the St. Croix, U.S. Virgin Islands, population, the average annual juvenile survival rate was estimated to be approximately 0.63, and the total survival rate from hatchling to first year of reproduction for a female hatchling was estimated to be between 0.004 and 0.02, given assumed age at first reproduction between 9 and 13 (Eguchi et al. 2006). Spotila et al. (1996) estimated survival in the first year to be 0.0625. The longest observed reproductive lifespan of 18 years has been reported from South Africa (Hughes 1996).

Genetics

Current data from genetic research suggest that Pacific leatherback stock structure (natal origins) may vary by region. Due to the fact that leatherback turtles are highly migratory and stocks mix in high seas foraging areas, and based on genetic analyses of samples collected by both Hawaii-based and west coast-based longline observers, leatherback turtles inhabiting the northern and central Pacific Ocean are comprised of individuals originating from nesting assemblages located south of the equator in the western Pacific (e.g., Indonesia, Papua New Guinea, Solomon Islands, and Vanuatu) and in the eastern Pacific along the Americas (e.g., Mexico, Costa Rica) (Dutton et al. 2000).

The declining eastern Pacific genetic population is likely more limited to foraging primarily in the southeastern Pacific. Genetic studies in Chile and Peru (Donoso et al. 2000; P. Dutton, NMFS, unpublished data) and telemetry studies (Morreale et al. 1996, Eckert and Sarti 1997) have indicated that leatherbacks foraging in the southeastern Pacific are primarily from the eastern Pacific nesting population. Shillinger et al. (2006) tracked leatherbacks at Playa Grande, Costa Rica, and found consistencies with earlier studies that suggested a leatherback "migration corridor" along the Cocos Ridge from Las Baulas National Park toward the Galapagos Islands

(Morreale et al. 1996). One of the reasons put forth for the greater collapse of eastern Pacific populations compared to western Pacific populations is the difference in foraging strategies as demonstrated by satellite telemetry work, genetics, and tag returns. The large nesting population in Papua, Indonesia, in the western Pacific uses several foraging areas both near and distant, just like Caribbean populations, whereas eastern Pacific populations have limited foraging areas that occur primarily in the southeastern Pacific (Dutton 2006).

Global Status

The leatherback sea turtle was listed as endangered throughout its global range on June 2, 1970. In 1980, the leatherback population was estimated at approximately 115,000 adult females globally (Pritchard 1982); that number is probably an overestimation as it was based on a particularly good nesting year in 1980 (Pritchard 1996). By 1995, the global population of adult females had declined to 34,500 (Spotila et al.1996). Pritchard (1996) suggested that the population estimates from Spotila et al. (1996) likely underestimated the actual population size as the data modeled in the time series ended with a particularly bad nesting year (1994) while excluding nesting data from 1995, which was a good nesting year. In 2007, NMFS and the USFWS published their five year review of the status of leatherback sea turtles and concluded that the leatherback population should not be delisted or reclassified at this time (NMFS and USFWS 2007).

Some populations are stable or increasing, but other populations for which information is available are either decreasing or have collapsed. For example, a recent population assessment of North Atlantic leatherbacks estimates a stable population of 34,000-94,000 adults, while eastern Pacific and Malasian populations have collapsed (Turtle Expert Working Group 2007; NMFS and USFWS 2007). In addition, there is uncertainty over the status of leatherback turtles in the western Pacific Ocean due to a lack of consistent and long-term monitoring and the challenges associated with working in the region. The available information is not sufficient to determine the status or trend of the leatherback population as a whole.

Populations Exposed to the Hawaii-based Longline Fishery

Based on genetic sampling from leatherback interactions (33 samples from 1995-2007) with the deep-set and shallow-set components of the Hawaii longline fishery 100 percent of the leatherback turtles (18 genetic samples) that interacted with shallow-set fishery originated from western Pacific nesting beaches (L. Smith, NMFS PIRO, pers. comm., July 2008). Although turtles could represent individuals from Indonesia (Jamursba-Medi or Wermon), Papua New Guinea, Malaysia (Terrenganu), the Solomon Islands, or Fiji, the abundance of the nesting aggregations in Indonesia relative to the small size of the other nesting aggregations suggests that the interactions between Indonesian leatherback turtles and the Hawaii-based longline fisheries are the most likely scenario.

One leatherback sample taken from an interaction with the deep-set fishery was found to be that of a leatherback that originated from an eastern Pacific nesting aggregation. This interaction occurred in the deep-set tuna fishery at 14° 48' N, 157° 19' W, which is well south of the area the shallow-set fishery occurs (L. Smith, NMFS PIRO, pers. comm., July 2008). This turtle could have been from a nesting aggregation along the coast of Mexico, Costa Rica, or Panama and research has suggested that turtles from these nesting aggregations may occur outside their normal range when oceanic phenomena like El Niño events prevent them from migrating south to the coasts of Peru and Chile. Several investigators who have followed leatherback turtles equipped with satellite tags have reported that leatherback turtles from the beaches of Mexico and Costa Rica migrate through the equatorial current towards the coasts of Peru and Chile (Eckert 1997; Marquez and Villanueva 1993; Morreale et al. 1994). Eckert (1997) suggested that EPO leatherback turtles migrate toward the coast of South America where upwelling water masses provide an abundance of prey.

3.3.1.1.1 Leatherbacks of the Western Pacific

Leatherback turtles originating from the western Pacific are threatened by poaching of eggs, killing of nesting females, human encroachment on nesting beaches (development, beach armoring, beachfront lighting, etc.), incidental capture in fishing gear, beach erosion, and egg predation by animals. A documented traditional harvest of leatherbacks occurs in the Kei Islands (Suarez and Starbird 1996, Lawalata et al. 2006). Low hatching success is characteristic of leatherbacks despite high fertility rates (reviewed in Bell et al. 2003), and low hatchling production has been confirmed by current research in Papua (Hitipeuw et al. 2007, Tapilatu and Tiwari 2007).

While there used to be a paucity of information regarding the Western Pacific population, over the past few years significant new information has been acquired about the leatherback nesting population (Dutton et al. 2007; Benson et al. 2007; Hitipeuw et al. 2007; Kinan 2005). There is some evidence, including anecdotal information, suggesting that although there are indications of a long-term decline, this population has not been depleted to the extent found at other major rookeries in the Pacific (Hitipeuw et al. 2007).

Research has been conducted in the last several years to more thoroughly identify leatherback nesting beaches and estimate numbers of nesting animals in the western Pacific (Papua Indonesia, Papua New Guinea, Solomon Islands, and Vanuatu). At the *Western Pacific Sea Turtle Cooperative Research and Management Workshop* sponsored by the Council from May 17 -21, 2004, regional experts identified a total of 28 leatherback nesting sites for the western Pacific region, of which 21 were previously unknown or poorly documented (Dutton et al. 2007; Kinan, 2005). Leatherback turtle nesting among these 28 sites was estimated to be between 2,100–5,700 females nesting annually (Dutton et al., 2007). Dutton et al. (2007) and the Bellagio Blueprint (Worldfish 2004) highlight the need for continued nesting beach monitoring and protection at key leatherback turtle nesting sites in the western Pacific.

There has been uncertainty over the status of leatherback turtles in the western Pacific Ocean due to a lack of consistent and long-term monitoring and the challenges associated with working in the region. The global population assessment by Spotila et al. (1996) estimated the total nesting abundance of leatherbacks in the western Pacific at 700 females nesting annually. However, this is certainly an underestimate given that current published information (Dutton et al. 2007) identified 28 nesting sites, 21 of which had never previously been identified, that were not included in Spotila's estimate. Dutton et al. (2007) estimates an approximate total of 5,000–9,100 leatherback nests are laid each by 2,700- 5,100 females per year among 28 identified beaches in the western Pacific, with approximately 75% of this nesting activity concentrated at four sites along the northwest coast (Bird's Head Peninsula) of Papua, Indonesia.

Using the methods by Spotila et al. (1996), Dutton et al. (2007) estimates a total of 1,113 females nesting annually (FNA) in the western Pacific region. This number might be larger, because there are still areas where undocumented nesting occurs throughout the Island of New Guinea and beyond, such as in Thailand and Vietnam. Use of these new estimates produces a regional population estimate of 2,782 breeding females in the western Pacific by applying the same simplified methods used by Spotila et al. (1996) (multiplying FNA by 2.5 which is the average female remigration interval). This is likely a conservative estimate and depends on the assumption that the average number of nests laid per female is five (Spotila et al. 1996). Five nests per female is used to estimate the number of FNA from nest counts (total nest count/5 ~ FNA). If leatherbacks lay fewer nests on average then the estimated number of females derived from the nest counts will be greater and vice versa, so that estimates would range from 2,700–5,100 females based on estimates ranging from ca. 840-3,200 (Dutton et al. 2008).

Malaysia

The catastrophic decline of the rookery at Terengganu, Malaysia is well documented (Chan and Liew 1996). The leatherback turtle population plummeted from over 3,000 nesters per year in the late 1960s to less than 20 per year by 1993. In the last decade, only two or three leatherbacks nested each year (Liew 2002), with much of this decline attributed to systematic overharvest of eggs (Chan and Liew 1996).

Indonesia

The north Vogelkop coast (also known as Bird's Head Peninsula) in Papua, Indonesia is thought to support the largest leatherback nesting population in the Pacific (Hitipeuw et al. 2007). Jamursba-Medi is the principal known nesting site for leatherbacks on Papua, and is comprised of 3 black sand beaches (Wembrak, Warmamedi, and Batu Rumah) that together span 18 km of coastline. A second nesting site is located at Wermon, which consists of a 6-km beach about 30 km east of Jamursba-Medi and halfway between Welos Cape and Wau Village.

The rookery at Jamursba-Medi currently supports ca. 300–900 nesting females annually compared with about 1,000–3,000 before 1985 (not including nesting at Wermon) (Hitipeuw et al. 2007). Hitipuew et al. (2007) recorded 1,865–3,601 nests each season at Jamursba-Medi (compared to 13,000 nests recorded in 1984 by Bhaskar (1985) and as shown in Table 15), and 1,788–2,881 nests at Wermon laid between November 2002 and August 2004. There appears to be a declining trend since 1993 for the Jamursba-Medi nesting population (Table 15). Hitipuew et al. (2007) warn that previous population estimates should be interpreted with caution, because it is clear that Wermon is a sizable rookery that has been overlooked in the past, with as many nests laid on Wermon as on Jamursba-Medi in 2003–2004. It is unclear whether this represents a recent demographic shift or if there has always been this level of nesting on Wermon. Studies are ongoing to determine whether the Papuan leatherbacks consist of two demographically distinct nesting populations (i.e., one that nests primarily between October and March at Wermon, and another that nests at Jamursba-Medi between April and October).

Table 15: Number of nests recorded at Jumursba-Medi, Papua, Indonesia from 1981-2004

Survey Period	Nests no.	Adjusted no. nests	No. estimated females[a]	Reference
Sept 1981	4000+	7143	1232–1623	Salm 1982
Apr-Oct 1984	13,360	13,360	2303–3036	Bhaskar 1985
Apr-Oct 1985	3000	3000	517–682	Bhaskar 1987
June-Sept 1993	3247	4091	705–930	J. Bakarbessy unpubl. data
June-Sept 1994	3298	4155	716–944	J. Bakarbessy unpubl. data
June-Sept 1995	3382	4228	729–961	J. Bakarbessy unpubl. data
Jun-Sept 1996	5058	6373	1099–1448	J. Bakarbessy unpubl. data
May-Aug 1997	4001	4481	773–1018	Lamuasa unpubl. data
May-Sept 1999	2983	3251	560–739	Teguh unpubl. data
Apr-Dec 2000	2264	2194	378–499	KSDA-YAL, unpubl. data
Apr-Oct 2001	3056	3056	527–695	Wamafma unpubl. data
Mar-Aug 2002	1865	1921	331–437	World Wildlife Fund 2003
Mar-Nov 2003	3601	2904	501–660	World Wildlife Fund 2003
Mar-Aug 2004	3183	3871	667–879	World Wildlife Fund 2003

[a] Number of females were estimated by dividing number of estimated nests by average number of nests/female reported by Dutton et al. (2000) (5.8 nests/female) and Sarti et al. (2000) (4.4 nests/female).

Betz and Welch (1992) reported large-scale egg harvest during the 1980s as the main reason for this decline. Commercial exploitation of eggs at Jamursba-Medi Beach was relatively intense for many years, with eggs being harvested largely by fishermen from adjacent districts (Sorong, Manokwari, Biak, and North Maluku). For example, in 1984 and 1985, 4 to 5 boats were observed visiting the beach weekly and returning with 10,000–15,000 eggs per boat (Betz and Welch 1992). During the peak nesting season, the beaches would become crowded with temporary dwellings that housed egg collectors and traders. Commercial egg harvest has been effectively eliminated since beach monitoring was established in 1993.

Additionally, information on leatherback nesting is lacking for a large area of coastline stretching from Jamursaba-Medi to the border with Papua New Guinea (Dutton et al. 2007). Low density nesting is also believed to occur along western Sumatra (200 females nesting annually) and in southeastern Java (50 females nesting annually), although the last known information for these beaches is from the early 1980s (*in* Suarez and Starbird 1996, Dermawan 2002).

Papua New Guinea

The Huon Coast of the Morobe Province in Papua New Guinea (PNG) hosts 50% of leatherback nesting activity in PNG (Benson et al. 2007), and is among the largest population in the western Pacific, second only to West Papua, Indonesia (Dutton et al. 2007). The estimates of total nests laid annually at all the sites in the Huon Gulf range from 500 to 1,150 (Dutton et al. 2007). This range reflects the annual variability in nests and is based on preliminary data from 3 years of aerial surveys (S.R. Benson and V. Rei, unpubl. data, in Dutton et al. 2007). However, anecdotal information from Huon Coast villagers and nesting beach surveys undertaken in the 1980s (Hirth et al. 1993; Quinn et al.1983; 1985; Bedding and Lockhart 1989) indicates a decline in leatherback nesting females over the past 20-30 years when compared with present nesting levels

(Benson et al. 2007, Pilcher 2006). The nesting trends of leatherbacks along the Huon Coast are represented in Figure 15.

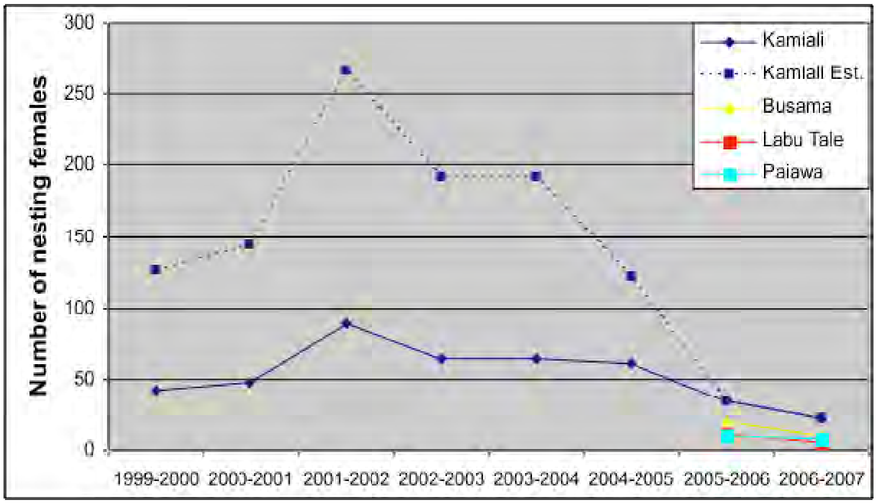

Figure 15: Trend in number of nesting adults along the Huon Coast, PNG, 1999-2007
Note: Historical data only exists for Kamiali and for one additional season only at Busama, Labu Tale and Paiawa). Source: Pilcher, 2007

The first attempts to quantify leatherback nesting activity along the Huon Coast occurred in the Labu Tale and Busama village areas near the mouth of the Buang River in the early 1980s (identified as the Maus Buang site in subsequent literature). The approximate area surveyed during these initial investigations ranged from 725 meters (Hirth et al. 1993) to approximately 1-2 km (Quinn et al. 1983; 1985; Bedding and Lockhart, 1989). These surveys resulted in population estimates of 1,200 to 300 females per year (Quinn et al.1983; Bedding and Lockhart, 1989).

In January 2004, aerial surveys of 2,800 km of coastline in north PNG and New Britain Island were completed. A total of 415 nests were located, of which 71% were found within the Huon Gulf region. Within the Huon Gulf region only 29 percent of nests were located in areas other than the two nesting beaches of Kamiali and Maus Bang (also known as Baung Buassi). After applying a correction factor based on missed nests identified from beach walk surveys, the total estimate was 559 nests (Benson et al. 2007).

The Huon Coast Leatherback Turtle Conservation Project (HCLTCP) began at the Kamiali Wildlife Management Area (KWMA) in November 2003 and by late 2005 expanded to incorporate three additional communities of Labu Tale, Busama and Paiawa which were identified via aerial surveys (Benson et al. 2007), historical accounts (such as Hirth et al.1993), and community leaders to have observed significant leatherback nesting. During the 2006/07 nesting season, three additional communities of Sapa, Kobo and Salus were incorporated into the project. The HCLTCP project sites are located 20 to 60 km southeast of Lae, PNG, and in total (as of the 2006/07 nesting season) results in approximately 20 km of monitored (or protected) beach. Project expansion from one site to seven has been made possible by funding from the Council through partnerships with PNG Department of Environment and Conservation, and the Village Development Trust and MAREMCO (two locally based NGOs).

Primary threats to leatherback turtle survival and recovery in PNG are from direct harvest, predation and beach erosion (Pilcher, 2006 and 2007). Significant nest-loss occurs through beach erosion and wave inundation (up to 100% loss in some locations); egg collection by villagers in areas outside the HCLTCP monitoring zones or project sites; continued harvest and/or killing of adult turtles; and high instances of dog depredation (up to 80% of unprotected nest). Given their critical status, maximizing hatchling production is seen as most vital to the welfare of leatherback turtles in PNG.

Leatherback turtles have been consumed to some extent in different areas of Madang, Morobe, Manus, East Sepik, East New Britain, Milne Bay and Central Provinces (Pritchard 1979; Spring 1982; Lockhart 1989). In some areas, they were part of the subsistence diet or were utilized in extending social relationships through trade, but in general it appears the consumption of leatherback turtles was not widely practiced because their oily flesh is considered unpalatable (Quinn et al. 1985, Pritchard 1979), although direct harvest does occur[12].

Egg harvesting is still widely practiced. Harvest is perpetuated partly because beaches along the Huon Coast are used as pathways for local people that go to and from their gardens or to visit neighboring residential areas, and because local fishers use the beaches at night to catch fish. Turtle eggs are either consumed immediately or distributed through clan and kin networks, or sold at market to generate income for things such as school fees, medical expenses, or church commitments (Hirth et al. 1993, Spring 1982). In historical periods, egg exploitation along the Huon Coast would have likely had a reduced impact on the leatherback turtle populations, as the villages were small and scattered, with little access to markets. After World War II, egg exploitation increased, with leatherback turtle eggs changing from a protein supplement to a commercialized commodity, and it has been suggested that all turtle eggs laid along sections of the Huon Coast were taken soon after laying (Quinn et al. 1983, Bedding and Lockhart 1989, Work 2002). For example, Quinn et al. (1983) witnessed the harvest of all nests laid during their survey period. It is entirely possible that the leatherback population in PNG has experienced near total egg loss for some 40+ years.

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[12] Along the Morobe coast, 3 leatherbacks were reportedly killed at Kobo in 2003; Ewa village, south of Kobo, killed at least 2 leatherbacks in 2005-06; Sapa village documented 17 adults killed from 2001 to 2005; 2 leatherbacks were taken in Maiama, 1 each in Salus and Busama in 2006 (Kinch, 2006; Kinch, pers. comm.; Krueger, pers. comm.). At Paiawa, people regularly killed and smoked leatherback turtle meat to trade with mountain peoples residing in the interior for pig meat (Kinch 2006).

Only in recent years has the loss of eggs been curtailed in some locations due to the presence of the HCLTCP. Participating communities of the HCLTCP agree to abide by an egg and turtle harvest moratorium. This is consistent with PNG wildlife law and policy for leatherback turtle resources. Monthly market surveys undertaken by the PNG Coastal Fisheries Management and Development Program (NFA 2006) and a recent WWF survey of the Eye Grease Market (Kinch et al. 2007) confirm that no turtle eggs are being openly sold in Lae.

During the 2004-05 nesting season, approximately 40% of nests and at the KWMA were lost to erosion (Kisakau 2005). At Paiawa all (28) nests laid were washed away during the 2005-06 season, and erosion continues to be an issue (Pilcher 2006). During a 25km beach survey undertaken on January 20-23, 2006 from Labu Tale to Busama, many of the 181 nests observed had been washed over in several locations and considerable flotsam covered nests, suggesting periodic inundation (Kinch 2006).

Predation by feral and domestic dogs (*Canis familiaris*) has been documented and characterized as a 'great threat' to hatchlings and nests laid along the Huon Coast (Kisakau 2005; Pilcher 2006). Dog predation occurs as the hatchlings are digging to the surface (two to three days after initial hatching as hatchlings are digging to the surface, but not after oviposition or during incubation). A high level of depredation by dogs (~ 80%), was observed and reported for nests during the 2005-2006 season at KWMA (C. Naru pers. comm.; Pilcher 2006), and one report suggests that nearly 100% of all nests were lost during the 2004-2005 season (Ambio, pers. comm.). Crocodiles (*Crocodilus porosus*) have also been documented to occasionally kill leatherback turtles as they emerge to nest (Rei 2005; Hirth et al.1993; Quinn et al.1983).

Nest and hatchling protection measures were developed in January 2006 by HCLTCP staff which involved the construction and deployment of locally-made bamboo grids. This was the first time dogs were prevented from causing hatchling loss. Grids were placed over many of the nests within the KWMA monitoring zone to reduce village and feral dog predation; however, outside of the monitoring zone where the grids were not deployed nest loss was still in the region of 80% (C. Naru, pers. comm.). Although grids were not used as comprehensively as might have been possible, they proved effective at combating dog depredation. As of the 2006/07 nesting season, grids were used on nearly every nest, within the zones monitored by the seven communities (approximately 236 nests; Pilcher 2007), and will be used during future seasons across a wider spatial range.

Solomon Islands

In the Solomon Islands, the rookery size is estimated to be on the order of 100s of females nesting per year (Dutton et al. 2007). Past studies have identified four important nesting beaches in Isabel Province: Sasakolo, Lithoghahira, Lilika, and Katova. Harvest of adults and eggs by humans has been reported and may continue in some areas (MacKay 2005). In addition, lizards and iguanas have been documented predating on leatherback eggs (Rahomia et al. 2001).

Vanuatu

Leatherbacks are known throughout many islands of Vanuatu. Residents of a number of different islands, from Espirito Santo in the north through Ambae, Aneityum and Efate, to Tanna in the South, indicate that there were formerly at least small nesting populations of leatherbacks on these islands, with most recent nesting in Epi and Malekula (Petro 2005). Nesting events on these islands have significantly declined since the 1980s in response to increasing human population growth and subsistence pressure on nesting females and eggs (Petro et al. 2007). This reduction in leatherback nesting areas is the same trend observed with all species of turtles in Vanuatu, with more remote areas still supporting turtle nesting but needing to be thoroughly surveyed.

A nesting beach survey at Votlo, Southern Epi between November 2003 and February 2004 resulted in counts of 31 nests and 9 tagged leatherbacks. Overall, Epi Island appears to have the largest number of nests, with two nesting areas with southwesterly exposed coasts probably having 20-30 annually nesting females (Petro 2005).

Fiji

In Fiji, leatherbacks are uncommon, although there are recorded sightings and 4 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).

Australia

In Australia, leatherback nesting is sporadic, less than five per year, generally outside of Great Barrier Reef in southeast Queensland (Dobbs 2002). In eastern Australia a small nesting site identified in the 1970s is reportedly close to extirpation as no nesting has been recorded since 1996 (Hamann et al. 2006). Human related threats include incidental capture in fisheries and ingestion and entanglement in marine debris (Dobbs 2002).

3.3.1.1.2 Leatherbacks of the Eastern Pacific

Leatherback nesting populations have declined along the Pacific coast of Mexico and Costa Rica. Spotila et al. (2000) estimated that there were 1,690 adult female leatherbacks in the eastern Pacific. Since that time, trends in the major nesting beaches have continued to decline. Three countries which are important to leatherbacks nesting in the eastern Pacific include Costa Rica, which has the highest abundance and density in this area, Mexico, with several important nesting beaches, and Nicaragua, with two important nesting areas. Leatherbacks have been documented nesting as far north as Baja California Sur and as far south as Panama (Sarti 2002).

Mexico

Proyecto Laúd coordinates the conservation activities for the leatherback turtle on four index beaches of the Mexican Pacific - Mexiquillo, Tierra Colorada, Cahuitán, and Barra de la Cruz. Daily nesting track counts done from 1982 to 2004 showed a declining trend for the number of leatherback nests on these four index beaches (Sarti Martinez et al. 2007; Figure 16). The worst nesting season was 2002–2003, in which only 20 leatherback nests were recorded on the index beaches combined. There was a slight increase in nesting activity during the 2005-06 season with 173 nesters, this is still quite low but optimistic - the status of leatherbacks in Mexico is dire but not hopeless. The decline is attributed to a combination of extensive egg harvest on all Mexican Pacific beaches before conservation activities and high mortality of large adults in pelagic fisheries.

A total of 5,314 females have been individually identified since 1982; the average remigration interval is 3 years, and there is evidence of interchange of females between some beaches (Sarti Martinez et al. 2007). The female population has an average curved carapace length of 143.8 cm and an average clutch size of 62 eggs. The average estimated clutch frequency is 5.5 ± 1.9, with an average clutch interval of 9.7 ± 1.2 days. From 1982 to 2004 a total of 270,129 leatherback hatchlings were released to the wild population. This comparatively small number was likely not enough to offset the mortality of juveniles and adults offshore. This may explain the continuing population decline in spite of 20 years of protection activities. Currently, hope for the future of the population relies on the protection of at least 80% of the clutches laid on the priority beaches, the participation of local communities in conservation activities, and increased awareness of the leatherback's status among Mexican society.

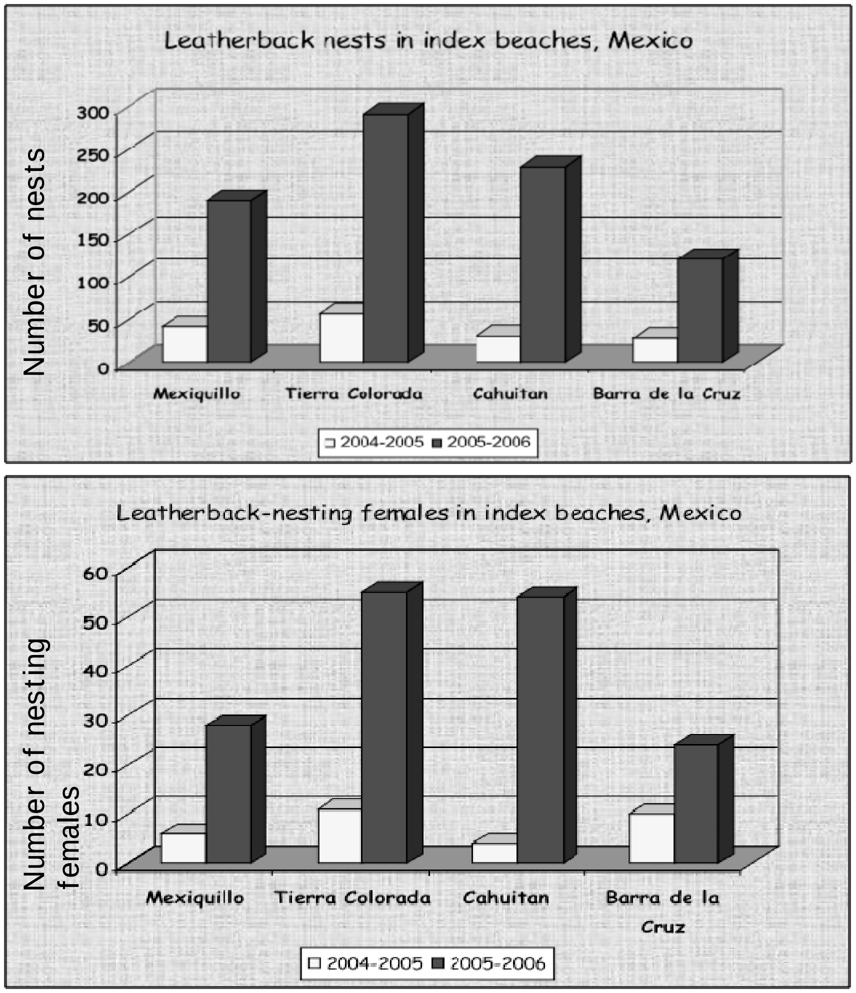

Figure 16: East Pacific leatherback nesting data for the 2005 – 2006 season in Mexico
Source: Sarti et al. 2007

Costa Rica

During the 1980s researchers realized that the beaches of Playa Grande, Playa Ventanas and Playa Langosta collectively hosted the largest remaining Pacific leatherback populations in Costa Rica. Since 1988, leatherback turtles have been studied at Playa Grande (in Las Baulas), the fourth largest leatherback nesting colony in the world. 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 (Figure 17; Spotila et al. 2000). The 2003/2004 nesting season showed an increase in nesting abundance from the previous two seasons. An estimated 159 females nested at Playa Grande in 2003/2004 up from 69 and 55 in 2001/2002 and 2002/2003. Scientists speculate that the low turnout during 2002-03 may have been due to the "better than expected season in 2000-01 (397 nesting females) which temporarily depleted the reproductive pool of adult females in reproductive condition following the El Niño /La Niña transition" (R. Reina, Drexel University, personal communication, September, 2003). In 2004/2005 nesting fluctuated down to 49 nesting females - the lowest on record, but then up to 109 during the 2005/2006 season.

Researchers began tagging females at Playa Grande in 1994. Since then, tagged leatherbacks have had a low return rate - 16% and 25% in the five or six years following tagging. Spotila et al. (2000) calculated a mean annual mortality rate of 35% for leatherbacks nesting at Las Baulas. At the St. Croix, U.S. Virgin Islands nesting grounds, female leatherbacks returned approximately 60% over the same period (McDonald and Dutton 1996 *in* Reina et al. 2002) indicative of mean annual mortality rates from 4-10% (Dutton et al. 1999 *in* Reina et al. 2002). Thus, comparatively few leatherback turtles are returning to nest on east Pacific nesting beaches and it is likely that eastern Pacific leatherback turtles are experiencing abnormally high mortalities during nonnesting years.

Since 1993, environmental education and conservation efforts through active law enforcement have greatly reduced egg poaching in Costa Rica (Chaves et al. 1996). During the 1993-94 nesting season, poaching accounted for a loss of only 1.3% 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). Bell et al. (2003) found that while leatherbacks at Playa Grande had a high rate of fertility (mean = 93.3% ± 2.5%), embryonic death was the main cause of low hatchling success in this population. 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 (Bell et al. 2003).

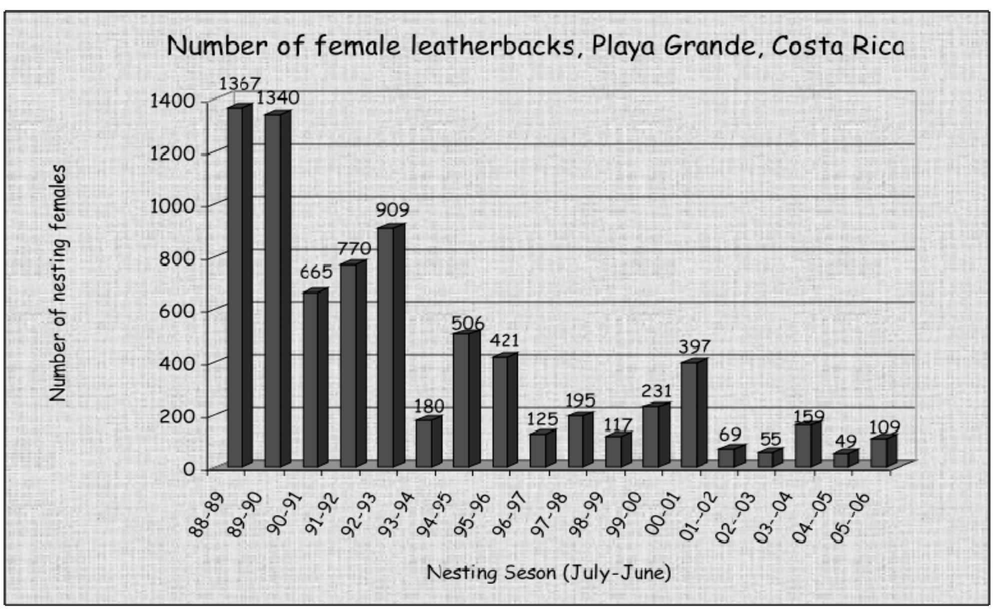

Figure 17: Nesting trends of leatherback turtles in Costa Rica
Source: Spotila et al. unpublished data in Hall et al. 2007

3.3.1.1.3 Council's Leatherback Conservation Projects

Wermon Beach, Papua Indonesia – Nesting Beach Management

The Council has contracted with the World Wildlife Fund-Indonesia (WWF-Indo) since November 2003 to hire village rangers to protect the Wermon nesting beach at Jamursba-Medi, Bird's Head Peninsula in Papua Indonesia. This project builds on the existing program established by WWF-Indo since 1990 at the Jamursba-Medi beach, the largest known leatherback nesting site in Indonesia and in the western Pacific region. Prior to project implementation, disturbance was unchecked at Wermon: poaching affected more than 60% of all nests and pig predation impacted the remaining nests (Starbird and Suarez 1994; NMFS 2005). To date, WWF-Indo has achieved great success in eliciting the enthusiastic support and involvement of local people and the Indonesian government. In December 2005, 26 million hectares comprised of 126,499 km of beaches (including Jamursba Medi and Wermon) were designated as a local marine protected area or MPA (ABUN MPA decree No. 142/2005).

This project monitors and protects one third of the known leatherback nesting beach habitat along the north coast of Papua Indonesia and results in the protection of leatherback nests from predation by feral pigs, beach erosion and egg collectors. Protection is achieved through nightly beach patrols and electric fences to keep pigs off beaches, by relocating eggs to more secure areas, and deterring poachers through monitoring presence. Standardized techniques for data recording is applied with community-based beach rangers employed to patrol nightly, PIT tag nesting females and record nesting data (including impacts: predation and inundation).

Prior to implementation of the Council-funded Wermon conservation project, egg harvest and predation were considerable threats (Hitipeuw et al. 2007; Starbird and Suarez 1994; Suarez et al. 2000). As documented by Starbird and Suarez (1994), poaching at unprotected Wermon Beach exceeded 60% and pig predation impacted the remaining 40%. With the establishment of the year round monitoring project in 2003/04, coastal patrols are currently being conducted to prevent disturbance and exploitation of the beach, with an average over the past 4 field season of approximately 70% of nests laid conserved (2003/04 through 2006/07 nesting seasons; see Table 16).

To date, impacts from predation have been significantly reduced (by 90%), and through the process of implementing this program it has been realized that the beach is of far greater importance than previously assumed. It has become an excellent new research platform for Western Pacific leatherbacks, including aerial surveys, genetic sampling, hatching success, and nest relocation studies. Approximately 5,226 nests and 169,942 hatchlings have been conserved by this project (Table 16).

Table 16: Summary of conservation activities at Wermon beach, 2004-2007

Year	Nests laid	Nests conserved	Estimated eggs conserved	Estimated hatchlings produced
2003 (baseline)	1,788	NA	NA	NA
2004	2,881	2,039	154,964	72,833
2005	2,080	1,160	88,160	41,452
2006	1,346	1,198	91,048	42,792
2007	1,052	829	63,004	29,611
Total1	7,359 (baseline not included)	5,226	397,176	18,667

1 not including 2003 baseline numbers
2 Estimated by 76 eggs per clutch and 47% hatching success rate ((Tapilatu and Tiwari 2008))
NA = not applicable
Source: WWF project reports to WPRFMC 2004-2007

It is generally reported that 1 egg out of 1000 eggs will survive to become an adult sea turtle[13] (see Appendix IV). Based on this simple model, this conservation project is estimated to produce approximately 397 adult leatherback turtles in the future. Note that prior to implementation of this project, nearly 100% of all eggs laid at Wermon beach were thought to have been lost to depredation, direct harvest, or inundation. A recent economic analysis of three leatherback conservation strategies found that activities to recruit hatchlings at nesting beaches are not only effective in producing adult turtles, but may also be substantially less costly per adult turtle generated than certain fisheries regulations and closures to mitigate bycatch (Gjertsen 2008). In the analysis, Gjertsen compared current conservation activities at Jamursba-Medi and Wermon nesting beaches in Indonesia with the Hawaii shallow-set longline regulations and California drift gillnet time area closure. The results indicated that activities at nesting beaches are over 10 times more cost effective per turtle than the shallow-set regulations and over 100 times more cost effective per turtle than the drift gillnet closure (Gjertsen 2008).

Kei Islands, Western Papua Indonesia – Coastal Harvest Reduction
The Council has contracted with WWF-Indo since November 2003 to provide information, education and outreach, and work with local villagers to reduce direct harvest pressure of leatherback turtles in the coastal foraging habitats of Kei Kecil Islands of western Papua, Indonesia. In 2007, WWF-Indo transferred management of the project to the locally-based NGO, SIRaN. The Council now contracts with SIRaN as a subcontract through the Marine Research Foundation to implement the project.

[13] http://www.greatturtlerace.org/2008/greatturtleschool.php, accessed July 2008

Leatherback turtles (*Tabob*) have been traditionally hunted for generations in Kei Kecil Islands for both subsistence and ritual purposes. The capture level was estimated to be approximately 100 leatherbacks per season (Suarez 1999), but recent monitoring has identified that about 45 individuals are harvested per year (Kinan 2006). However, the critical endangered status of, and the multi-dimensional threats to, Pacific leatherbacks requires that efforts continue to ease this impact.

The traditional practice of harvesting leatherback turtles is of high socio-cultural value to indigenous people of the Kei Islands. These practices reflect the vital linkage of people to land/water, reinforce spiritual beliefs that govern their existence and responsibility to their natural resources, and serve as a tool for passing on the socio-cultural knowledge to future generations. Accordingly, sustainable resource management (including conservation) needs to consider both the social and cultural aspects of local communities. This project strives to operate within the socio-cultural and economic perspectives of the local community, as well as Indonesian law that preserve indigenous harvest rights, relating to leatherback turtles to determine the best approach for conservation and adaptation of the local customary institutional frameworks.

This project began by first studying and quantifying the parameters associated with leatherback hunting to establish a harvest baseline and to investigate option means of livelihood to support sustained management over time. To date, a greater understanding of the socio-cultural issues associated with local harvest has been achieved. The harvest rate is not as significant as previously believed, suggested by Suares (1999) to be 100 turtles/yr. Findings from this project estimate that approximately 45 turtles/yr are harvested (Table 17). In 2007, the project began an in-water monitoring and sightings network to identify leatherback turtle abundance in the region to help better address localized impacts.

Table 17: Summary of leatherback turtle harvest observed in Kei Kecil, Papua, Indonesia 2003-2006

Year	Harvest/yr	Conservation activities
Baseline	100 (estimate by: Suares, 1999)	NA
2003/04 (yr 1)	29	Education & outreach, community meetings
2004/05 (yr 2)	44	Education & outreach, community meetings
2005/06 (yr 3)	30	Education & outreach, community meetings, soccer tournament implemented (to engage local community in alternative option activity)
2006/07 (yr 4)	58	Education & outreach, community meetings, alternative activities implemented, turtle sighting network established.

Huon Coast, Papua New Guinea – Nesting Beach Management

The Huon Coast Leatherback Turtle Conservation Project (HCLTCP) began at the Kamiali Wildlife Management Area (KWMA) in November 2003 and by late 2005 expanded to incorporate three additional communities of Labu Tale, Busama and Paiawa which were identified via aerial surveys (Benson et al. 2007), historical accounts (such as Hirth et al.1993), and community leaders to have significant leatherback nesting. During the 2006/07 nesting season, three additional communities of Sapa, Kobo and Salus were incorporated into the project. The HCLTCP project sites are located 20 to 60 km southeast of Lae, PNG, and in total results in approximately 20 km of monitored (or protected) beach. Project expansion from one site to seven has been made possible by funding from the WPRFMC through partnerships with PNG Department of Environment and Conservation and the Village Development Trust (a locally based NGO). The Marine Research Foundation provides scientific and management oversight and anthropological consultancy is provided by the University of Papua New Guinea.

The Huon Coast hosts 50% of leatherback nesting activity in PNG (Benson et al. 2007), and is among the largest population in the western Pacific, second only to Papua, Indonesia (Dutton et al. 2007). Primary threats to leatherback turtle survival and recovery results from direct harvest, predation and beach erosion. Significant nest-loss occurs through beach erosion and wave inundation (up to 100% loss in some locations); egg collection by villagers in areas outside the HCLTCP monitoring zones or project sites; continued harvest and/or killing of adult turtles; and high instances of dog depredation (up to 80% of unprotected nest). Given their critical status, maximizing hatchling production is seen as most vital to the welfare of leatherback turtles in PNG.

The HCLTCP employs a community-based approach, similar to other turtle conservation projects (Marcovaldi and Marcovaldi 1999, Troeng and Rankin 2005; Hitipeuw et al. 2007) which involve local communities in monitoring activities and beach management / conservation initiatives. Staff duties are geared to reduce nesting beach impacts and to optimize hatchling production. Specifically, the objectives of the HCLTCP staff are to monitor nesting activities of leatherback turtles, to implement beach management measures (such as bamboo grids) to maximize hatchling production, to increase local awareness and understanding of sea turtle conservation issues, and to share knowledge with other communities to promote sustainable management of leatherback resources.

Over the past two years there has been conscious effort to change local perceptions and overall program focus from “tagging turtles” to “protecting nests.” Past research and monitoring efforts (prior to 2003) focused almost entirely on tagging turtles, and thus only this information was transferred to local monitors. However, tagging will not conserve or recover the species. To preserve sea turtles, one must ensure that nests hatch and hatchlings reach the water. The HCLTCP strives to provide local villagers with more appropriate skills and knowledge to influence leatherback conservation. Overall, poaching and dog predation has been reduced at beaches of participating communities and hatchling production has increased.

Communities that participate in the HCLTCP agree to an egg and turtle harvest moratorium. This is consistent with PNG national wildlife legislation which prohibits harvest of leatherback turtles and their eggs. The size of the moratorium has been variable over time, beginning within the KWMA during the 2002/03 season of 0.5 km of beach and then expanding: 2 km in 2004, 3 km in 2005, and 10 km (full scope of the beach) in 2006. As of the 2006/07 field season the seven participating communities also agreed to the egg harvest moratorium resulting in approximately 20km of protected beach throughout the Huon Coast. Additionally, as of the 2006 Monthly market surveys undertaken by the PNG Coastal Fisheries Management and Development Program (NFA 2006) and a recent WWF survey of the Eye Grease Market (Kinch et al. 2007), confirm that no turtle eggs are being openly sold in Lae. Nesting beach trends for Kamiali are provided in Table 18.

Table 18: Kamiali WMA nesting beach trends

Year / monitored beach size KWMA	**# Female turtles KWMA (# at other sites)**	**Nests laid KWMA (# at other sites)**	**Conservation**
2002/03 (baseline)	64	?	0.5 km egg harvest moratorium
2003/04 - 2 km	64	?	2 km egg harvest moratorium
2004/05 - 3 km	75	197	3 km egg harvest moratorium
2005/06 - 3 km	34 (114) [a]	139 (237) [a]	7,000 eggs [b *] (12,000 eggs)[a]
2006/07 - 3 km	N/A	59 (236) [c]	3,000 eggs[*] (12,000 eggs)[c] 20 km of beach protected

[a] Includes three additional sites: Busama, Labu Tale and Paiawa (7 km estimated beach monitored)
[b] First year that beach mitigation (bamboo grids) implemented to address dog predation
[c] Seven total sites: KWMA, Busama, Labu Tale, Paiawa, Sapa, Kobo and Salus
[*] Estimated by 101 eggs per clutch (Pilcher 2007) and 50% hatching success rate (Bell et al. 2003)
Source: Dr. N. Pilcher, Marine Research Foundation, project report to WPRFMC, December 2007

Beaches along the Huon Coast have deep-water approaches reaching surf and shore-lines. This subjects the narrow nesting beaches to seasonal or storm-related erosion and deposition (accretion) cycles, which leads to nest loss when portions of the beach succumb to changes in current direction or velocity (Benson et al. 2007). Rivers frequently breach at different times of the year and at different sites depending upon the level of rainfall. Leatherback turtle nests located close to the banks of these rivers and other natural drainage systems are exposed and have been destroyed during high tides and heavy rainfall (Pritchard 1971, Quinn et al. 1983).

During the 2004-05 nesting season, approximately 40% of nests and at the KWMA were lost to erosion (Kisokau 2005). At Paiawa all (28) nests laid were washed away during the 2005-06 season, and erosion continues to be an issue (Pilcher 2006). During a 25 km beach survey undertaken January 20-23, 2006 from Labu Tale to Busama, many of the 181 nests observed had been washed over in several locations and considerable flotsam covered nests, suggesting periodic inundation (Kinch 2006).

Predation by feral and domestic dogs (*Canis familaris*) has been documented and characterized as a 'great threat' to hatchlings and nests laid along the Huon Coast (Kisokau 2005; Pilcher 2006). Dog predation occurs as the hatchlings are digging to the surface (two to three days after initial hatching as hatchlings are digging to the surface, but not after oviposition or during incubation). A high level of depredation by dogs (circa 80%), was observed and reported for nests during the 2005-2006 season at KWMA (C. Naru pers. comm.; Pilcher 2006), and one report suggests that nearly 100% of all nests were lost during the 2004-2005 season (Ambio, pers. comm.). Crocodiles (*Crocodilus porosus*) have also been documented to occasionally kill leatherback turtles as they emerge to nest (Rei, 2005; Hirth et al. 1993; Quinn et al. 1983).

Nest and hatchling protection measures were developed in January 2006 by HCLTCP staff which involved the construction and deployment of locally-made bamboo grids. This was the first time dogs were prevented from causing hatchling loss. Grids were placed over many of the nests within the KWMA monitoring zone to reduce village and feral dog predation; however, outside of the monitoring zone where the grids were not deployed nest loss was still in the region of 80% (C. Naru, pers. comm.). Although grids were not used as comprehensively as might have been possible, they proved effective at combating dog depredation. As of the 2006/07 nesting season, grids were used on nearly every nest, within the zones monitored by the seven communities (approximately 236 nests; Pilcher 2007), and will be used during future seasons across a wider spatial range. The grids are a low-cost solution to protecting nests, and while they would likely not be as effective against stronger predators such as pigs, or at high density nesting beaches (where subsequent nesting turtles could displace the grids), after a couple of seasons of use they appear to be effective for local conditions in PNG and have effectively bolstered hatchling production and population recruitment.

Using the simple model that estimates 1 egg out of 1,000 eggs will survive to adulthood, the Council's nesting beach conservation project in Kamiali, PNG is estimated to produce 24 adult leatherback turtles in the future.

3.3.1.2 Loggerhead Sea Turtles

General Distribution
Loggerhead sea turtles are circumglobal, and are associated with a broad range of habitat types that vary by life stage and region including continental shelves, bays, estuaries, lagoons and

oceanic fronts and eddies in temperate, subtropical, and tropical waters. Major nesting grounds are generally located in temperate and subtropical regions, with scattered nesting in the tropics (NMFS and USFWS 1998d).

Loggerheads can be divided into five regions: the Atlantic Ocean, Pacific Ocean, Indian Ocean, Caribbean Sea and Mediterranean Sea. These regions may be further divided into nesting aggregations. In the Pacific Ocean, loggerhead turtles are represented by a northwestern Pacific nesting aggregation (located in Japan) which may be comprised of separate nesting groups (Hatase et al. 2002) and a smaller southwestern nesting aggregation that occurs in Australia (Great Barrier Reef and Queensland) and New Caledonia (Limpus 2006).

North Pacific loggerhead turtles nest in Japan, undertake trans-Pacific developmental migrations in the waters of the Central North Pacific, Mexico, and U.S. territorial waters throughout the eastern Pacific, and reside as adults in waters of the Asian region. Loggerheads orginating in Japan travel westward, move seasonally north and south primarily through the region 28–40° N, and occupy sea surface temperatures (SST) of 15–25° C. Their dive depth distribution indicated that they spend 40% of their time at the surface and 90% of their time at depths <40 m. Loggerheads are found in association with fronts, eddies, and geostrophic currents. Specifically, the North Pacific Transition Zone Chlorophyll Front (NPTZCF) and the southern edge of the Kuroshio Extension Bifurcation Region (KEBR) appear to be important forage and migration habitats for loggerheads (Polovina et al. 2004 and 2007). Kobayashi et al. (2008) found that loggerhead distribution in the pelagic environment may be associated with the following five environmental variables: sea surface temperature, and chlorophyll-a concentration, earth magnetic force, earth magnetic declination, and earth magnetic inclination).

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. 2005). 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. 2005). 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).

Size and Identification
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 (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 3 years or less, while those greater than 36 cm were estimated to be 6 years or more. Age specific growth rates for the first 10 years were estimated to be 4.2 cm/year (Zug, et al. 1995).

Age at Maturity

Age to maturity for the Japanese loggerhead population is not understood. This parameter is estimated at >30 yr for Atlantic loggerheads (Snover 2002); however Japanese loggerheads nest at a smaller size (Hatase et al. 2004) and potentially at a younger age.

Genetics

Bowen et al. (1995) identified two genetically distinct nesting stocks in the Pacific - a northern hemisphere stock nesting in Japan and a southern hemisphere stock nesting primarily in Australia. This study concluded that 95% of loggerheads in Baja California originated from Japanese nesting beaches, but also identified an apparent presence of Australian origin individuals at foraging areas in the North Pacific, as indicated by a few individuals sampled as bycatch in the North Pacific that had a mtDNA haplotype only found in Australia (Bowen et al. 1995). Hatase et al. (2002) detected this common Australian haplotype at low frequency at Japanese nesting beaches. This finding, taken together with preliminary results from microsatellite (nuclear) analysis, confirms that loggerheads inhabiting the north Pacific originate from nesting beaches in Japan (P. Dutton, NMFS, unpublished data). LeRoux et al. (2007) report additional genetic variation in north Pacific loggerheads based on analyses using new mtDNA primers designed to target longer mtDNA sequences. Kamezaki et al. (in press) report that there are no significant differences in the mtDNA haplotype frequencies between Omaezaki rookery in northern Japan and the Yakushima rookeries in southern Japan, but that there are significant differences in the haplotype frequency between Minabe rookery in the Kii Peninsula and Yakushima rookeries. From limited data available, it appears that there is no latitudinal trend in population structuring (Kamezaki et al. in press).

Global Status

Loggerhead sea turtles inhabit the Atlantic Ocean, Pacific Ocean, Indian Ocean, Caribbean Sea and Mediterranean Sea. The loggerhead sea turtle was listed as a threatened species throughout its global range on July 28, 1978. It was listed because of direct take, incidental capture in various fisheries, and the alteration and destruction of its nesting habitat. Based on a review of the existing recovery criteria and the best available information, NMFS and USFWS do not believe that the loggerhead should be delisted or reclassified at this time (NMFS and USFWS 2007).

Population Exposed to Hawaii-based Longline Fisheries

Of the loggerheads taken in the Hawaii-based longline fishery, all have been determined to have originated from Japanese nesting beaches, based on genetic analyses (Snover 2008).

Impacts and Threats

Destruction and modification of loggerhead nesting habitats are occurring worldwide throughout the species range (NMFS 2007). The main anthropogenic (caused by humans) threats impacting loggerhead nesting habitat include coastal development/construction, placement of erosion control structures and other barriers to nesting, beachfront lighting, vehicular and pedestrian traffic, sand extraction, beach erosion, beach nourishment, beach pollution, removal of native vegetation, and planting of non-native vegetation (Baldwin 1992, NMFS and USFWS 1998b, Margaritoulis et al. 2003).

Beach erosion is a significant impact at Japanese nesting beaches as a result of severe storms (e.g., typhoons), coastal development (such as construction of harbors, jetties, and upriver dams), and beach armoring (Matsuzawa 2006). Additionally, burgeoning numbers of visitors to beaches may cause sand compaction and nest trampling. For example, on Yakushima in Japan, egg mortality is higher and hatchling emergence success is lower in areas where public access is not restricted and is mostly attributed to human foot traffic on nests (Kudo et al. 2003).

The construction of beachfront armoring (e.g., rigid structures placed parallel to the shoreline on the upper beach to prevent both landward retreat of the shoreline and inundation or loss of upland property by flooding and wave action; includes bulkheads, seawalls, soil retaining walls, rock revetments, etc.) greatly impacts nesting opportunities and hatching success of loggerhead turtles. Armoring structures can effectively eliminate a turtle's access to upper regions of the beach/dune system. Consequently, nests on armored beaches are generally found at lower elevations than those on non-walled beaches. Nests laid at lower elevations are subject to a greater risk of repeated tidal inundation and erosion, which can lead to total nest lost as well as potentially altered thermal regimes, and thus sex ratios (Mrosovsky and Provancha 1989, Mrosovsky 1994, Ackerman 1997).

Egg harvesting no longer represents a problem in Japan (Ohmuta 2006); however, the poaching of adults and juveniles is still a problem in Baja California Sur, Mexico (Koch et al. 2006). As the population of black turtles declined in Baja California Sur waters during the 1990's, poachers switched to loggerheads (H. Peckham, Pro Peninsula, personal communication, 2006).
Incidental capture (bycatch) of loggerheads occurs in various fisheries throughout the range of the species. Longline gear, drift and set gillnet, bottom trawling, fishing dredges, and pot and trap gear are the primary gear types affecting loggerheads (Gilman et al. 2007; Lewison and Crowder 2004, 2006; Peckham et al. 2007). In the eastern Pacific, significant bycatch has been reported in gillnet and longline fisheries operating out of Peru (Shigueto et al. 2006). Ongoing studies regarding loggerhead mortality and bycatch have been conducted in Baja California Sur, Mexico, where significant bycatch in the gillnet and bottom-longline halibut fishery occurs (Peckham and Nichols, 2002). Based on fisheries observations and surveys conducted in 2005, 1400 loggerheads were estimated killed by just 2 of the 13 or more small-scale fishing fleets that fish within loggerhead juvenile foraging areas off the coast of Baja California Sur, Mexico (Peckham et al. 2007). The incidental capture of loggerheads in Baja Sur likely exceed 2,000 mortalities per year in that region making it likely the most significant source of mortality identified for the north Pacific loggerhead population and underscores the importance of

reducing bycatch in small-scale fisheries (Peckham, Pro Peninsula, pers. comm., December 2007). Coastal pound (pond) nets or setnets in Japan and Taiwan are also a significant source of loggerhead mortality with estimates of hundreds to over a thousand loggerheads killed per year in Japan pound net fisheries alone (Takaishi, STAJ, pers. comm., December 2007).

Global warming may result in significant impacts to loggerhead turtles as increased temperatures can change hatchling sex ratios, result in loss of nesting beach habitat due to sea level rise, change nesting behavior, and alter foraging habitats and prey abundance. See section 3.3.1.6 for more information on global warming and impacts on sea turtles.

3.3.1.2.1 Loggerheads in Japan

In the North Pacific, loggerhead nesting is essentially restricted to Japan on beaches across 13 degrees of latitude (24° N to 37° N), from the mainland island of Honshu south to the Yaeyama Islands, which appear to be the southernmost extent of loggerhead nesting in the western North Pacific. Researchers have separated 42 beaches into five geographic areas: (1) the Nansei Shoto Archipelago (Satsunan Islands and Ryukyu Islands); (2) Kyushu; (3) Shikoku; (4) the Kii Peninsula (Honshu); and (5) east-central Honshu and nearby islands.

From 1998-2000, approximately 2,500 nests were documented annually across Japan and, considering clutch frequency, it is probable that fewer than 1,000 females breed annually in Japan (Kamezaki et al. 2003). Kamezaki et al. (2003) reviewed census data collected from most of the Japanese nesting beaches. Although most surveys were initiated in the 1980’s and 1990’s, some data collection efforts were initiated in the 1950’s. Along the Japanese coast, nine major nesting beaches (>100 nests/season) and six “submajor” beaches (10-100 nests/season) were identified. Census data from 12 of these 15 beaches provide composite information on longer-term trends in the Japanese nesting assemblage. Using information collected on these beaches, Kamezaki et al. (2003) concluded a substantial decline (50-90%) in the size of the annual loggerhead nesting population in Japan in the latter half of the 20th century.

Two of the most important beaches in Japan, Inakahama Beach and Maehama Beach, located on Yakushima Island in the Nansei Shoto Archipelago, account for more than 30% of all loggerhead nesting in Japan (Kamezaki et al. 2003). Monitoring on Inakahama Beach has taken place since 1985. Monitoring on some other nesting beaches has been ongoing since the 1950s, while other more remote beaches have only been monitored since the 1990s. According to Kamezaki et al. (2003) there are limited reports describing the trends and status of loggerheads in Japan. However, Matsuzawa (2006) provided updated information on annual nest numbers from 2001 through 2004 – 3,122, 4,035, 4,519, and 4,854 nests were documented, respectively. Current work by Kamezaki et al. (in press) suggests an increasing population trend at Yakushima Island and further suggests that there are synchronized,10-15 yr quasi-cyclic nesting beach abundance fluctuations across the archipelago likely due to environmental forcing such as foraging area productivity. Estimates of the number of nests laid each year from 1998-2008 have been provided by the Sea Turtle Association of Japan (Table 19; Figure 18). The number of loggerhead nests for 2008 is estimated to be approximately 6,500 nests based on the best available data from STAJ (Matsuzawa 2008). However, the actual total for 2008 may exceed 10,000 nests, after all the data are tallied and verified. For the 19-year period 1990-2008, the total number of nests per year for the North Pacific population ranged between 2,064 – 6,638 nests (using 6,500 as the 2008 total) Assuming a clutch frequency of 3.49 per female per year (NMFS 2005), the number of nesting females per year during 1990-2008 was 591 – 1,902.

Table 19: Number of loggerhead turtle nests on all Japanese nesting beaches, 1998-2007

Year	Number of Nests
1998	2447
1999	2255
2000	2589
2001	3122
2002	4035
2003	4568
2004	4854
2005	5167
2006	2833
2007	3660
2008	6,500

Source: 1998-2002: Matsuzawa (2006) *In:* Kinan (ed.) Loggerhead Sea Turtle Workshop Proceedings; 2003-2006: Sea turtle association of Japan, presentation at 17th Annual Sea turtle Symposium, Kumano, Japan, Nov. 2006. 2007: Y. Matsuzawa personal communication November 8, 2007. 2008 data estimated from Matsuzawa 2008 in NMFS 2008c.

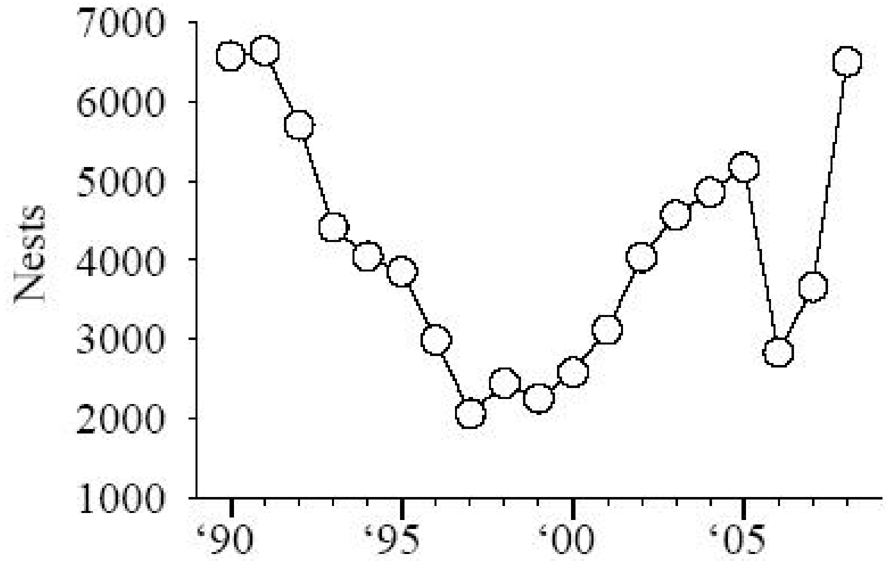

Figure 18: Trend in annual number of loggerhead nests in Japan, 1990-2008
Source: data through 2007 from STAJ, 2008 data estimated from Matsuzawa 2008 in NMFS 2008c.

Mortality of eggs and pre-emergent hatchlings seem to be unusually high in Japanese rookeries due to various factors such as beach use by tourist, predation, inundation, erosion, and excessive heat (Matsuzawa et al. 2002). For example, hatching success in the Minabe-Senri beach were 24% (1996), 50% (1997), 53% (1998), 48% (1999), 62% (2000), 41% (2001), 34% (2002) (Matsuzawa, unpublished data).

Nesting beaches suffer environmental disruption from beach erosion and light pollution. Extreme weather events, such as high temperatures result in overheating of nests, and many nests are washed out or inundated during the many typhoons that strike Japanese nesting beaches during summer months - sometimes up to six per season (Matsuzawa, 2006). Moreover, over the last few years egg and pre-emergent mortality has been relatively high due mainly to trampling by tourists that has increased over the past few years (Kamezaki et al. 2003).

Many beaches suffer serious beach erosion due to upstream dams and jetties, and beaches in many locations have been armored with tetrapods (concrete blocks) between the shoreline and the vegetation line. These blocks have been documented to obstruct loggerhead females from prime nesting habitat near dunes and vegetation (Matsuzawa, 2006 and presented at the 17th Annual Japan Sea Turtle Symposium). As a result, female turtles are forced to nest close to shoreline and almost all of the eggs are eventually washed out or drowned.

3.3.1.2.1.1 Council's Loggerhead Conservation Project in Japan

In an effort to mitigate some of the nesting beach impacts in Japan listed above, the Council in collaboration with the Sea Turtle Association of Japan (STAJ) began supporting nesting beach management activities at five nesting beaches in 2004. Actions to protect loggerhead nests and hatchlings occur at Hii-Horikiri, Minabe-Senri and Myojinyama-Oida beaches, and Inakahama and Maehama beaches of Yakushima Island. Yakushima Island is the most significant loggerhead nesting location in the North Pacific where more than 30 percent of nesting occurs. Activities include: relocating nests from erosion prone areas, keeping people away from nests to prevent crushing, and cooling the nests with water to prevent overheating during incubation.

A variety of techniques are employed to reduce egg and hatchling mortality due to both environmental and anthropogenic threats including erosion, extreme temperatures, predation, and nest compression due to human activities. Beaches are patrolled nightly during the summer nesting season. Nesting loggerheads are tagged and nesting data are recorded. Nests laid in compromised locations (e.g., below high tide line or adjacent to streams) are relocated using standardized and internationally recognized methodologies. Nests left *in-situ* and those translocated are protected with mesh and fences from predation and human trampling. Furthermore, nest temperature is monitored and regulated using water when critical thresholds are exceeded.

The STAJ has perfected techniques in nest relocation with an average of 60% hatchling success rates (compared to 0% survival of same nests laid in erosion prone areas). The Council's TAC, during their second meeting in 2005, encouraged the STAJ to relocate as many nests as possible.

This project was initially implemented under the expectation of conserving approximately 6,000 hatchlings per year. However, management activities have been surprisingly successful with over 100,000 hatchlings conserved and released over the past four years that would have otherwise been lost (Table 20).

Table 20: Summary of conservation benefits at five beaches in Japan

Year	**# Nests Relocated**	**Eggs**	**Hatchlings conserved**
2004	238	24,900	14,994
2005	470	49,350	29,610
2006	569 (45% of nests laid relocated)	59,745	35,847
2007 (to July)	452	47,460	28,476
Total	1,729	181,545	108,927

Note: Estimated by 105 eggs per clutch (Matsuzawa, pers. comm.) and 60% hatchling success rate (average rate at Inakahama and Maehama beaches: Matsuzawa 2006).
Source: STAJ Report to WPRFMC 2007

Assuming 1 out of 1,000 loggerhead eggs will reach adulthood, it is estimated that the Council's nesting beach conservation project in Japan will produce 181 adult loggerhead turtles from nest relocations that otherwise would not have survived.

3.3.1.2.2 Loggerheads in Baja, Mexico

Loggerhead hatchlings on nesting beaches in Japan undertake developmental migrations in the North Pacific, using the Kuroshio and North Pacific Currents. Tagging programs to study migration and movement of sea turtles and genetic analyses provide evidence that loggerhead turtles undergo trans-Pacific migrations and have been found foraging off Baja California. For example, loggerheads tagged in Mexico and California with flipper and/or satellite transmitters have been monitored returning to Japanese waters (Resendiz, et al.1998a-b). Based on aerial surveys, it is estimated that between 5,000 and 15,000 juvenile loggerhead turtles reside in the Baja California Sur (BCS) region (Eguchi, NMFS SWFSC, pers. comm., December 2007). Within the BCS area west of Santa Rosa, there appears to be a hotspot where loggerhead turtles aggregate in high densities (Figure 19).

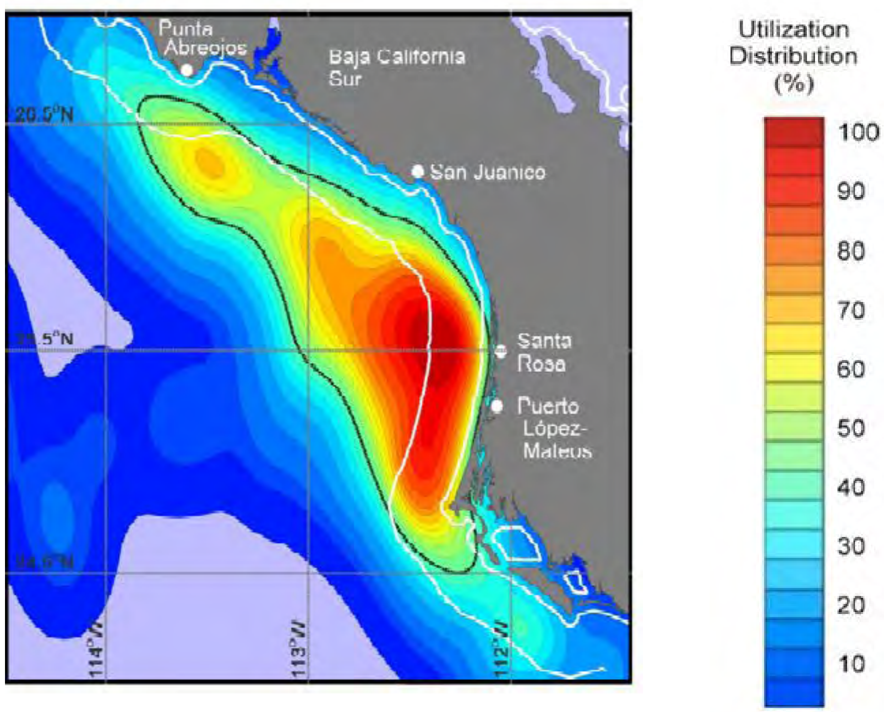

Figure 19: Loggerhead habitat utilization in Baja California Sur
Source: Peckham, Pro Peninsula, pers. comm., December 2007

Threats from Baja Fisheries
Gillnet fisheries of Baja California Sur (BCS), Mexico are a leading source of loggerhead turtle mortality in the North Pacific - with a minimum of 1,000 and perhaps up to 2,000 turtles killed per year in that region (Peckham et al. 2007; Peckham and Nichols 2002). In 2005 and 2006, bottom-set gillnet and bottom-set longline operations were observed. The results indicate that all loggerhead interactions occur when bottom-set gillnets are set at depths between 20-23 fathoms or 120-138 ft. When fishing at those depths, the fishermen were observed to catch 0.65

loggerheads per day, of which 73% caught are dead. Bottom-set longlining in the BCS was observed to have much higher loggerhead interaction rates. In 2005, 7 observer trips were made on bottom-set longline vessels, with 26 loggerheads caught on a total of 1200 hooks set, or a bycatch rate of 19.3 per 1000 hooks. Of the turtles caught, 24 of 27 were dead when retrieved, providing an 89% mortality rate. One bottom-set longline trip was observed in 2006, where 21 loggerheads were caught dead from fishing 236 hooks, resulting in a kill rate of 89 turtles per 1,000 hooks (Peckham, Pro Peninsula, pers. comm., December 2007). The incidental capture of loggerheads in Baja Sur likely exceed 2,000 mortalities per year in that region making it likely the most significant source of mortality identified for the north Pacific loggerhead population and underscores the importance of reducing bycatch in small-scale fisheries (Peckham, Pro Peninsula, pers. comm., December 2007). Additionally, loggerhead turtle poaching is another serious source of mortality in Baja (Koch et al. 2006; Gardner and Nichols 2001).

3.3.1.2.2.1 Council's Loggerhead Conservation Project in Baja Sur, Mexico

In 2004, the Council began supporting the bycatch/mortality reduction and gillnet gear mitigation component of the Proyecto Caguama (or ProCaguama) project implemented by the locally-based NGO, ProPeninsula, operating in Baja California SUR, Mexico in communities of Puerto López Mateos, Puerto San Carlos, Santo Domingo, and Magdalena Bay. This project aims to raise awareness of the bycatch, harvest and mortality problem among Mexican fishers and working with these fishers and their communities to develop mortality reduction solutions. Objectives of the project are being met through activities involving outreach, education, gear research and mitigation, and increased patrolling. The overall project objectives are to reduce the approximately 35,000 turtles taken per year along the Baja California peninsula (Nichols 1998) - of which many are loggerheads (Koch et al. 2006; Gardner and Nichols 2001).

The Council funded ProCaguama to conduct 45 km systematic shoreline surveys at Playa San Lazaro, Baja California Sur and to directly quantify and monitor turtle mortality, and test the efficacy of potential bycatch reduction solutions identified by fishers. In addition to monitoring turtle strandings, ProCaguama assessed turtle bycatch and mortality/harvest rates through a voluntary observer program for the halibut gillnet fleet of Puerto Lopez Mateos, and through semi-structured interviews of fishermen and community members.

In 2004 and 2005, the project focused on gear mitigation research and testing potential gear alternatives for the gillnet fishery, and to understand the dynamics and characteristics of the fishery. It was during this time that intensive community consultations (workshops) ensued. Many of the gillnet research experiments were based on ideas of local fishermen who were working with project personnel to identify feasible solutions. Since 2004, tested bycatch reduction measures include: twine vs. mono-filament, nets without suspenders, and buoyless nets (in effort to sink the nets). Poaching reduction patrols and enforcement was implemented at hunting hotspots. Additionally, the annual Turtle Festival was born and intensive education and outreach activities were initiated during this time.

In 2005 and 2006, bottom-set gillnet and bottom-set longline operations were observed. The results indicate that all loggerhead interactions occur when bottom-set gillnets are set at depths between 20-23 fathoms or 120-138 ft. When fishing at those depths, the fishermen were observed to catch 0.65 loggerheads per day, of which 73% caught are dead. Bottom-set longlining in the BCS was observed to have much higher loggerhead interaction rates. In 2005, seven observer trips were made on bottom-set longline vessels, with 26 loggerheads caught on a total of 1200 hooks set, or a bycatch rate of 19.3 per 1000 hooks. Of the turtles caught, 24 of 27 were dead when retrieved, providing an 89% mortality rate. One bottom-set longline trip was observed in 2006, where 21 loggerheads were caught dead from fishing 236 hooks, resulting in a kill rate of 89 turtles per 1000 hooks.

To date, the project has conducted mortality reduction workshops with fishermen and placed observers on local boats to quantify interaction rates and insure that any live loggerheads caught in halibut gillnets are returned to the ocean. ProCaguama has implemented an outreach and educational awareness campaign that consists of a Turtle Festival, booklets, various media (news, radio, music and art) and has a growing network of community conservation activists throughout BCS.

In 2007, representatives from ProCaguama, Grupo Tortuguero and the Santa Rosa Fish Producing Cooperative Society signed the Santa Rosa Declaration – a document that outlines the agreement that several Santa Rosa highline fishermen will no longer fish within the high density loggerhead sea turtle area with bottom longline gear. This agreement is estimated to save approximately 700-900 loggerheads each year (Peckham et al. 2007). Based on fisher and community surveys, changes in fishing techniques and locations is being reported, plus project staff have recognized steep drops in consumption to almost zero across several communities. Increased collaborations with Japan has led to Japan coastal pound net monitoring and fishery collaborations in Muroto Prefecture, and a tri-national fisherman's exchange has been implemented to raise awareness and implement strategies to reduce sea turtle interactions within specific fisheries in the U.S., Japan and Mexico.

3.3.1.3 Olive Ridley Sea Turtles

General Distribution

Olive ridley turtles occur throughout the world, primarily in tropical and sub-tropical waters. The species is divided into three main populations, with distributions in the Pacific Ocean, Indian Ocean, and Atlantic Ocean. Nesting aggregations in the Pacific Ocean are found in the Mariana 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 there are very large aggregations in Orissa, India. In the Atlantic Ocean, nesting aggregations occur from Senegal to Zaire, Brazil, French Guiana, Suriname, Guyana, Trinidad, and Venezuela (Pritchard 1979; Marquez 1990).

Olive ridleys are best known for their arribada behavior (Carr 1967, Hughes and Richard 1974). Hundreds to tens of thousands of olive ridleys may emerge synchronously from the ocean in just a few days to nest in close proximity. This remarkable phenomenon has been filmed in many natural history documentaries and is well known among non-scientists, yet understanding of this behavior remains largely obscure.

Size and Identification

Olive ridleys are the smallest living sea turtle (similar in size to Kemp ridley turtles), 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).

Diet

The species appears to forage throughout the eastern tropical Pacific Ocean on tunicates, salps, crustaceans, other invertebrates, and small fish often in large groups or flotillas, and are occasionally found entangled in scraps of net or other floating debris. 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).

Age at Maturity

Olive ridleys are considered to reach sexual maturity between 8 and 10 years of age, and approximately three percent of the numbers of hatchlings recruit to the reproductive population (Marquez, 1982 in Salazar, et al. 1998).

Global Status

The olive ridley turtle is listed as threatened in the Pacific, except for the Mexican nesting population, which is classified as endangered under the ESA. This latter classification was based on the extensive over-harvesting of olive ridleys in Mexico, which caused a severe population decline. Since the ban on the harvest of turtles in Mexico, the primary threat to the Mexican nesting population has been reduced and the population appears to be increasing. Olive ridley sea turtles are considered the most abundant sea turtle in the world (NMFS and USFWS 1998e). Olive ridleys are known for major nesting aggregations called *arribadas* with tens of thousands to over a million nests annually, the largest of which occur on the west coasts of Mexico and Costa Rica, and on the east coast of India. Minor *arribadas* and solitary nesters are found throughout the remaining tropical and warm temperate areas of the world, except in the western Pacific and eastern Indian Oceans where the species is uncommon. Population structure and genetics are poorly understood for this species, but populations occur in at least the eastern Pacific, western Pacific, eastern Indian, central Indian, western Indian, western Africa, and western Atlantic areas (Spotila 2004, NMFS and USFWS 2007c). The eastern Pacific population includes nesting aggregations on the west coast of Mexico, which are listed under the ESA as endangered. All other olive ridleys are listed as threatened.

The eastern Pacific population is thought to be increasing, while there is inadequate information to suggest trends for the other populations. The global status of olive ridleys is described in the most recent 5-year status review (NMFS and USFWS 2007c).

Eastern Pacific olive ridleys nest primarily in the world's largest *arribadas* on the west coasts of Mexico and Costa Rica. Since reduction or cessation of egg and turtle harvest in both countries in the early 1990s, annual nest totals have increased substantially. On the Mexican coast alone, in 2004-2006, the annual total was estimated at 1,021,500 – 1,206,000 nests annually (NMFS and USFWS 2007c). Eguchi et al. (2007) counted olive ridleys at sea, leading to an estimate of 1,150,000 – 1,620,000 turtles in the eastern tropical Pacific in 1998-2006 (Eguchi et al. 2007). In contrast, there are no known *arribadas* of any size in the western Pacific, and apparently only a few hundred nests scattered across Indonesia, Thailand and Australia. Data are not available to analyze trends (NMFS 2005, NMFS and USFWS 2007c).

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). 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; however, its eggs are considered a delicacy, and egg harvest is 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; however, 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 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, such as those in the eastern Pacific, 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.

Populations exposed to the Hawaii-based Longline Fishery

While olive ridleys are the most common turtle species that interact with the Hawaii-based deep-set longline fishery, they are very uncommon in the shallow-set fishery. Only three genetics samples have been collected from the shallow-set fishery and analyzed since 1995; two were from the eastern Pacific population and one was from the western Pacific (NMFS 2008c). Since the reopening of the shallow-set fishery in 2004, two interactions with olive ridleys were observed (see Table 21). The deep-set fishery interacts with olive ridleys at low levels (e.g., seven in 2007; NMFS on-line observer reports). Genetic information analyzed from 44 olive ridleys taken in the Hawaii-based longline fishery (deep-set and shallow-set) indicates that 75% of the turtles (n=33) originated from the eastern Pacific (Mexico and Costa Rica) and 25% of the turtles (n=11) were from the Indian and western Pacific rookeries (P. Dutton, NMFS, personal communication, August 9, 2005). This indicates that the olive ridleys from both sides of the Pacific converge in the north Pacific pelagic environment.

Based on the number of olive ridleys nesting on the Pacific coast of Mexico, the endangered population appears to be stable at some locations (e.g., Mismaloya and Moro Ayuta) and increasing at one location (La Escobilla; Table 21). A comparison of the current abundance of the Mexico nesting assemblages with the former abundance at each of the large arribada beaches indicates that the populations experienced steep declines that have not yet been overcome. Nesting trends in Mexico at non-arribada beaches are stable or increasing in recent years. However, current threats, particularly with regard to commercial fisheries, remain a serious concern for the future of this population. Incidental capture of olive ridleys in shrimp trawl fisheries has been and remains a significant threat to nesting populations. Also of concern is the growing threat posed by expansion of the longline fisheries in this region. The nationwide ban on harvest of nesting females and eggs has decreased the threat to the endangered population. The nesting population at La Escobilla, Oaxaca, Mexico, has increased from 50,000 nests in 1988 to more than a million nests in 2000 as a result of the harvest prohibitions and the closure of a nearshore turtle fishery. Illegal harvest of eggs and turtles is, however, believed to still be widespread in Mexico.

In the eastern Pacific, the large *arribada* nesting populations have declined since the 1970s. Nesting at some arribada beaches continues to decline (e.g., Nancite in Costa Rica) and is stable or increasing at others (e.g., Ostional in Costa Rica). There are too few empirical data available from solitary nesting beaches to confirm the declining trend that has been described for numerous countries throughout the region including El Salvador, Guatemala, Costa Rica, and Panama.

In the northern Indian Ocean, *arribada* nesting populations are still large but are characterized as stressed and either in decline or on the verge of decline due primarily to the incidental capture of large numbers of turtles in shrimp trawl and gillnet fisheries. Declines of solitary nesting olive ridleys have been reported in Bangladesh, Myanmar, Malaysia, Pakistan, and southwest India.

Table 21: Annual olive ridley population estimates at major nesting sites

Location	**Average number per arribada (unless specified)**
La Escobilla, Mexico	1,000,000 + nests
Ostional, Costa Rica	50,000 - 200,000 females
Playa Nancite, Costa Rica	2,000-12,000 females
Chacocente, Nicaragua	42,500 nests
Gahirmatha, India	1,000-100,000 females

Source: NMFS and USFWS 2007c

3.3.1.4 Green Sea Turtles

General Distribution
Green turtles are found throughout the world, occurring primarily in tropical, and to a lesser extent, subtropical waters. The species occurs in five major regions: the Pacific Ocean, Atlantic Ocean, Indian Ocean, Caribbean Sea, and Mediterranean Sea. These regions 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 Caribbean Sea Green turtles appear to prefer waters that usually remain around 20° C 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 appear most frequently in U.S. coastal waters that have temperatures exceeding 18° C.

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). 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 km 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, a distance of approximately 1,500 km (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 km from Michoacán, Mexico.

Size and Identification
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 1998c).

Growth and Age at Maturity
Compared to all other sea turtles, green turtles exhibit a 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. 2008, 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).

Diet

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 (Landsberg et al. 1999).

Global Status

Green turtles were listed as threatened under the ESA on July 28, 1978, except for breeding populations found in Florida and the Pacific coast of Mexico, which were listed as endangered. Using a precautionary approach, Seminoff (2004) estimates that the number of nesting female green turtles has declined by 48% to 67% over the last three generations (~ 150 yrs). Causes for this decline include harvest of eggs, subadults and adults; incidental capture by fisheries; loss of habitat; and disease. The degree of population change is not consistent among all index nesting beaches or among all regions. Some nesting populations are stable or increasing. However, because many of the threats that have led to these declines have not yet ceased, it is evident that green turtles globally face a measurable risk of extinction (Seminoff 2004).

Population Status and Trends

As stated above, despite an overall declining trend globally, green turtle population growth rates are variable among nesting populations and regions and some populations are stable or increasing in abundance (Chaloupka et al. 2008). Changes in subpopulation size were inferred based on actual and extrapolated counts of adult nesting females at 5 index beaches in the Pacific (Seminoff 2004). Index beaches in the eastern Pacific include Colola, Michoacan, Mexico, historically the most important green turtle nesting rookery in the eastern Pacific Ocean; and the current largest nesting congregation in the eastern Pacific, Galapagos Island, Ecuador. French Frigate Shoals, Hawaii, comprised the index beach for the central Pacific; and southern Great Barrier Reef (Heron Island) and northern (Raine Island) Great Barrier Reef were the index beaches for western Pacific green turtle populations. Since the initial nesting surveys at French Frigate Shoals (FFS) in 1973, there has been a marked increase in annual green turtle nesting. The increase over the last 30+ years corresponds to an underlying near-linear increase of about 5.7 percent per year. Information on in-water abundance is consistent with the increase in nesting.

Eastern Pacific green turtles nest on at least the west coasts of Mexico and elsewhere in Central America, as well as in the Revillagigados Islands (Mexico) and Galapagos Islands (Ecuador). An estimated 3,319 – 3,479 eastern Pacific female sea turtles nested annually in the past few years. Nesting has been steadily increasing at the primary nesting sites in Michoacan, Mexico, and in the Galapagos Islands since the 1970s. Both sites are reported in the 5-year status review to host between 1,000 and 2,000 nesting females annually (NMFS and USFWS 2007d), but in recent years nesting females have increased to over 2,000 annually at Michoacan. In addition, previously unknown nesting areas have recently come to the attention of scientists, such as in El Salvador (J. Seminoff, pers. comm. in NMFS 2008c), further boosting estimates of the eastern Pacific population.

Genetics

Molecular genetic techniques have helped researchers gain insight into the distribution and ecology of migrating and nesting green turtles. Throughout the Pacific, nesting assemblages group into two distinct regional clades: 1) western Pacific and South Pacific islands, and 2) eastern Pacific and central Pacific, including the rookery at French Frigate Shoals, Hawaii (Dutton 2003).

Populations Exposed to the Hawaii-based Longline Fishery

The shallow-set fishery interacts with green sea turtles on low levels, with one interaction between 2004 and 2008 (see Table 14). The deep-set component also interacts with green sea turtles at low levels. Green turtles that interact with the Hawaii-based deep-set longline fishery are either of the endangered Mexican (Pacific coast) or threatened Hawaiian (French Frigate Shoals) nesting aggregations. Genetic halotypes have been confirmed from 14 green turtles caught by the deep-set component of the Hawaii-based longline fishery. Of the 14 confirmed green turtle genetic samples, 8 turtles (57%) represented nesting aggregations from the eastern Pacific (Mexico – both Revillagigedos and Michoacan and Galapagos), and 6 turtles (43%) represented the Hawaiian nesting aggregation (P. Dutton, NMFS, personal communication, August 9, 2005).

Hawaii

Balazs and Chaloupka (2004) conclude that the Hawaiian green sea turtle stock is well on the way to recovery following 30+ years of protection. This increase can be attributed to increased female survivorship since harvesting of turtles in the foraging grounds was prohibited in the mid-1970s and cessation of habitat damage at the nesting beaches since the early 1950s (Balazs and Chaloupka 2004). Moreover, the increase in the abundance of nesting turtles (Figure 20) has occurred despite existing impacts such as fibropapillomatosis[14], local inshore fisheries bycatch, and boat strikes (Balazs and Chaloupka 2004).

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[14] Fibropapillomatosis (FP), a tumor-forming and debilitating transmissible disease of sea turtles, has emerged in recent years as a serious threat in the Hawaiian Islands, Australia, Florida, and the Caribbean. A herpes virus and retrovirus have been identified in association with FP, but the etiology of the disease, the environmental co-factors required for its occurrence, and modes of transmission in the wild have not been determined.

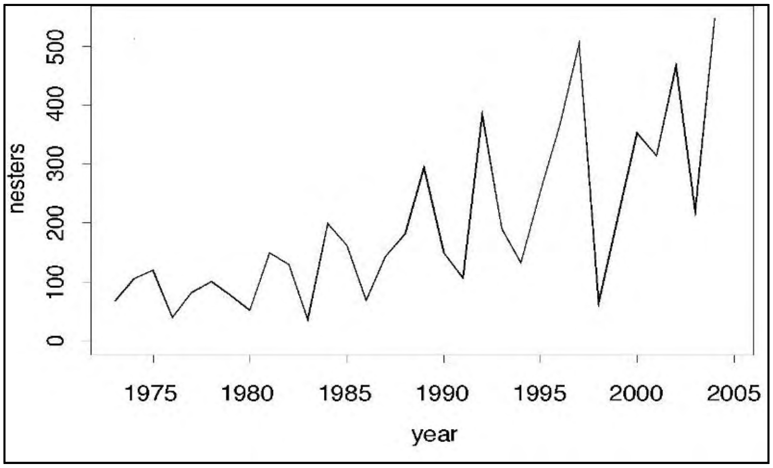

Figure 20: Estimated number of Hawaiian green sea turtles nesting at East Island, French Frigate Shoals, NWHI, 1973-2004.
Source: NOAA Fisheries, PIFSC, unpublished data

Mexico
Nesting has been steadily increasing at the primary nesting sites in Michoacan, Mexico, and in the Galapagos Islands since the 1970s. Both sites are reported in the 5-year status review to host between 1,000 and 2,000 nesting females annually (NMFS and USFWS 2007d), but in recent years nesting females have increased to over 2,000 annually at Michoacan. In addition, previously unknown nesting areas have recently come to the attention of scientists, such as in El Salvador (J. Seminoff, pers. comm. in NMFS 2008c), further boosting estimates of the eastern Pacific population.

3.3.1.5 Hawksbill Sea Turtles

The hawksbill turtle is listed as endangered under the ESA. 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. Hawksbill populations occur in at least the Insular and western Caribbean, southwestern and eastern Atlantic, the southwestern, northwestern, and central/ eastern Indian Ocean, and the western, central, and eastern Pacific. As described in the recent 5-year review (NMFS and USFWS 2007e), available trend data for the past 20 years suggest that while some Caribbean/Atlantic sub-populations may be increasing, nearly all Indian and Pacific sub-populations are decreasing. 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 (NMFS 2001).

Like other sea turtles, hawksbills will make long migrations between foraging and nesting areas (Meylan 1999), but otherwise remain within coastal reef habitats.

Central Pacific hawksbills nest in small numbers in several archipelagos, including Samoa, Fiji, the Marianas, Hawaii, Micronesia, Palau, the Solomons, and Vanuatu. All are declining, except possibly at the small Hawaii rookery (NMFS and USFWS 2007e), where an estimated 10-15 females have nested annually since the early 1990s (Seitz and Kagimoto 2008). The largest central Pacific hawksbill rookeries are in Fiji and the Solomon Islands, where harvests of adults and eggs still appears to be occurring at unsustainable levels. Total number of nesting females for the central Pacific hawksbill population was estimated at 940 – 1,200 females annually for the last few years, with an overall downward trend (NMFS and USFWS 2007e).

Hawksbill turtles occur in the water around the Hawaiian Islands (on Oahu, Molokai, Maui and Hawaii) and nest on Maui and the southeast coast of the Island of Hawaii, but they are not known to interact with the Hawaii-based shallow-set longline fishery (there have been no reported or observed interactions between these pelagic longliners and hawksbill turtles; Table 14). In the shallow-set Hawaii-based fishery in 2007, a derelict net with a decomposed hawksbill was hooked and retrieved (the turtle had clearly been killed by the derelict net, not the longline (NMFS 2008c). Based on the available data and the distribution of hawksbill turtles relative to the distribution of the shallow-set longline fishery, it is not anticipated that interactions between hawksbill turtles and the fishery will occur.

3.3.1.6 Global Climate Change and Impacts to Sea Turtle Populations

As highly migratory, wide-ranging organisms that are biologically tied to temperature regimes, sea turtles are vulnerable to the effects of global climate change in various aspects of their physiology and behavior. These effects must be considered in addition to all other anthropogenic impacts on sea turtle populations. The major ways climate change will affect sea turtles are: 1) changes in hatchling sex ratios as a species that exhibits temperature-dependent sex determination; 2) loss of nesting beach habitat due to sea level rise; 3) changes in nesting behavior that correlate with fluctuations in sea surface temperature; and 4) alterations to foraging habitats and prey abundance resulting from global climate change.

Sex ratios

All species of sea turtle exhibit temperature-dependent sex determination (Standora and Spotila, 1985). Warmer temperatures within the nest chamber produce females while cooler ones produce males. As global temperatures continue to increase, so will sand temperatures, which in turn will alter the thermal regime of incubating nests and alter natural sex ratios within hatchling cohorts, presumably toward a heavier female bias. While sex ratios vary within and among seasons and nesting locations, several species already exhibit general trends of female bias throughout their major rookeries worldwide. Loggerheads nesting in the U.S. are already heavily skewed toward female (Mrosovsky and Provancha 1992, Hanson et al. 1998). Although some beaches at the northern limit of their nesting range in North Carolina may produce up to 55% males (Webster and Gouveia 1988), over 90% of loggerhead nesting in the U.S. occurs along the Atlantic coast of Florida, where warmer temperatures produce substantially more females than males. Nesting beaches in Cyprus, Brazil, and Turkey produce estimates of 89-99%, 82.5%, and 60-74% female loggerheads, respectively (Godley et al. 2001, Marcovaldi et al. 1997, Kaska et al. 2006, Oz et al. 2004). While less information is available on sex ratios for green, hawksbill, and leatherback sea turtles, the existing data also suggest that the nesting assemblages of these species that have been examined are slightly to severely female biased (Binckley et al. 1998, Godfrey et al. 1996, Chan and Liew 1995, Godfrey et al. 1999). In addition to altered sex ratios, the range of thermal tolerance for egg survival should be considered as nesting aggregations that already produce 100% females may be at the high end of their thermal range. Increases in temperature could reduce hatchling production altogether under such conditions (Matsuzawa et al. 2002). Rainfall has also been correlated with sex ratios in sea turtles as months with higher rainfall produce more males, lower rainfall more females (Godfrey et al. 1996). Climate change effects on rainfall are not well understood but could potentially have an indirect impact on the sex ratios of sea turtles.

Sea level rise
Sea level rose approximately 15 cm during the 20th century (Ruddiman 2001 *In* Baker et al. 2006) and further increases are expected. Resulting coastal inundation will have serious consequences for sea turtles in the form of loss of nesting beaches. For example, 23% and 52% of the total current sea turtle nesting beach area in Bonaire, Netherlands Antilles would be under threat of flooding with 0.5 m and 0.9 m rises in sea level respectively (Fish et al. 2005). While under natural conditions beaches can migrate landward or seaward with fluctuations in sea level, extensive coastal development has inhibited or eliminated this natural process. The North Pacific population of loggerhead turtles nests mainly on beaches along the Japanese coast. Sea walls and beach armoring are common along these beaches as precautions against tsunamis and sea level rise, severely limiting access for nesting females. In some cases, nesting beaches occur on small, low-lying islands or atolls on which there is limited space for the beach to migrate landward. Over 90% of Hawaiian green turtles nest at French Frigate Shoals (FFS), a group of low-lying atolls in the Northwestern Hawaiian Islands. The best available demonstration of the potential effects of sea level rise indicates that the islands of FFS may lose from 40-57% of their current area by 2100 (Baker et al. 2006).

SST and nesting behavior
A change in phenology for Atlantic loggerheads has been correlated with rising sea surface temperatures (SST). Weishampel et al. (2004) found that as nearshore SST rose 0.8°C over the last 15 years, the median nesting date became earlier by ten days. In North Carolina, earlier nesting and longer nesting seasons were correlated with warmer sea surface temperature (Hawkes et al. 2007). The implications/consequences of temporal shifts in nesting activity are speculative. The findings lead to numerous follow up questions (listed by Weishampel et al. 2004) including whether earlier nesting will affect overall fecundity, clutch size, incubation length, hatch success, hatchling, survivorship, food availability for hatchlings, mating synchrony, and sex ratio.

Ocean productivity/foraging resources
Global climate change may have varying effects on sea turtle foraging habitat/prey abundance. Seagrasses are a major food source for green turtles worldwide. Potential effects of climate change on seagrasses include decreased productivity in deeper water due to sea level rise and

shifts in distribution as a result of increased temperature stress and changes in salinity in seagrass habitats (Short and Neckles 1999, Duarte, 2002). Hawksbills forage mainly on particular species of sponges inhabiting coral reefs. As mentioned above, changes to coral reef communities are likely to result from global climate change. A substantial increase in gelatinous zooplankton (large medusae) in the Bering Sea from 1979 to 1997 is possibly linked to climate change (Brodeur et al. 1999). Leatherbacks, which prey mainly on large jellyfish, are thought to have extended their range in the Atlantic north by 330 km in the last 17 years as warming has caused the northerly migration of the 15° C SST isotherm, the lower limit of thermal tolerance for leatherbacks (McMahon and Hays, 2006). Loggerheads in the North Pacific demonstrated lower breeding capacity in years following higher sea surface temperatures (Chaloupka et al. 2008). Studying loggerhead nesting beach trends in Australia and Japan, Chaloupka et al. 2008) found that during the last 50 years of increasing sea surface temperatures in foraging areas, there was an inverse relationship between nesting beach abundance and mean sea surface temperatures. Cooler foraging habitat is associated with increased ocean productivity resulting in higher loggerhead nesting abundance and warmer ocean temperatures could lead to long-term decreased food supply and nesting abundance unless loggerheads shift their foraging habitat to cooler waters. This effect of sea surface temperature in foraging areas on inter-season nesting beach abundance has also been found for Pacific green sea turtles (Limpus and Nichols 2000, Chaloupka 2001) as well as for Pacific leatherback sea turtles (Saba et al. 2007). It is important to note that turtles appear to return to the same foraging areas, so if the rate of change to those habitats is rapid, turtles will have to adapt quickly to keep up with shifted distributions and will be displaced to new foraging areas.

3.3.1.7 Information Used to Assess Fishery Impacts on Sea Turtle Populations

The best available population data for the affected turtle populations are nest counts; therefore, to estimate the fishery's impact on sea turtle populations, it is necessary to know the number of adult female mortalities for each species resulting from interactions. The 2008 SQE analysis (Snover 2008; See Appendix II) relies upon nesting beach trends (i.e., numbers of nesting adult females) to determine the status of sea turtle populations. The SQE analysis modeled the trajectory of the adult female component of each affected population in the absence of the proposed action. Then, in order to determine the effect of the proposed action on the adult female component of each population, the effect of "x" number of adult female mortalities annually was modeled. Adult females are the only component of the affected populations for which data are available to build a population model, such as the SQE analysis. In order to know the estimated number of adult female mortalities that occur as a result of interactions with the fishery, estimations of post-hooking mortality rates, proportion of females to males in the population, and adult equivalents (not all bycaught turtles are adults) must be determined. The estimated annual adult female mortalities for sea turtles that interact with the fishery are calculated using the following formula:

(# interactions/yr)(post-hooking mortality rate)(sex ratio)(adult equivalent) = # adult females mortalities from interactions with the fishery

Tables 22-25 provide information on how the number of adult female mortalities will be estimated in Chapter 4.

Table 22: Leatherback information used to assess fishery impacts

Leatherbacks (*Dermochelys coriacea*)	
Variable	Mean
Post-hooking mortality	0.229 mortalities/interaction
Sex ratio	65:35 (♀:♂) = 0.65 females
Adult equivalents	0.85 adult equivalent

Source: Snover 2008

Leatherback post-hooking mortality (0.223 mortalities/interaction) is based on the 16 leatherback interactions in the fishery from 2004 to 2007 (See Appendix II: Snover 2008. Leatherback sex ratio (0.65 females) is generally female-dominated, ranging from ~60 – >90% females, based on hatchling studies, with increasing female sex ratio associated with warmer nest temperatures. Leatherback adult equivalencies (0.85 adult equivalent per turtle) is based on mean size of nesting females in the western Pacific, mean size of turtles caught in the shallow-set fishery from 2004 to 2007, early age at maturity, and rapid growth. The majority of shallow-set fishery leatherback interactions are believed to be with adult leatherback turtles. Curved carapace lengths (CCLs) of leatherback turtles measured by onboard observers following longline interactions, range from 100 to 192 cm, with a mean CCL of 139. The mean size of nesting western Pacific leatherback females at onset of maturity is estimated at 163 cm CCL. Considering uncertainties associated with the estimates of growth, survival rates and fecundity parameters, a mean adult equivalent value of 0.85 (which represents the mean CCL of turtles observed following interactions divided by the mean CCL at which maturity is believed to occur - or 139/163) was used to account for the fact that most, but not all, of the interactions likely involve adults.

Table 23: Loggerhead information used to assess fishery impacts

Loggerheads (*Caretta caretta*)	
Variable	Mean
Post-hooking mortality	0.205 mortalities/capture
Sex ratio	65:35 (♀:♂) = 0.65 females
Adult equivalents	0.41 adult equivalent

Source: Snover 2008

Loggerhead post-hooking mortality (0.205 mortalities/interaction) is based on the 45 interactions in the fishery from 2004 to 2007 (Snover 2008). Loggerhead sex ratio (0.65 females) is generally female-dominated, ranging from 60 – >90% females, based on hatchling studies, with increasing female sex ratio associated with warmer nest temperatures. Loggerhead adult equivalencies (0.41 adult equivalent per turtle) are based on population models using a range of age to maturity and survival rates (Snover 2008).

Table 24: Olive ridley information used to assess fishery impacts

Olive ridleys (*Lepidochelys olivacea*)	
Variable	Mean
Post-hooking mortality	0.2 mortalities/interaction
Sex ratio	65:35 (♀:♂) = 0.65 females
Adult equivalents	1 adult equivalent

Source: NMFS 2008d

Olive ridley post-hooking mortality (0.2 mortalities/interaction) is based on post-hooking mortalities of more commonly-caught sea turtle species in this fishery from 2004 to 2007 (See NMFS PIRO 2008). Olive ridley sex ratio (0.65 females) is assumed in the absence of information on likely sex ratio of olive ridleys caught in this fishery. Olive ridley adult equivalencies (1.0 adult equivalent per turtle) are assumed in the absence of information on likely adult equivalents of olive ridleys.

Table 25: Green information used to assess fishery impacts

Greens (*Chelonia mydas*)	
Variable	Mean
Post-hooking mortality	0.2 mortalities/capture
Sex ratio	65:35 (♀:♂) = 0.65 females
Adult equivalents	1 adult equivalent

Source: NMFS 2008d

Green sea turtle post-hooking mortality (0.2 mortalities/interactions) is based on post-hooking mortalities of more commonly-caught sea turtle species in this fishery from 2004 to 2007 (See

NMFS PIRO 2008). Green sea turtle sex ratio (0.65 females) is assumed in the absence of information on likely sex ratio of greens caught in the fishery. Green sea turtle adult equivalencies (1.0 adult equivalent per turtle) are assumed in the absence of information on likely adult equivalents of greens caught in the fishery.

3.3.1.7.1 Post-hooking Mortality Rates

In 2004, NMFS convened a workshop to elicit expert opinion on post-interaction mortality rates based on the severity of fishery interactions with sea turtles. A result of that workshop was the development of a method of assigning post-hooking mortality values based on injury categories to each turtle interaction (Ryder et al. 2006). Using the observer data from the Hawaii-based shallow-set fishery since 2004, each turtle interaction with the fishery was assigned a post-interaction mortality rate, based on Ryder et al. (2006) to assess a mean post-interaction mortality rate for each species.

Since the reopening of the Hawaii-based shallow-set fishery in 2004, all of the loggerhead and leatherback (and other turtles as well) turtles taken have been released alive. NMFS found that the overall mean post-interaction mortality rate for the Hawaii-based shallow-set fishery from 2004 to 2007 is 20.5% (95% C.I. 14.7 – 26.2%) for loggerhead turtles and 22.3% (95% C.I. 12.6 –33.1%) for leatherback turtles ((NMFS Internal Memorandum to PIRO, Regional Administrator, W.L. Robinson, 1 Feb. 2008). Using updated information that includes 2008 data, the leatherback post-hooking mortality rate is estimated to be 22.9% (Snover 2008, in Appendix II). Many of the injury categories in Ryder et al. (2006) were not found in the loggerhead and leatherback takes in the shallow-set fishery since 2004.

With these small numbers, even a single event of a serious injury with a high post-interaction mortality rate would alter the mean post-interaction mortality rates reported here, hence these numbers should be monitored as the fishery progresses to ensure they do not change substantially. Nearly half of the leatherbacks were externally hooked and released with the hook and substantial line still attached. The remaining leatherbacks were primarily externally hooked and released with the hook and little line or with no gear. Of the 16 leatherbacks interacting with the shallow-set fishery between 2004 and 2007, only one was mouth-hooked. For loggerheads, the highest interaction category was category III (hooked in soft tissues of the mouth or esophagus above the level of the heart) and most of these were released with all gear removed. The next highest category for loggerhead interactions was externally hooked and again most of these were released with no gear attached.

A recent study using satellite tags on loggerhead turtles suggests that the loggerhead post-release mortality rate may be lower than that currently estimated by NMFS and may only amount to about 9.5% of all interactions (Y. Swimmer, NMFS PIFSC, pers. comm., December 2007).

3.3.2 ESA-Listed Seabirds

3.3.2.1 Short-tailed Albatross

Of the 18 species of seabirds with potential to occur on the fishing grounds of the action area, only the short-tailed albatross (*Phoebastria albatrus*) is listed as endangered under the ESA. The short-tailed albatross population is the smallest of any of the albatross species occurring in the North Pacific. Land-based sighting records indicate that 15 short-tailed albatrosses have visited the NWHI over the past 60 years. Five of these visits were between 1994 and 1999 (NMFS 1999). Numbers of short-tailed albatrosses were reduced significantly in the past; however, its primary nesting population which breeds in Torishima, Japan has been steadily increasing since the 1950's (Okamura et al. 2007, NMFS 2008b, Naughton et al. 2008c). Short-tailed albatross were reduced to near extinction primarily because of excessive hunts for feathers at the breeding colonies since the 1880's to the extent that it was thought to be extinct in 1949 (USFWS 2005). Fisheries bycatch mitigation measures have been in place in U.S. fisheries since 2001 and breeding habitat protection efforts have been undertaken in Japan for several years.

The species began to recover during the 1950s, and currently, due to habitat management and habitat protection, the population is growing exponentially at about 7.3% annually (Naughton et al. 2007). Today, the only known currently-active breeding colonies are on Torishima south of Honshu Island, Japan, (30° 29' N, 140° 18' E) and Minami-kojima in the Senkaku Islands just north of Taiwan (25° 43' N, 123° 33' E). It is estimated that 80-85% of the known breeding short-tailed albatross use a single colony at Tsudame-zaki, on Torishima, an active volcanic island. The current worldwide population is estimated to be approximately 2,717 individuals, with 382 nesting pairs observed on Torishima Island during the 2007-2008 breeding season (Balogh 2008). This is an increase from the approximately 2,000 individuals and 341 nesting pairs observed on Torishima Island for the previous (2006-2007) breeding season (Hasagawa 2007, NMFS 2008b). In 2008, ten chicks were translocated to Mukoshima Island to try to establish a new breeding colony (NMFS 2008b). The breeding season for short-tailed albatross occurs from August to December. Their breeding and non-breeding distribution is in the north Pacific as shown in Figure 21.

There have never been any observed interactions between short-tailed albatross and Hawaii longline fisheries (shallow-set or deep-set).

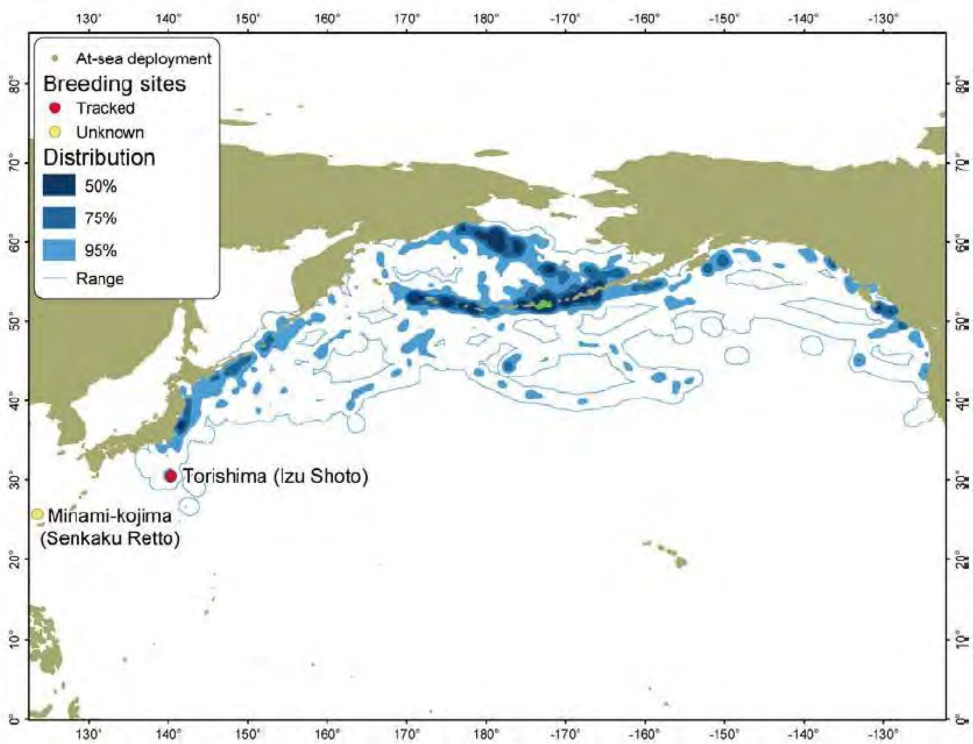

Figure 21: Distribution of short-tailed albatrosses in the North Pacific
Source: R. Suryan In: AC4 Doc 59 Agenda Item No. 17. Agreement on the Conservation of Albatrosses and Petrels Fourth Meeting of Advisory Committee Cape Town, South Africa, 22–25, August 2008.
Note: Information was derived from birds that were captured and satellite-tagged at two locations; on Torishima Island, where breeding, non-breeding and post-breeding birds (n = 23) were tagged between 2006 and 2008; and near Seguam Pass, where birds were captured and satellite-tagged from 2003-2006 (n = 12).

3.3.3 Marine Mammals

Longline fisheries occasionally interact with marine mammals incidental to fishing operations. These may include those listed under the ESA and those which are not listed but are protected pursuant to the Marine Mammal Protection Act (MMPA).

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

3.3.3.1 Endangered Marine Mammals

Blue whale (*Balaenoptera musculus*)
Fin whale (*Balaenoptera physalus*)
Humpback whale (*Megaptera novaeangliae*)
North Pacific right whale (*Eubalaena japonica*)

Sei whale (*Balaenoptera borealis*)
Sperm whale (*Physeter macrocephalus*)
Hawaiian monk seal (*Monachus schauinslandi*)

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 hookings or entanglements of these species in these fisheries. Recent shallow-set fishery interactions are presented in Table 26.

Table 26: Interactions between the shallow-set fishery and marine mammals, 2004-2008

Species	**2004**	**2005**	**2006**	**2007**	**2008***
Number of sets made:	135	1,645	850	1,497	619
Bryde's whales: released injured	0	1	0	0	0
Bottlenose dolphins: released injured	0	0	1	3	0
Risso's dolphins: released dead	0	0	1	0	0
Risso's dolphins: released injured	0	1	1	3	2
Unidentified whales: released injured	0	1	0	0	0
Humpback whales: released injured	0	0	1	0	1
Pygmy sperm whale: released injured	0	0	0	0	1

Source: NMFS PIRO observer reports
* 2008 1st quarter only
Note: One false killer whale interaction was observed in the second quarter of 2008

3.3.3.1.1 Humpback Whale

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 Marine Mammal Protection Act (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).

Humpback whales occur off all eight Hawaiian Islands during the winter breeding season, but particularly within the shallow waters of the “four-island” region (Kahoolawe, 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).

As part of the international SPLASH (Structure of Populations, Levels of Abundance and Status of Humpbacks) project, a recent study has estimated the abundance of North Pacific humpbacks to be just under 20,000, an estimate that is about double estimates made previously (Calambokidis et al. 2007). For management purposes, NMFS uses the a lower estimation of 18,000 animals and but acknowledges that available information indicates that this population is increasing by 6.8 percent per year as a result of international and federal protections (NMFS 2008).

Over 50% of the North Pacific population is estimated to winter in Hawaiian waters with large populations also inhabiting Mexican waters. The abundance estimates of humpback whales wintering in Asia and Central America were fairly low (1,000 or less). Among feeding areas, regional estimates differed greatly among models. Average estimates of abundance ranged from about 100-700 for Russia, 6,000-14,000 for the Bering Sea and Aleutians, 3,000-5,000 each for the Gulf of Alaska and the combined Southeast Alaska and Northern British Columbia area, 200-400 for Southern British Columbia-Northern Washington, and 1,400-1,700 for California-Oregon (Calambokidis et al. 2008).

Reports of entangled humpback whales found swimming, floating, or stranded with fishing gear attached have been made in both Alaskan and Hawaiian waters. The overall U.S. commercial fishery-related minimum mortality and serious injury rate for the entire stock is 3.2 humpback whales per year, based on observer data from Alaska (0.20), stranding records from Alaska (3.0), and stranding records from Hawaii (0) (Carretta et al. 2007). There have been two interactions observed between the shallow-set fishery and humpback whales since 2004 (see Table 26).

3.3.3.1.2 Sperm Whale

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 MMPA. Critical habitat has not been designated for sperm whales.

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 an 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 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 been sighted in the Kauai Channel, the Alenuihaha Channel between Maui and the Island of Hawaii, and off the Island of Hawaii (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). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 7,082 (CV=0.30) sperm whales (Barlow 2003), including a correction factor for missed diving animals.

3.3.3.1.3 Blue Whale

The blue whale is the largest animal ever known to have lived. The IWC recognizes only one stock of blue whales in the North Pacific (eastern North Pacific stock), but some evidence suggests that there may be as many as five separate stocks (Carretta et al. 2007). Blue whales are listed as endangered under the ESA, and consequently the Hawaiian stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. Insufficient information is available to determine whether the total fishery mortality and serious injury for blue whales is insignificant and approaching zero mortality and serious injury rate. Increasing levels of anthropogenic noise in the world’s oceans has been suggested to be a habitat concern for blue whales (Reeves et al. 1998).

Blue whales feed in California waters during the summer/fall and migrate south to productive areas off Mexico during the winter/spring. Whaling catch data indicate that whales feeding along the Aleutian Islands are probably part of a central Pacific stock (Reeves et al. 1998), which may migrate to offshore waters north of Hawaii in winter (Berzin and Rovnin 1966). Recent stock estimates include 1,744 blue whales in waters off California for the eastern Pacific (Carretta et al. 2007). No estimate of abundance is available for the western Pacific blue whale stock. Large whales have been entangled in longline gear off the Hawaiian Islands (Nitta and Henderson 1993, Forney 2004), but no interactions with blue whales were observed in the Hawaii deep-set longline fishery between 1994 and 2002, with approximately 4-25 percent of all effort observed (Forney 2004), or in the shallow-set fishery between 2004 and 2007, with 100 percent observer coverage.

3.3.3.1.4 Sei Whale

The IWC recognizes only one stock of sei whales in the North Pacific (the eastern North Pacific stock) for management purposes, although there is evidence that more than one stock exists

(Carretta et al. 2006). Sei whales are distributed in temperate waters in all oceans, and are not usually associated with coastal features. In the North Pacific Ocean, the summer range extends from southern California to the Gulf of Alaska and across the North Pacific south of the Aleutian Islands, extending into the Bering Sea in the deep southwestern Aleutian Basin (Carretta et al. 2007).

Ohsumi and Wada (1974) estimate the pre-whaling abundance of sei whales to be 58,000-62,000 in the North Pacific. Later, Tillman (1977) used a variety of different methods to estimate the abundance of sei whales in the North Pacific and revised this pre-whaling estimate to 42,000. All methods depend on using the history of catches and trends in CPUE or sighting rates; there have been no direct estimates of sei whale abundance in the entire North Pacific based on sighting surveys. As part of the Marine Mammal Research Program of the Acoustic Thermometry of Ocean Climate (ATOC) study, a total of twelve aerial surveys were conducted within about 25 nm of the main Hawaiian Islands in 1993-98 (Mobley et al. 2000), but no sightings of sei whales were made. A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in a summer/fall abundance estimate of 77 (CV=1.06) sei whales (Barlow 2003). This is currently the best available abundance estimate for this stock, but the majority of sei whales would be expected to be at higher latitudes in their feeding grounds at this time of year (Carretta et al. 2007). Between 1994 and 2002, no interactions with sei whales were observed in the Hawaii deep-set longline fishery, with approximately 4-25 percent of all fishing effort observed (Forney 2004), or in the shallow-set fishery between 2004 and 2007, with 100 percent observer coverage.

3.3.3.1.5 Fin Whale

Fin whales (*Balaenoptera physalus*) are found throughout all oceans and seas of the world from tropical to polar latitudes (Forney et al. 2000). Although it is generally believed that fin whales make poleward feeding migrations in summer and move toward the equator in winter, few actual observations of fin whales in tropical and subtropical waters have been documented, particularly in the Pacific Ocean away from continental coasts (Reeves et al. 1999). There have only been a few sightings of fin whales in Hawaiian waters.

There is insufficient information to accurately determine the population structure of fin whales in the North Pacific, but there is evidence of multiple stocks (Forney et al. 2000). The status of fin whales in Hawaii waters relative to the optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney et al. 2000).

3.3.3.1.6 North Pacific Right Whale

North Pacific right whales were listed as endangered on March 6, 2008 (73 CFR 12024). Together with North Atlantic right whales they were previously listed as endangered on December 2, 1970 (35 CFR 18319) as northern right whales. They are the rarest of all large whale species and are among the rarest of all marine mammal species.

North Pacific right whales primarily inhabit coastal or shelf waters between 20° and 60° North latitude, but movements over deep waters are also known. Their migratory patterns are poorly understood, but in general, the whales spend the summer on high-latitude feeding grounds and migrate to more temperate waters where calving takes place during the winter. In recent years, summer sightings have been most common in the western North Pacific, in the Okhotsk Sea and adjacent areas. Sightings also occur, but are rare, in the central North Pacific, Bering Sea, and eastern North Pacific. Although the winter whereabouts remains unknown for much of the population, winter sightings have been reported as far south as the Ryukyu Islands in the western North Pacific, Hawaii in the central North Pacific, and central Baja California in the eastern North Pacific. The current population is likely below 1,000 animals. Two distinct groups, East and West (based on feeding ground divisions), are currently recognized. About 90% of all North Pacific right whales are thought to exist in the western Pacific. North Pacific right whale sightings have been very rare in the eastern and central North Pacific since the seventies. They were twice sighted in the waters around the Main Hawaiian Islands in the spring of 1979, and once again in the spring of 1996. According to the 2006 Stock Assessment Report for this species, "…there is no reason to believe that either Hawaii or tropical Mexico have ever been anything except extralimital habitats for this species" (NMFS 2006).

North Pacific right whales are baleen whales that feed by continuously filtering prey through their baleen while moving, mouth open, through patches of zooplankton (skimming). Most other baleen whales gulp then strain. Existing records indicate that right whales feed almost entirely on copepods. They reach sexual maturity in nine to ten years, may live to 80 years, and grow to 16.7 m long. Females are typically larger than males. They produce a single calf about once every three to five years. Detailed information about the biology, habitat, and conservation status of this species is described in the recovery plan (NMFS 2005) and the Review of the Status (NMFS 2006).

3.3.3.1.7 Hawaiian Monk Seal

The Hawaiian monk seal was listed as endangered under the ESA in 1976 (41 FR 51612). 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 non-migratory, but studies show that their home ranges may be extensive (Abernathy and Siniff 1998). Counts of individuals on 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).

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, the 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). Current estimates indicated that the population is in a decline that has lasted 20 years and only around 1,200 monk seals remain. Modeling predicts the population will fall below 1,000 animals in the next five years (NMFS 2007c).

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 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 to the Pelagics FMP established a permanent 50-mile Protected Species Zone around the NWHI that is closed to longline fishing. Since 1993, no interactions between Hawaiian monk seals and the Hawaii longline fishery have been reported.

3.3.3.2 Non-Listed Marine Mammals

Based on research, observer, and logbook data, the following marine mammals, which are not listed under the Endangered Species Act, occur in the region and may be affected by the fisheries managed under the Pelagics FMP:

- Blainville’s beaked whale (*Mesoplodon densirostris*)
- Bryde’s whale (*Balaenoptera edeni*)
- Bottlenose dolphin (*Tursiops truncatus*)
- Common dolphin (*Delphinus delphis*)
- Cuvier’s beaked whale (*Ziphius cavirostris*)
- Dwarf sperm whale (*Kogia simus*)
- False killer whale (*Pseudorca crassidens*)
- Fraser’s dolphin (*Lagenodelphis hosei*)

- Killer whale (*Orcinus orca*)
- Longman's beaked whale (*Indopacetus pacificus*)
- Melon-headed whale (*Peponocephala electra*)
- Minke whale (*Balaenoptera acutorostrata*)
- Northern fur seals (*Callorhinus ursinus*)
- Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)
- Pantropical spotted dolphin (*Stenella attenuata*)
- Pilot whale, short-finned (*Globicephala melas*)
- Pygmy killer whale (*Feresa attenuata*)
- Pygmy sperm whale (*Kogia breviceps*)
- Risso's dolphin (*Grampus griseus*)
- Rough-toothed dolphin (*Steno bredanensis*)
- Spinner dolphin (*Stenella longirostris*)
- Striped dolphin (*Stenella coeruleoalba*)

The above marine mammals occur in the region; however, specific population estimates that are found in NMFS' Marine Mammal Stock Assessment Reports (SARs)[15] are often only reported for those populations that occur in U.S. EEZs such as EEZ around Hawaii. The Hawaii shallow-set fishery rarely fishes within the Hawaiian EEZ, but rather, the majority of the fishing effort targets swordfish in the central North Pacific approximately 600-1,000 nm north of Hawaii.

3.3.3.2.1 Delphinids

The Pacific white-sided dolphin is found throughout the temperate North Pacific (Hill and DeMaster 1999). Two stocks, the California, Oregon, Washington stock and the North Pacific stock, 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 most complete population abundance estimate (931,000 (CV = 0.90)) for Pacific white-sided dolphins was calculated from line transect analyses applied to the 1987-90 central North Pacific marine mammal sightings survey data (Buckland et al. 1993). This abundance estimate more closely reflects a range-wide estimate rather than one that can be applied to either of the two management stocks off the west coast of North America (Carretta et al. 2007).

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 (Carretta et al. 2007). The status of rough-toothed dolphins in Hawaii's waters relative to their optimum sustainable population is

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[15] http://www.nmfs.noaa.gov/pr/sars/species.htm

unknown, and there are insufficient data to evaluate trends in abundance (Carretta et al. 2007). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 19,904 (CV=0.52) rough-toothed dolphins (Barlow 2003). This is currently the best available abundance estimate for this stock in the Hawaii EEZ (Carretta et al. 2007). This species is unlikely to interact with the swordfish fishery because of their tendency to occupy tropical and subtropical waters and in areas where the fishery does not readily target swordfish.

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 five reported strandings of Risso’s dolphins on the Main Hawaiian Islands (Nitta 1991,Maldini et al. 2005). Risso's dolphins have also been sighted near Guam and the Northern Mariana Islands (Reeves et al. 1999). Risso's dolphins within the Pacific U.S. EEZ are divided into two discrete, noncontiguous areas: 1) Hawaiian waters, and 2) waters off California, Oregon and Washington (Carretta et al. 2007). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 2,351 (CV=0.65) Risso’s dolphins (Barlow 2003). This is currently the best available abundance estimate for this stock in the Hawaii EEZ (Carretta et al. 2007). Based on observer data from 2004-2008, this species is the most likely marine mammal to interact with swordfish fishery (see Table 26); however the numbers of interactions are low with 2007 having the highest number of interactions at 3.

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 (Carretta et al. 2007). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 3,215 (CV= 0.59) bottlenose dolphins (Barlow 2006). Elsewhere, the Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) is found in the coastal waters of Southeast Asia and extends into the larger Melanesian islands of Papua New Guinea and the Solomon Islands. These waters are typically not fished by U.S. longline boats but are part of the fishing grounds for the U.S. purse seine fleet. This species is unlikely to interact with the swordfish fishery because of their tendency to occupy tropical and subtropical waters.

As its name implies, the pantropical spotted dolphin has a pantropical distribution in both coastal and oceanic waters (Perrin 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 (Perrin 1975, Dizon et al. 1994, Perrin 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 (Carretta et al. 2007). Twelve strandings of this species have been documented in Hawaii (Nitta 1991, Maldini and Atkinson 2005). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 10,260 (CV=0.41) pantropical spotted dolphins (Barlow 2003). This is currently the best available abundance estimate for this stock in the Hawaii EEZ (Carretta et al. 2007). This species is unlikely to interact with the swordfish fishery because of their tendency to occupy tropical waters.

Spinner dolphins are commonly seen around oceanic islands throughout the Pacific (Perrin and Gilpatrick 1994) and occur in tropical and warm-temperate waters. 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 (Carretta et al. 2007). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 2,805 (CV=0.66) spinner dolphins (Barlow 2003). This is currently the best available abundance estimate for this stock in the Hawaii EEZ (Carretta et al. 2007). This species is unlikely to interact with the swordfish fishery because of their tendency to occupy tropical and sub-tropical, nearshore waters.

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 20 times (Nitta 1991; Maldini 2005), yet at-sea sightings of this species are infrequent (Shallenberger 1981; Mobley et al. 2000). 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 (Carretta et al. 2007). 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 (Carretta et al. 2007). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 10,385 (CV=0.48) striped dolphins (Barlow 2003). This is currently the best available abundance estimate for this stock in the Hawaii EEZ (Carretta et al. 2007). This species is unlikely to interact with swordfish fishery because of their tendency to occupy tropical waters.

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 six strandings have been documented from Maui and the Island of Hawaii (Nitta 1991, Maldini 2005). According to the MMPA stock assessment reports, there is a single Pacific management stock (Carretta et al. 2007). 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 (Carretta et al. 2007). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 817 (CV=1.12) pygmy killer whales (Barlow 2003). This is currently the best available abundance estimate for this stock in the Hawaii EEZ (Carretta et al. 2007). The Hawaii shallow-set fishery is unlikely to interact with this species as it occurs primarily in tropical and sub-tropical waters.

False killer whales occur in tropical, subtropical and warm temperate seas worldwide (Stacey et al. 1994). In the North Pacific, this species is well known from southern Japan, Hawaii, and the eastern tropical Pacific. This species also occurs in U.S. EEZ waters around Palmyra Atoll and sightings of false killer whales have been recently confirmed within the Johnston Atoll EEZ (NMFS/PIRO/PSD unpublished data) and the U.S. EEZ waters of American Samoa (NOS/HIHWNMS unpublished data). The stock structure for this species is not definitively established; however, it appears there is a genetically distinct and isolated stock of false killer whales that is resident to the Hawaiian Islands and does not occur outside 50-75 miles from shore. The false killer whales that occur more than 50-75 miles from the islands appear to be part of a broadly distributed eastern Pacific stock (Carretta et al. 2007). A recent Southwest Fisheries Science Center Administrative Report indicates that the density and estimated overall abundance of false killer whales increase farther south in warmer waters (e.g., on the high seas south of the Hawaiian Islands and around Palmyra Atoll and possibly other U.S. possessions). 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). There are six stranding records from Hawaiian waters (Nitta 1991; Maldini 2005). A recent re-analysis of the Hawaiian Islands Cetacean and Ecosystem Assessment Survey (HICEAS) data using improved methods and incorporating additional sighting information obtained on line-transect surveys south of the Hawaiian EEZ during 2005, resulted in a revised estimate of 484 (CV = 0.93) false killer whales within the Hawaiian Islands EEZ (Barlow and Rankin 2007). This is currently the best available abundance estimate for this stock in the Hawaii EEZ (Carretta et al. 2007). In addition, there has been a NMFS survey of waters south of Hawaii and in the EEZ around Palmyra that produced an estimate of 1,329 (CV = 0.65) false killer whales (Barlow and Rankin 2007). This is currently the best available abundance estimate for this stock in the Palmyra EEZ (Carretta et al. 2007); however, trends in abundance cannot be determined based on that single survey. There are observations of interactions of this species with the Hawaii-based deep set longline fishery that targets tuna south of Hawaii. Average 5-yr estimates of annual mortality and serious injury for 2001-2005 are 7.7 (CV = 0.34) false killer whales outside of U.S. EEZs, 4.9 (CV = 0.41) within the Hawaiian Islands EEZ, and 1.9 (CV = 0.59) within the EEZ of Palmyra Atoll.

Forney and Kobayashi (2007) report that two (1997 and 1998) interactions with false killer whales occurred with the Hawaii shallow-set fishery prior to 2004. In the second quarter of 2008, an interaction between a shallow-setting longline boat and a false killer whale was observed within EEZ waters around Hawaii approximately 150 nm northeast of Molokai (Adam Bailey, NMFS, pers. comm. October 2008). Based on the location of the interaction it appears the interaction would have involved an animal from the false killer whale pelagic stock.

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. One stranding from the island of Hawaii was reported in 1950 (Richards 1952) and another in 2004 (R.W. Baird, pers. comm. in Carretta et al. 2007). 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 (Carretta et al. 2007). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 430 (CV=0.72) killer whales (Barlow 2003). This is currently the best available abundance estimate for this stock in the Hawaii EEZ (Carretta et al. 2007). In 1990, a solitary killer whale was reported to have removed the catch from a longline in Hawaii (Dollar 1991). No hookings or entanglements have ever been observed in the Hawaii-based longline (shallow-set and deep-set) fishery.

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 (Carretta et al. 2007). 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 (Carretta et al. 2007). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 2,947 (CV=1.11) melon-headed whales (Barlow 2003). This is currently the best available abundance estimate for this stock in the Hawaii EEZ (Carretta et al. 2007). This species is unlikely to interact with the swordfish fishery because of their tendency to occupy tropical and sub-tropical waters.

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 present around the Northwestern Hawaiian Islands (Shallenberger 1981; Barlow 2006). Stock structure of short-finned pilot whales has not been adequately studied in the North Pacific, except in the waters around Japan where two stocks have been identified based on pigmentation patterns and differences in the shape of the heads of adult males (Kasuya et al. 1988). The pilot whales in Hawaiian waters are similar morphologically to the Japanese "southern form." Preliminary photoidentification work with pilot whales in Hawaii indicated a high degree of site fidelity around the main island of Hawaii (Shane and McSweeney 1990) and around Kauai and Niihau (Baird et al. 2006). Genetic analyses of tissue samples collected near the main Hawaiian Islands indicate that Hawaiian short-finned pilot whales are reproductively isolated from short-finned pilot whales found in the eastern Pacific Ocean (S.Chivers, NMFS/SWFSC, unpublished data); however, the offshore range of this Hawaiian population is unknown. Fishery interactions with short-finned pilot whales demonstrate that this species also occurs in U.S. EEZ waters of Palmyra Atoll and Johnston Atoll, but it is not known whether these animals are part of the Hawaiian stock or whether they represent separate stocks of short-finned pilot whales. Based on patterns of movement and population structure observed in other island-associated cetaceans (Norris and Dohl 1980; Norris et al.1994; Baird et al. 2001, 2003; S. Chivers, pers. comm. in Carretta et al. 2007), it is possible that the animals around Palmyra Atoll and Johnston Atoll are one or more separate stocks (Carretta et al. 2007). 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 (Carretta et al. 2007). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 8,846 (CV=0.49) short-finned pilot whales (Barlow 2006). This is currently the best available abundance estimate for short-finned pilot whales within the Hawaii EEZ (Carretta et al. 2007). Between 1994 and 2004, six short-finned pilot whales were observed hooked in the Hawaii-based deep-set longline fishery (Forney and Kobayashi 2005). No interactions have been observed for the Hawaii-based shallow-set fishery and potential future interactions are unlikely to occur.

3.3.3.2.2 Other Whales

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 (Carretta et al. 2007). 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 (Carretta et al. 2007). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 493 (CV=0.34) Bryde's whales (Barlow 2003). This is currently the best available abundance estimated for this stock in the Hawaii EEZ (Carretta et al. 2007). This species has never been observed to interact with the shallow-set fishery and potential future interactions are unlikely to occur.

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 (Carretta et al. 2007). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 2,138 (CV=0.77) Blainville's beaked whales (Barlow 2003), including a correction factor for missed diving animals. This is currently the best available abundance estimate for this stock in the Hawaii EZZ (Carretta et al. 2007). This species has never been observed to interact with the shallow-set fishery and potential future interactions are unlikely to occur.

The pygmy sperm whale is likely to occur all year in many parts of the tropical and subtropical Pacific (Caldwell and Caldwell 1989). Between the years 1949 and 2002, at least 22 strandings of this species were reported in the Hawaiian Islands (Tomich 1986, Nitta 1991, Maldini 2005).

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 (Carretta et al. 2007). A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 7,251 (CV=0.77) pygmy sperm whales (Barlow 2003), including a correction factor for missed diving animals. This is currently the best available abundance estimate for this stock in the Hawaii EEZ (Carretta et al. 2007). This species has never been observed to interact with the shallow-set fishery and potential future interactions are unlikely to occur.

3.3.3.2.3 Pinnipeds

Northern fur seals (*Callorhinus ursinus*) range throughout the North Pacific Ocean from southern California north to the Bering Sea and west to the Okhotsk Sea and Honshu Island, Japan. U.S. breeding sites or rookeries can be found at the Pribilof Islands and Bogoslof Island in the southern Bering Sea off Alaska and San Miguel Island in southern California (Reeves et al. 1992).

Northern fur seals and northern elephant seals (*Mirounga angustirostris*) may migrate into the northeastern portion of the historic Hawaii-based longline 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). On June 17, 1988, NMFS designated the Pribilof Islands stock (known since 1994 as the eastern Pacific stock) as "depleted" under the MMPA because it declined to less than 50 percent of the levels observed in the late 1950s and, at that time, there was no compelling evidence that carrying capacity had changed substantially since the late 1950s (50 CFR 216.15) (NMFS 2007b). These seals were harvested in great numbers through the 1960's (and halted in 1985) causing substantial population declines (NMFS 2007b).

Northern elephant seal adult females also may migrate into the area historically fished by the Hawaii-based fleet twice a year, returning briefly to land to breed in the winter and molt in the spring (Stewart and Delong 1995). 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). This species has never been observed to interact with the Hawaii shallow-set fishery.

3.4 Non-Listed Seabirds

Within the Hawaii Archipelago there are several seabird colonies in the MHI; however, the NWHI colonies harbor more than 90 percent of the total Hawaii seabird population. The NWHI provide most of the nesting habitat for more than 14 million Pacific seabirds. More than 99 percent of the world's Laysan albatross (*Phoebastria immutabilis*) and 98 percent of the world's black-footed albatross (*P. nigripes*) return to the NWHI to reproduce. Recent interactions between the Hawaii-based shallow-set fishery and seabirds are presented in Table 27.

Table 27: Interactions between the shallow-set fishery and seabirds, 2005-2008

Species	2004	2005	2006	2007	2008*
Number of sets made:	135	1,645	850	1,497	619
Black-footed albatrosses: released injured	0	3	0	6	1
Black-footed albatrosses: released dead	0	4	3	2	0
Laysan albatrosses: released injured	1	44	5	33	5
Laysan albatrosses: released dead	0	18	3	6	1
Short-tailed albatrosses	0	0	0	0	0

Source: NMFS PIRO unpublished observer data
* 2008 1st quarter data only

3.4.1 Albatrosses

Albatrosses and petrels that forage by diving are some of the most vulnerable species to bycatch in fisheries (Brothers et al. 1999). In general, seabirds are attracted to baited hooks (particularly during setting), dive on the hooks, become caught and drown. BirdLife International estimated that 300,000 seabirds are killed each year in this way, including 100,000 albatrosses. These species are long-lived, have delayed sexual maturity, small clutches and long generation times, resulting in populations that are highly sensitive to changes in adult mortality. Nineteen of the world's 21 albatross species are now globally threatened with extinction according to the IUCN (IUCN 2004, BirdLife 2004), and incidental catch in fisheries, especially longline fisheries, is considered one of the principal threats to many of these species (Veran et al. 2007). Hawaii-based longline fisheries may overlap with the short-tailed albatross but no interactions have been observed or reported. The fisheries do interact on low levels with black-footed and Laysan albatross species as described below.

A variety of seabird deterrence methods have been tested and found to reduce interaction rates and/or mortality of seabirds with longline fisheries (e.g., Brothers et al. 1995 and 1999, McNamara et al. 1999, Gilman et al., 2003, 2005, and 2007). When employed effectively, seabird avoidance measures have the potential to nearly eliminate seabird interactions (Naughton et al. 2007). Fishery interactions with seabirds under the Pelagics FMP have been drastically reduced since 2000 by new gear requirements and innovative technology resulting from research. Improved observer coverage (20 -26 percent for the tuna fishery and 100 percent for the swordfish fishery) has also resulted in better reporting.

The introduction of new seabird regulations in the Hawaii longline fishery reduced the seabird interaction rate by 67 percent on deep-sets (Gilman et al. 2008). Due to the low levels of observer coverage on shallow-sets prior to the implementation of the seabird regulations, as well as the low numbers of annual interactions that have occurred since these measures were implemented, NMFS has not published a quantitative analysis of their efficacy in terms of shallow-set interaction rates. However, as presented in Table 27, during 2007 the shallow-set fishery made 1,497 sets with 47 interactions observed with black-footed or Laysan albatrosses combined (0.031 interactions per set). This can be compared to the 1994-1998 combined interaction rate of 0.758 interactions per shallow-set used by the USFWS in their 2004 BiOp (USFWS 2004), yielding a 96 percent reduction in the combined black-footed and Laysan albatross shallow-set interaction rate.

3.4.1.1 Black-footed Albatross

Black-footed albatrosses are relatively long-lived, and some have worn bird-bands for at least 43 years. And although some black-footed albatross may return to the breeding colonies at two or three years of age, the minimum age at first breeding is at least five years and probably averages at seven or eight years (Rice and Kenyon 1962, Robbins 1966). Black-footed lay a single egg during a breeding season. In late October, they begin to return to the nesting colonies in the NWHI and Japan. Generally, the males arrive first in the last week of October and await the arrival of the females (Bailey 1952). Both black-footed and Laysan albatrosses mate for life, and the same mated pair will return each year to breed (Bailey 1952). Often the males will wait for their mate near the same nest site the pair shared in previous years (Bailey 1952).

Like other albatrosses, the black-footed albatross have well-developed visual and olfactory systems that assist them to locate food sources and these seabirds are predominantly crepuscular in their foraging activities (Warham 1990). They feed primarily by seizing prey off the ocean surface and by making shallow dives (~ 1 m) and their diet is comprised of crustaceans, squid, fish, flying fish eggs and zooplankton (Harrison 1990).

In their annual cycle, black-footed albatross normally range throughout the North Pacific between 20^{o} and 58^{o} N (Figures 22 and 23). Sanger (1974) suggests that the lowest southerly range is 10^{o} N. Anderson and Fernandez (1998) found that breeding adult black-footed albatrosses from the Tern Island colony covered much of the northeast Pacific Ocean during foraging activities; however, they caution that the study only tracked adult birds that were breeding or had bred in the 1997-98 breeding season and non-breeding or juveniles may or may not forage in the same area. Approximately 97 percent of black-footed albatrosses breed in the NWHI (Naughton et al. 2007). A smaller population of approximately 2,000 breeding pairs nests on small islands south of Japan. An estimated 62,437 breeding pairs were found on the NWHI in the hatch year 2006-07 count with 24,887 of these observed at Midway Atoll, a 3 percent increase since 2005 and a 30 percent increase from 2001 (Flint 2007). The most reliable and recent information indicates that black-footed albatross populations are stable or increasing (Naughton et al. 2007) with a combined population at Laysan and Midway Islands fluctuating around 50,000 breeding pairs since about 1992.

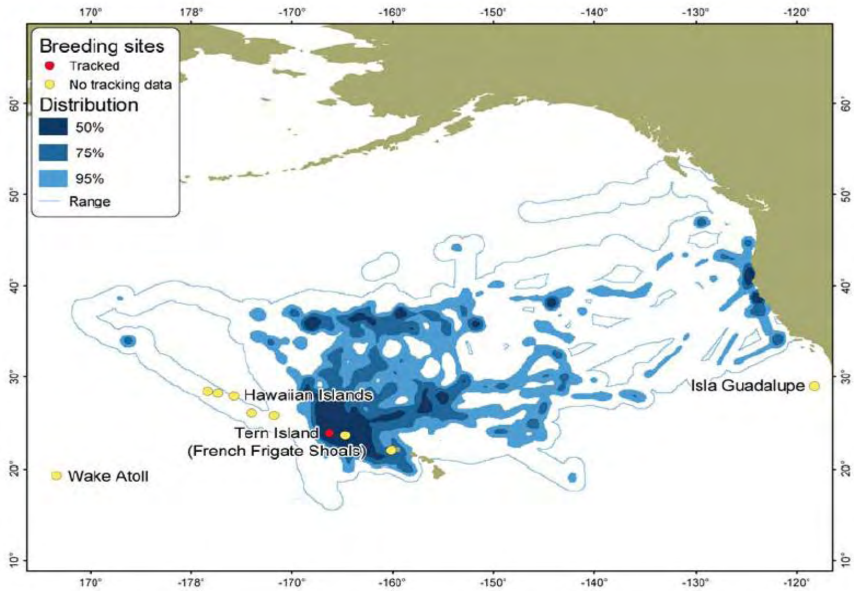

Figure 22: Breeding distribution of black-footed albatross in the North Pacific
Source: Map based on data contributed to BirdLife Global Procellariiform Tracking Database by S. Shaffer, Y. Tremblay, D.P. Costa, B. Henry, D.A. Croll, M. Antolos, J. Awkerman, and D. Anderson. *In:* AC4 Doc 61 Agenda Item No. 17. Agreement on the Conservation of Albatrosses and Petrels Fourth Meeting of Advisory Committee Cape Town, South Africa, 22–25, August 2008.

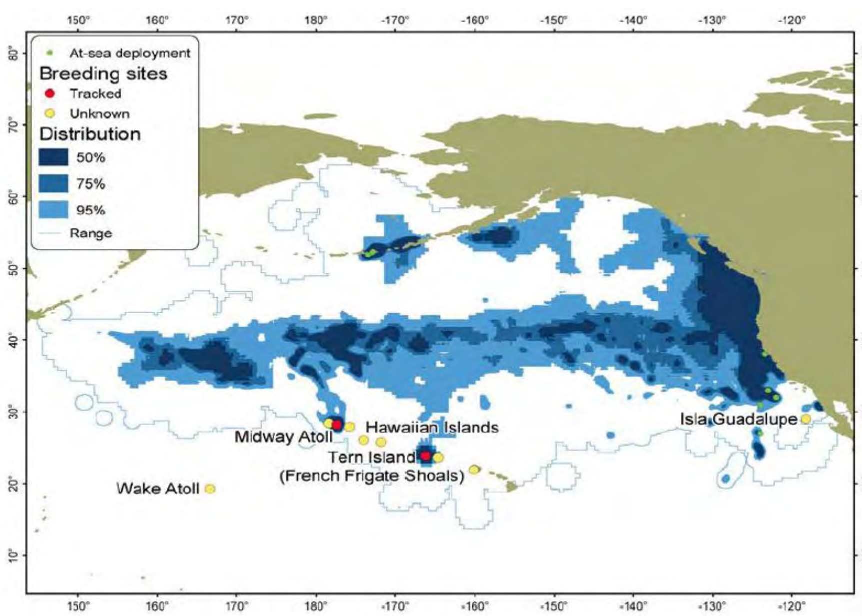

Figure 23: Non-breeding distribution of black-footed albatross in the North Pacific
Source: Map based on data contributed to BirdLife Global Procellariiform Tracking Database by: S. Shaffer, M. Kappes, Y. Tremblay, D. Costa, R. Henry, D. Croll; D. Anderson, J. Awkerman; M. Hester, D. Hyrenbach ,R. Suryan, K. Fischer, and G. Balogh. *In:* AC4 Doc 61 Agenda Item No. 17. Agreement on the Conservation of Albatrosses and Petrels Fourth Meeting of Advisory Committee Cape Town, South Africa, 22 – 25, August 2008.

3.4.1.2 Laysan Albatross

The Laysan albatross is the most abundant albatross in the world. They are characterized by a white head, neck and under parts. Their upper wings and back are black to dark gray and they have flesh-colored legs, feet, and bill. They also have dark plumage highlighting their eyes. Because variables such as population structure, mortality, and individual breeding frequency are not fully understood, a total world population estimate cannot be determined. Instead, an estimate of total numbers of nesting pairs has been used to track populations. Ninety-nine percent of the world's Laysan albatrosses breed in the NWHI with other small breeding sites in Japan and Mexico (Figures 24 and 25). The estimated world number of nesting pairs for the 2006-07 breeding season was 590,722 (Flint 2007). The largest breeding colony is at Midway Atoll, where the 2006-07 (December-January) count was 398,529 breeding pairs (Naughton et al. 2007), a 39 percent increase since 2001 (TenBruggencate 2006).

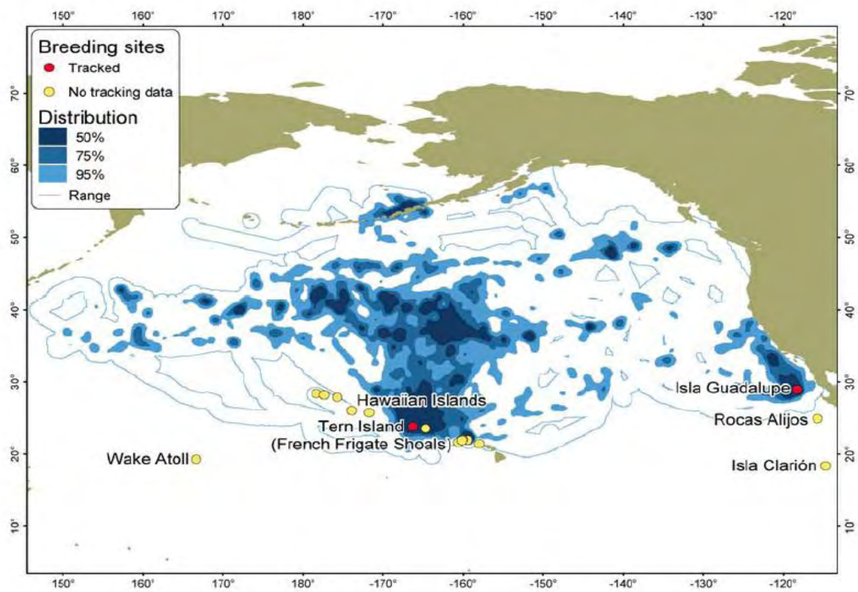

Figure 24: Breeding distribution of Laysan albatross in the North Pacific.

Source: Map based on data contributed to BirdLife Global Procellariiform Tracking Database by S. Shaffer, Y. Tremblay, D.P. Costa, B. Henry, D.A. Croll, M. Antolos, J. Awkerman, and D. Anderson. *In:* AC4 Doc 60 Agenda Item No. 17. Agreement on the Conservation of Albatrosses and Petrels Fourth Meeting of Advisory Committee Cape Town, South Africa, 22 – 25, August 2008.

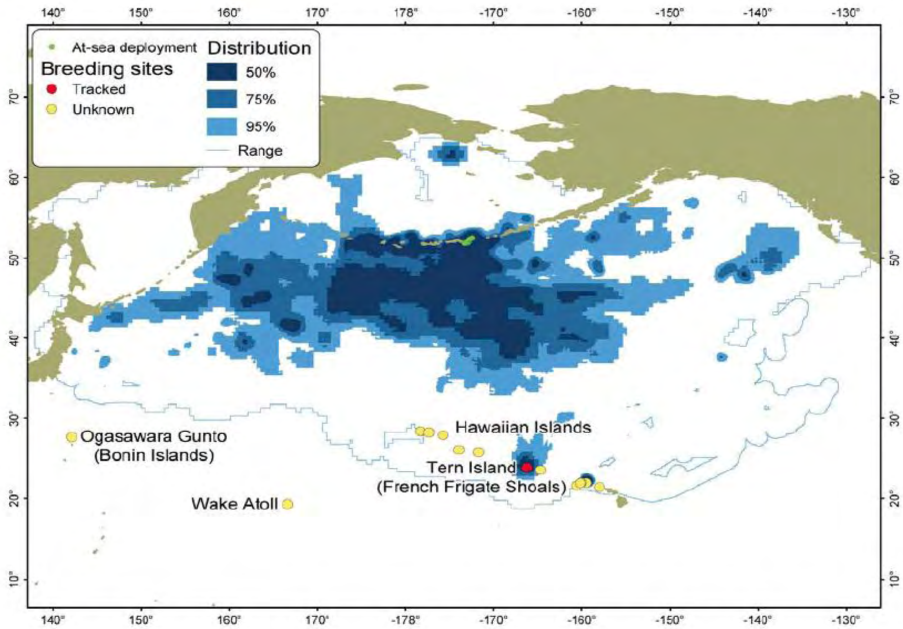

Figure 25: Non-breeding distribution of Laysan albatross in the North Pacific.
Source: Map based on satellite tracking data contributed to BirdLife Global Procellariiform Tracking Database by: S. Shaffer, M. Kappes, Y. Tremblay, D. Costa, R. Henry, D. Croll, D. Anderson, J. Awkerman, R. Suryan, K. Fischer, and G. Balogh. *In:* AC4 Doc 60Agenda Item No. 17. Agreement on the Conservation of Albatrosses and Petrels Fourth Meeting of Advisory Committee Cape Town, South Africa, 22 – 25, August 2008.

3.5 Social and Economic Environment

3.5.1 Description of the Hawaii Longline Fishery

Hawaii's longline fishery began around 1917 and was based on fishing techniques brought to Hawaii by Japanese immigrants. The early Hawaiian sampan-style flagline boats targeted large yellowfin and bigeye tuna using traditional basket gear with tarred rope mainline. This early phase of Hawaii longline fishing declined steadily into the 1970s due to low profitability and lack of investment in an ageing fleet (Boggs and Ito 1993). During the 1980s, tuna longline effort began to expand as there was increasing demand from developing domestic and export markets for high quality fresh and sashimi grade tuna. In the late 1980s and early 1990s, the nature of the fishery changed completely with the arrival of swordfish- and tuna-targeting fishermen from longline fisheries of the Atlantic and Gulf States. The influx of large, modern longline vessels promoted a revitalization of the fishery, and the fleet quickly adopted new technology to better target bigeye tuna at depth. The near-full usage of monofilament mainline longline reels further modernized the fleet and improved profitability. Longline effort increased rapidly from 37 vessels in 1987 to 138 vessels in 1990 (Ito and Machado 2001). An emergency moratorium was placed on the rapidly expanding fishery in 1991.

Longline fishing employs a mainline that is deployed as the fishing vessel moves across the water. The mainline is suspended horizontally below the surface by evenly spaced float lines that are clipped along the mainline's length. Branch lines that terminate with baited fishhooks are clipped to and suspended below the mainline. Longline deployment is typically referred to as "setting", and the gear, once it is deployed, is typically referred to as a "set". Longline sets are normally left to drift for several hours before they are hauled back aboard along with any catch. Mainlines typically consist of a single strand of monofilament line with a test strength of 450 to 680 kg (1000 to 1500 lb). Mainlines are stored on large horizontal reels, and may exceed 74 km (40 nm) in length. Float lines most frequently consist of braided, multi-strand lines with a quick release clip on one end and a large float on the other. Float lines are typically 10 to 30 meters (m) long. Branch lines typically consist of 15 to 30 m of 227 kg (500 lb) test monofilament line with a quick release clip on one end and a fishhook on the other. Depending on the fishery, branch lines may, or may not, have some form of weight attached above the hook.

The longline fleet is composed mostly of steel-hulled vessels and a few wood and fiberglass vessels. The longline fleet has historically operated in two distinct modes based on gear deployment: deep-set longline to target primarily tuna and shallow-set longline used to target swordfish or mixed species including bigeye, albacore and yellowfin tuna. Presently, Hawaii-based longline fishermen must declare themselves as shallow- or deep-set trips 72 hours in advance of their planned departure. Mixed trips are prohibited. Shallow-set fishermen must use float lines 20 m or less, 10 to 20 m float lines are standard. A typical shallow-set branch line is 15 to 20 m long, with a 45 to 85 gram lead weight in middle, and an 18/0 offset circle hook at end. About 840 hooks are deployed per shallow-set, with 4 to 5 hooks set between each float. Since swordfish are targeted at night, lightsticks are typically attached to every other branch line. Lightsticks are prohibited onboard vessels on deep-set declared trips. 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.

To further manage the rapidly expanding fishery, longline fishing was also prohibited within 50 nm of the main Hawaiian Islands to reduce gear conflicts between small troll and handline boats and longline vessels. Another area closure was established prohibiting longline fishing within a 50 nm radius of the Northwestern Hawaiian Islands to prevent interactions with endangered Hawaiian monk seals. A limited access program was established in 1994 allowing for a maximum of 164 transferable longline permits for vessels ≤101 feet in overall length that is administered by NMFS. During the same year, the Hawaii Longline Observer Program was initiated, primarily to monitor interactions with protected species.

In 1985, the longline fishery surpassed landings of the skipjack pole-and-line fleet and has remained the largest Hawaii-based fishery to date. Swordfish landings rose rapidly from 600,000 lbs in 1989 to 13.1 million pounds in 1993 (WPRFMC 2003). The Hawaii-based limited access longline fishery is the largest of all the pelagics fisheries under Council jurisdiction. This fishery accounted for the majority of Hawaii's commercial pelagic landings with an average of 9,672 t or 19.3 million lb for the years 2000 – 2005. The relative importance of swordfish to the fishery declined during the mid 1990s following a 47 percent decrease in landings in 1994. The latter part of 1994 saw a stabilization of swordfish landings at close to 6.5 million pounds/year, a significant increase in shark take, primarily blue shark fins, and a gradual increase in tuna fishing effort and landings. Effort continued to shift away from swordfish and back to tuna targeted trips throughout the latter 1990s (WPRFMC 2004).

During the mid to late 1990's, the fishery was often described as consisting of three components; a core tuna group, a swordfish targeting sector and vessels that were classified as "mixed"; switching between swordfish and tuna throughout the year or even within a single trip. Generally speaking, tuna vessels set deep gear with more than 15 hooks between floats in the morning, began hauling gear in the late afternoon or dusk, usually used a line shooter to deepen the set, preferred saury or sardine bait and made relatively short trips within 500 miles of home port. Swordfish boats were generally larger than tuna boats, set shallow gear at dusk with an average of 4 hooks between floats, used chemical light sticks, hauled gear at dawn, never used a line shooter, preferred large squid bait and made much longer trips beyond 700 miles from port. The swordfish grounds are generally north of Hawaii, between 145° and 175° W and 20° and 40° N, centered around the sub-tropical convergence zone. By the late 1990s, the fishery supplied 37 to 47 percent of the total U.S. domestic swordfish consumption.

Regulations imposed from 2001-2004 prohibited swordfish targeted longline fishing for Hawaii-based vessels due to concerns about interactions with protected sea turtles. As a result of restrictions on swordfish-targeted longline fishing by Hawaii-based boats, a number of vessels left Hawaii to exploit the same swordfish stocks from bases in California. Other swordfish boats converted gear to remain in Hawaii and target bigeye tuna.

Regulatory Amendment 3, effective April 2, 2004, re-opened the Hawaii-based shallow-set swordfish fishery by allowing 2,120 shallow-sets to be made annually (69 FR 17329, April 2, 2004). In order to reduce[16] and mitigate interactions with sea turtles, use of 18/0 (or larger) circle hooks with 10˚ maximum offset and mackerel-type bait instead of squid were required, along with other mitigation measures, and a maximum annual limit on the number of interactions with sea turtles is set at 16 leatherbacks and 17 loggerheads. Integral to this program has been the requirement for 100 percent observer coverage. Most of the swordfish boats that had moved to California have now returned to Hawaii; however, tuna directed effort remains higher than for swordfish.

Regulatory Amendment 4, effective December 15, 2005, further reduced and mitigated interactions between turtles and longline gear by requiring that: (1) owners and operators of vessels registered for use under longline general permits attend protected species workshops annually; (2) owners and operators of vessels registered for use under longline general permits carry and use dip nets, line clippers, and bolt cutters, and follow handling, resuscitation, and

[16] In experiments conducted by NMFS with longline vessels in the Atlantic, the use of circle hooks and mackerel-type bait significantly reduced sea turtle interaction rates. The mean reduction rate for loggerhead turtles was 92 percent, with an accompanying 67 percent reduction of leatherback interactions.

release requirements for incidentally hooked or entangled sea turtles; and (3) operators of non-longline vessels using hooks to target pelagic management unit species follow sea turtle handling, resuscitation, and release requirements, as well as remove the maximum amount of gear possible from incidentally hooked or entangled sea turtles (70 FR 69282). In addition, this rule extended the requirement to use circle hooks, mackerel-type bait and dehookers when shallow-setting north of the equator to include all longline vessels managed under the Pelagics FMP.

All longline vessels carry mandatory VMS monitored by the NMFS and must submit mandatory logsheet data at the completion of every trip. VMS are satellite-based vessel monitoring systems whereby each unit transmits a signal identifying the exact latitude and longitude of a vessel.

The limited access program allows for 164 vessels in the longline fisheries, but active vessel participation has been closer to 120 during the past decade. About 30 vessels have participated in the shallow-set fishery annually since its reopening; 33 in 2005, 37 in 2006, and 29 in 2007. Vessel sizes range up to nearly the maximum 101 foot limit, but the average size is closer to 65 – 70 ft. Most of the vessels are of steel construction and use flake ice to hold catch in fresh/chilled condition. A few older wooden boats persist in the fishery. Some of the boats have mechanical refrigeration that is used to conserve ice, but catch is not frozen in this fishery.

The operational characteristics of Hawaii-based longliners were summarized from interviews and NMFS data by O’Malley and Pooley (2003) during the 2000 season. Based on their interviews, swordfish vessels were newer than tuna boats on average (14 vs. 23 years), were slightly larger (average 74 vs. 65 feet), had larger fish hold capacities (mean 37,765 vs. 33,967 pounds), carried more fuel and had more powerful engines compared to tuna targeting vessels. Swordfish vessels made fewer, longer trips, set more times per trip and traveled much further than tuna vessels. Based on interview data, Hamilton et al. (1996) found that tuna vessels operated with an average of 3.7 – 4 crewmen, while swordfish vessels required a larger crew of 4 – 5 persons (both figures excluding the captain). The majority of crew members are non-citizens whose income is usually sent back to their home country as remittances and does not enter the local economy.

Almost all of the Hawaii-based longline catch is sold at the United Fishing Agency auction in Honolulu. It is believed that very little of the longline catch is directly marketed to retailers or exported by the fishermen. For detailed information and annual landings data see the Council’s Annual Reports. Table 28 illustrates that Hawaii’s longline fleet is by far the largest commercial pelagic producer in Hawaii. Figures 26-31 provide data and trends for the Hawaii-based longline fleet and shallow-set fishery.

Table 28: Hawaii commercial pelagic landings, revenue, and average price by fishery

	2005			2006		
Fishery	**Pounds Landed (1000 lbs)**	**Ex-vessel Revenue ($1000)**	**Average Price ($/lb)**	**Pounds Landed (1000 lbs)**	**Ex-vessel Revenue ($1000)**	**Average Price ($/lb)**
Longline	23,275	$61,379	$2.76	21,478	$49,207	$2.66
MHI trolling	2,517	$5,323	$2.40	2,363	$4,713	$2.44
MHI Handline	1,193	$2,138	$1.89	645	$1,187	$2.11
Offshore Handline	313	$410	$2.05	390	$458	$2.11
Aku boat	931	$1,137	$1.23	632	$812	$1.41
Other Gear	155	$250	$2.15	286	$432	$2.41
Total	**28,384**	**$70,637**	**$2.64**	**25,794**	**$56,809**	**$2.59**

Source: 2006 WPRFMC Pelagic Fisheries Annual Report

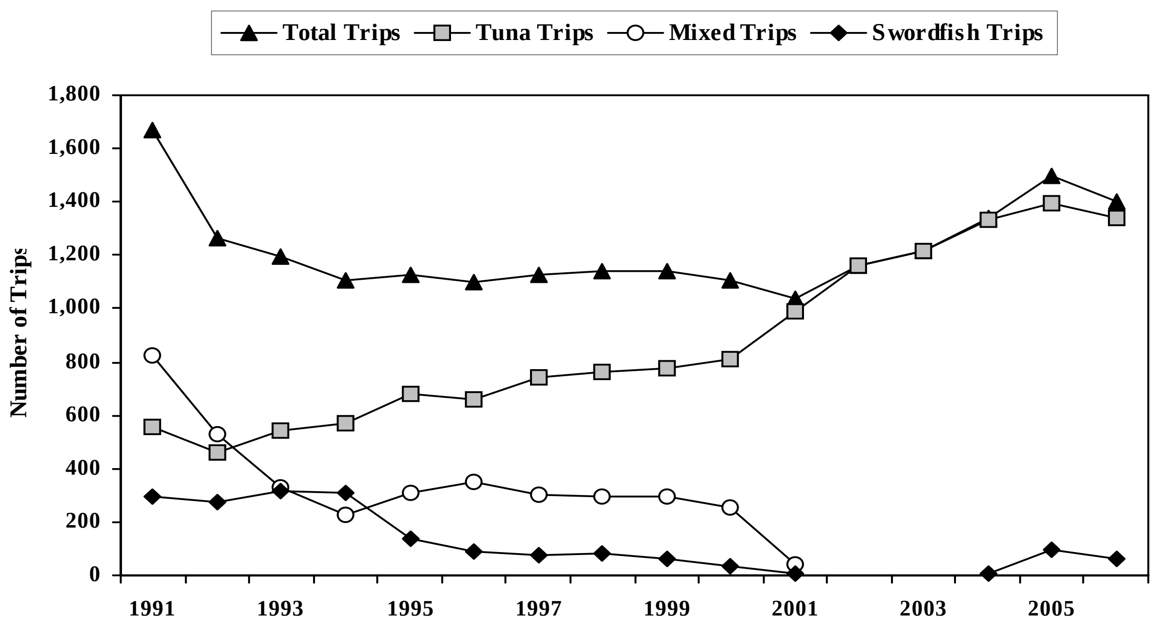

Figure 26: Annual number of trips in the Hawaii longline fishery, 1991-2006
Source: 2006 WPRFMC Pelagic Fisheries Annual Report

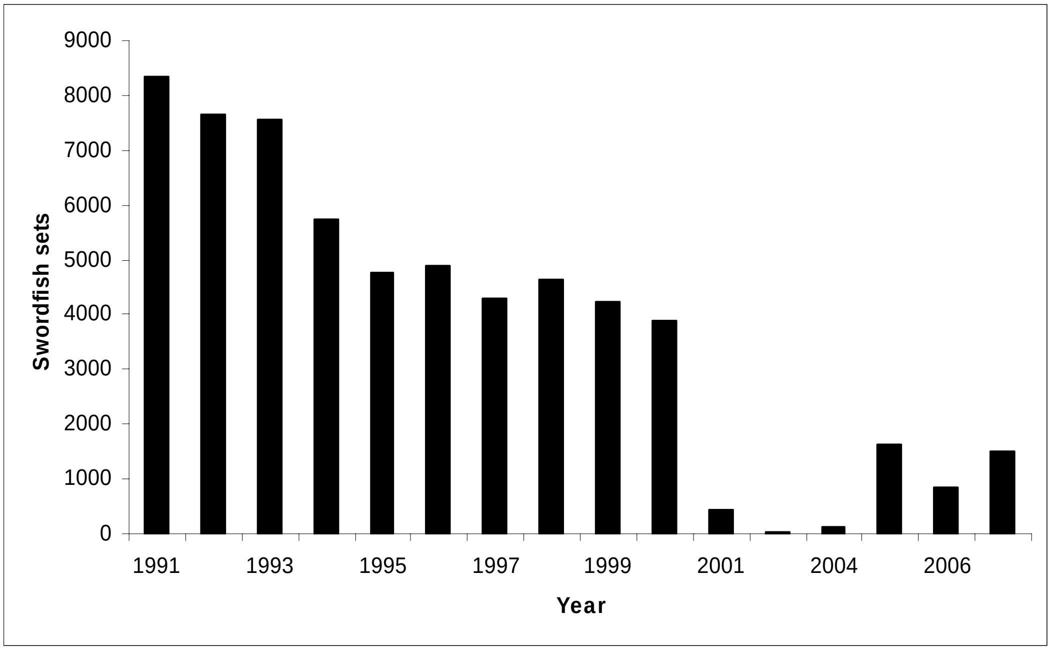

Figure 27: Annual Hawaii swordfish longline sets (shallow and mixed) 1991-2007
Source: NMFS PIFSC unpublished logbook data

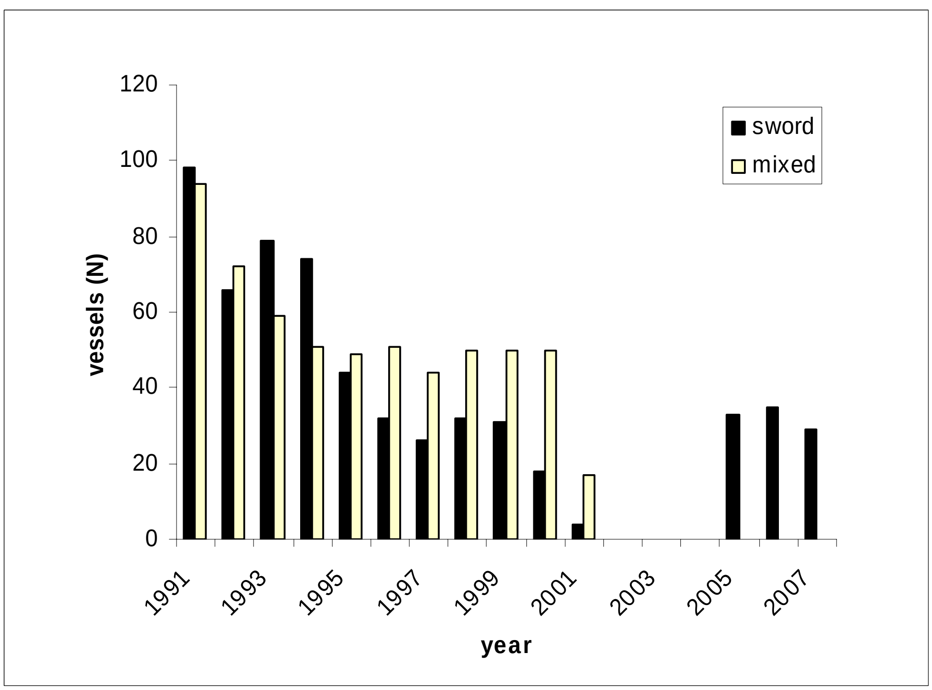

Figure 28: Number of active Hawaii longline vessels targeting swordfish, 1991-2007
Source: WPRFMC Pelagic Fisheries Annual Report 2007

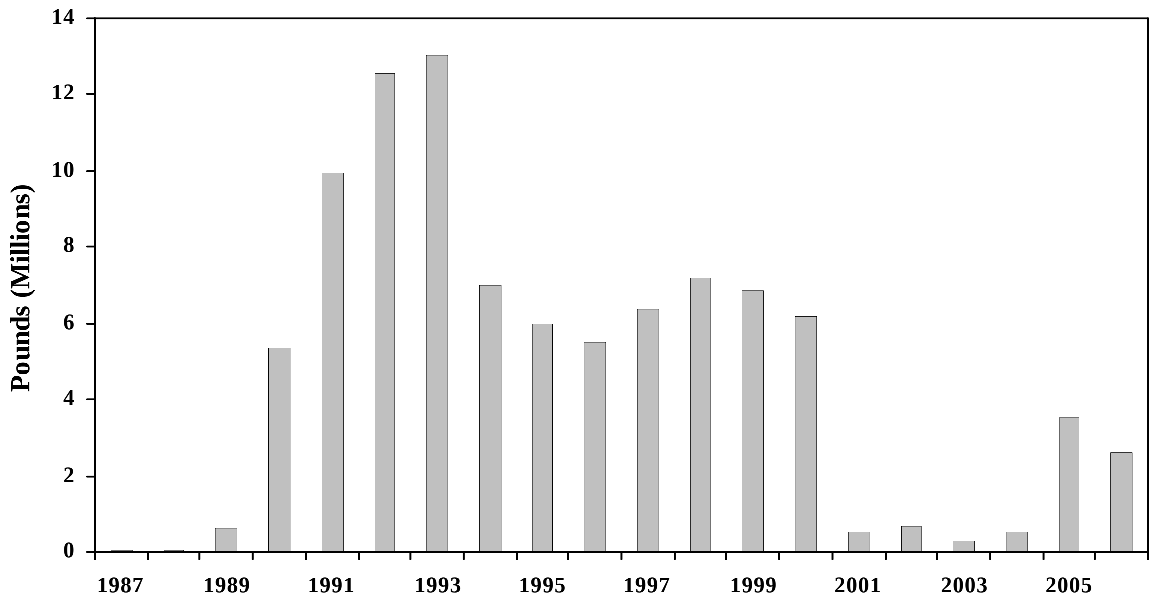

Figure 29: Hawaii swordfish landings, 1987-2006
Source: 2006 WPRFMC Pelagic Fisheries Annual Report

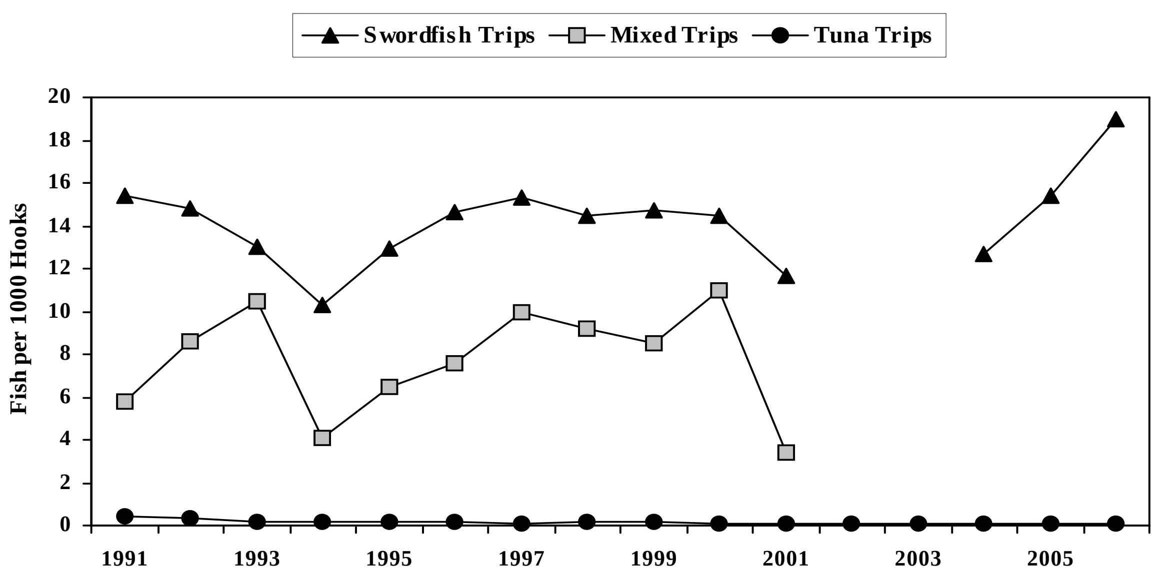

Figure 30: Catch per unit effort of the Hawaii longline fishery, 1991-2006
Source: 2006 WPRFMC Pelagic Fisheries Annual Report

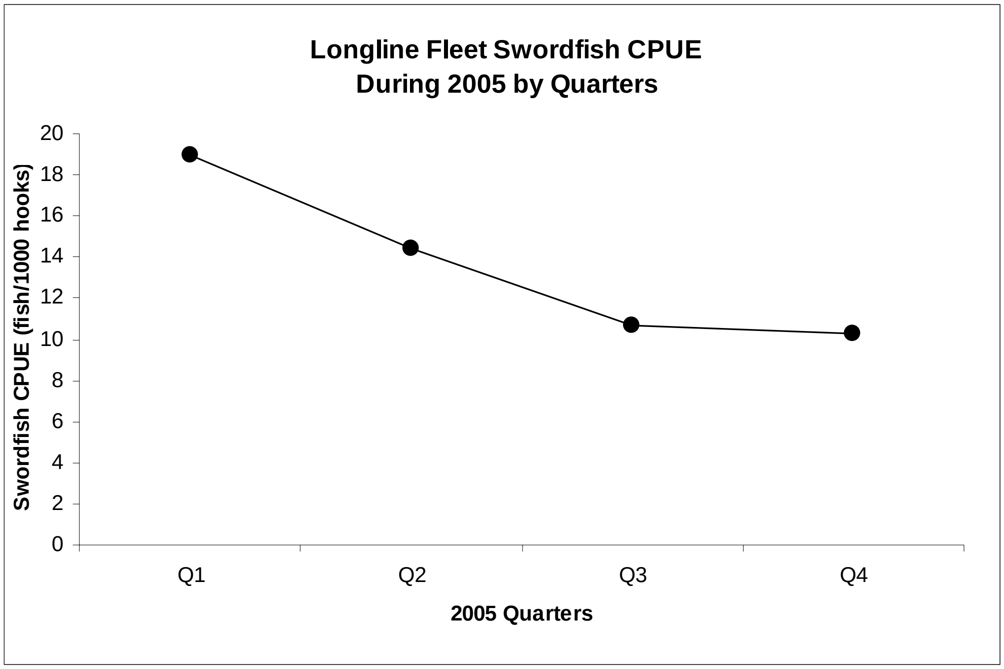

Figure 31: Swordfish CPUE by quarter, 2005
Source: 2006 WPRFMC Pelagic Fisheries Annual Report

As seen in Figure 31, swordfish CPUE is highest in the first quarter of the year with the second quarter also yielding high CPUE levels. Since the reopening of the shallow-set fishery in 2004, effort in the fishery has been highest in the first quarter. However, prior to 2004, effort in the fishery was highest in the second quarter. A plausible explanation for higher first quarter effort since 2004 is linked to the possibility that the annual sea turtle hard caps are driving effort in the first quarter, i.e., a race to the fish before a potential fishery closure due to reaching the turtle cap (see Chapter 4 for more discussion on quarterly effort distribution).

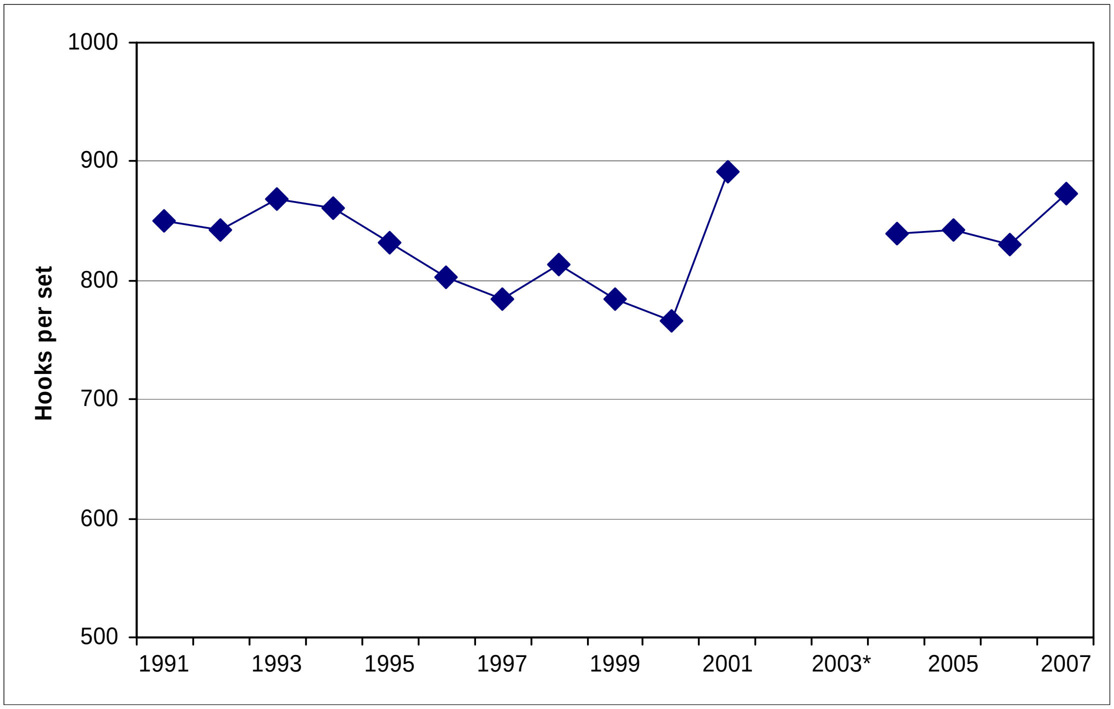

Figure 32: Average number of hooks per set in Hawaii shallow-set fishery, 1991-2007
Source: NMFS unpublished data

As seen in Figure 32, the number of hooks per shallow-set has been relatively stable since 1991. The number of hooks per set (846 hooks/set average) is limited by the shallow depth fishermen set at – as the weight of too many hooks would lower hooks out of the depth range from which the highest swordfish catch rates are recorded. In addition, existing Hawaii longline limited entry regulations limit vessels to a maximum length of 101 ft, which limits the number of hydraulic longline reels that can be carried on a vessel and thus the the length of longlines being set. Furthermore, FMP seabird mitigation regulations require that sets can only be made one hour after local sunset and completed one hour before local sunrise, thereby limiting the amount of gear that can be set in one fishing day.

3.5.2 Hawaii Fishing Community

The Magnuson-Stevens Act defines a "fishing community" as "...a community that is substantially dependent upon or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew, and fish processors that are based in such communities" (16 U.S.C. § 1802(16)). NMFS further specifies in the National Standard guidelines that a fishing community is "...a social or economic group whose members reside in a specific location and share a common dependency on commercial, recreational, or subsistence fishing or on directly related fisheries dependent services and industries (for example, boatyards, ice suppliers, tackle shops)".

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

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

The nature and magnitude of Hawaii communities' dependence on and engagement in pelagic fisheries have also been affected by the overall condition of the state's economy. As described in NMFS' 2001 and 2004 Final Environmental Impact Statements (NMFS 2001 and 2004a), tourism is by far the leading industry in Hawaii in terms of generating jobs and contributing to gross state product. In the first years of the new century Hawaii's tourism industry suffered major external shocks, including the September 11, 2001 terrorist attacks and SARS (severe acute respiratory syndrome) epidemic (Brewbaker 2003). The market for tuna weakened due to the decline in tourists arriving from Japan and elsewhere and due to a weak export demand. More recently, the decline in the value of the U.S. dollar compared with other currencies such as the Euro and the Japanese yen has made it more expensive for Americans to travel overseas and cheaper for foreign visitors to visit Hawaii. However, recent increases in fuel prices are raising both operating and consumer costs, which are believed to be impacting global tourism markets.

3.5.3 Hawaii Economic Information[17]

Hawaii's economy is dominated by tourism and defense, with tourism by far the leading industry in terms of employment and expenditures. The two represent approximately one quarter of Gross State Product without consideration of ancillary services and also comprise the largest shares of "export" earnings (Tables 29 and 30).

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[17] Some of the statistics and information presented in this section is dated; Updated statistics on Hawaii's Economic Data can be found at: http://hawaii.gov/dbedt/info/economic/library/facts/state

Table 29: Hawaii's gross state product

Year	Gross State Product (billion $)	Per Capita State Product ($)	Resident Population
2004	50.7	40,325	1,259,299
2005	53.7	42,119	1,275,194
2006	58.3	38,083	1,285,498
2007	61.3	47,945	1,283,388

Source: DBEDT 2007
http://hawaii.gov/dbedt/info/economic/library/facts/state

Table 30: Hawaii's "export" industries

Year	Sugar (million $)	Pineapple (million $)	U.S. Military (million $)	Tourism (million $)
2004	61.5	83.1	4,772	10,862
2005	58.9	79.3	5,015	11,904
2006	50.2	75.5	5,400	12,381

Source: DBEDT 2007

Natural resource production remains important in Hawaii, although nothing compared to the period of the sugar and pineapple plantations from throughout the first 60 or 70 years of the 20th century. Crop and livestock sales were $560,827 million in 2006, with the primary diversified agriculture crops being flower and nursery products, $100.6 million; pineapples, $79.2 million; seed crops, $70.4 million; vegetables and melons, $67.7 million; sugar, $58.8.million; macadamia nuts, $44.4 million; coffee, $37.3 million; cattle, $22.7 million; milk, $18.3 million (DBEDT 2007). Aquaculture production was $28.4 million in 2005 (DBEDT 2006), although much of aquaculture's value to Hawaii comes from development of technology.

Hawaii's commercial economy was particularly vibrant between 2000 and 2005, with a 7.5% growth in Gross State Product in 2005 and an average of 5.8% annual growth rate since 2000. Figure 33 indicates the long-term trend in Gross State Product (1970-2005), with the inflation-adjusted figures clearly showing the downturns in the early 1980s and the mid-1990s, followed by sustained growth recently.

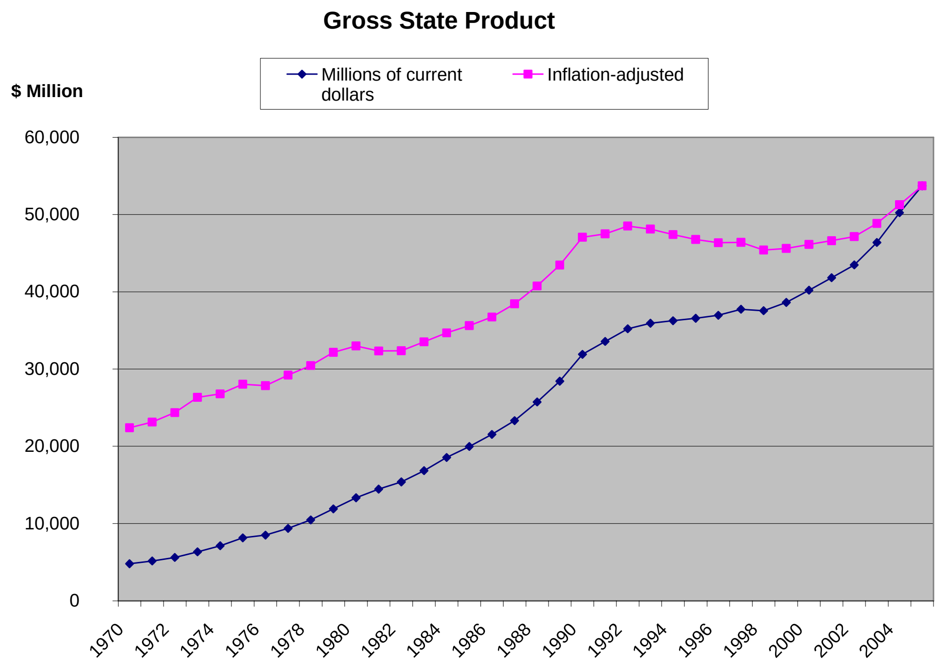

Figure 33: Gross State product, 1970-2005
Source: DBEDT 2006

The 2007 unemployment rate (see Table 31) of 2.6 percent (DBEDT 2007) was the lowest in the United States, and close to half the U.S. average rate. This marks a major turn-around from the 1990s when Asian economies declined, the U.S. military down-sized due to the end of the Cold War, and Hawaii plantation agriculture was battered by the cost effects of global trade. Construction, manufacturing and agriculture account for only 9 percent of wage and salary jobs. About 30 percent of civilian workers are professional or managerial. Federal, state and local government accounts for 20 percent of wage and salary jobs (DBEDT 2007).

Table 31: Hawaii employment statistics

	2007
Civilian labor force	649,100
Employed	639,100
Unemployment rate	2.6%
Payroll jobs	630,050
Real personal income ($ million)	50,359

Source: DBEDT 2007

Tourism arrivals increased almost monotonically from 1970-1990, but growth was slower in the 1990s until the past three years. There were 7.56 million tourists in Hawaii in 2006. This represents a daily rate of 185,445 tourists, 13 percent of the “de facto” population (resident, tourist, and military combined), indicating the weight of tourism in many sectors of Hawaii’s economy and society (DBEDT 2007). Tourism arrivals have become more evenly distributed across source locations, with the continental U.S. and Japan being the mainstays, but with arrivals increasing from Europe and China. Nonetheless, Hawaii's tourism economy remains subject to national and international economic factors such as the recent spikes in oil prices, which are believed to be hurting tourism markets such as Hawaii.

Total Federal expenditures were $12.2 billion in 2004, with 85,900 military personnel and dependents and 31,300 Federal civilian workers (not all of whom work on military bases, DBEDT 2007). Research and development spending by the Federal government (2003) was $349.6 million representing the importance of the University of Hawaii and a number of other public and private research entities in particular.

Despite these successes, at some individual and community levels Hawaii's commercial economy has been less successful. For example, per-capita disposable income in Hawaii ($29,174) has fallen to below the national average due to a cost of living that nearly doubles the national average (Table 32).

Table 32: Hawaii cost of living comparison

Cost of Living Analysis: Ratio of Honolulu living costs compared to U.S. Average at four income levels				
	Income level 1	Income level 2	Income level 3	Income level 4
Honolulu cost of living indexed to U.S. average	192.9	171.6	161.9	155.1
Rent, utilities	241.4	235.4	230.3	229.0

Source: DBEDT 2007

Hawaii per capita income has fallen from 122.5% of the U.S. average in 1970 to 99% in 2005 (Figure 34). Much of this is attributable to housing costs, with the average single family house selling for $744,174 in 2005, with the median being $590,000, the latter discrepancy also indicating the uneven nature of the housing industry in Hawaii over the past several years.

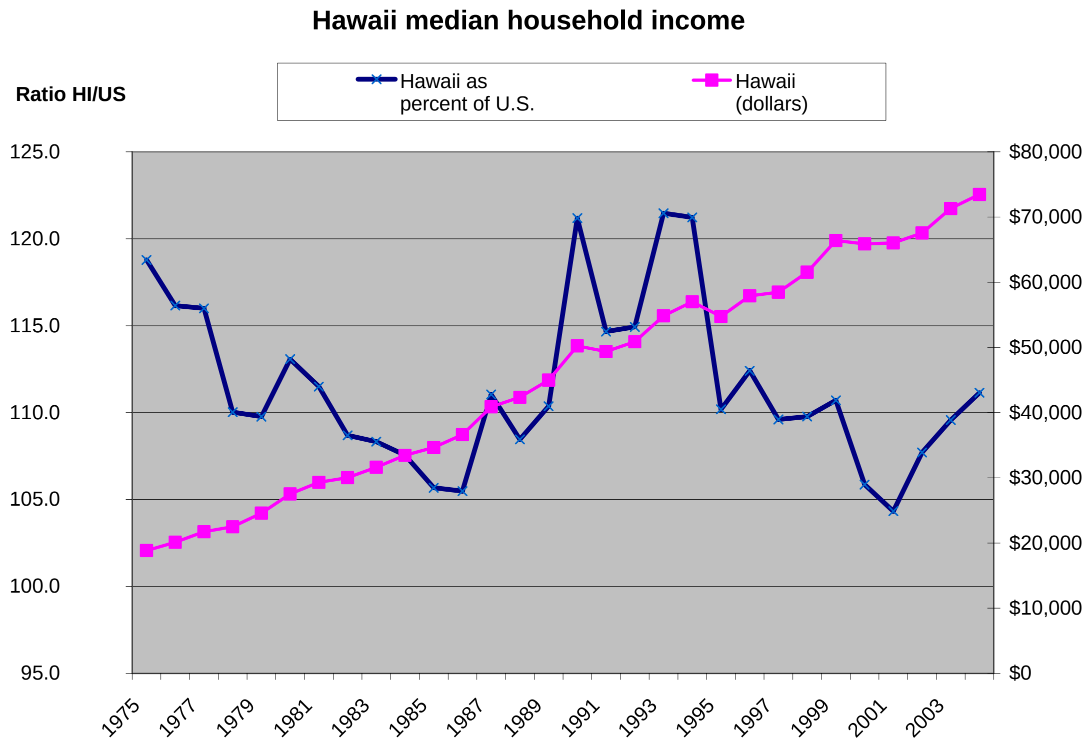

Figure 34: Hawaii median household income, 1975-2005
Source: DBEDT 2006

Tourism is a service industry, and as such, tends to have lower wage levels than manufacturing, for example. So the dominance of tourism means that many workers in Hawaii hold more than one job, with 8 percent of the workforce working more than one job (DBEDT 2007). Similarly, the benefits of the commercial economy are not spread evenly across either islands or ethnic groups in Hawaii. In 2006, 8.6% of Hawaii's population was below the poverty line (DBEDT 2007). The effect of these conditions is that the value of common use resources, such as shorelines, forests, and the ocean, is important for both subsistence and recreational reasons.

The State of Hawaii has been attempting to diversify its economy for many years. Industries encouraged are science and technology, film and television production, sports, ocean research and development, health and education tourism, diversified agriculture and floral and specialty food products (DBEDT 2007); however, these remain a small percentage of the Hawaii commercial economy.

Bank of Hawaii summarized the recent general trends as of August, 2008. At midyear, 2008, Hawaii's economic growth has slowed to a crawl due to higher oil prices, falling tourism, and falling residential investment. The decrease in tourism is being fueled by both decreased domestic demand and a reduction in the number of trans-Pacific flights resulting from the shutdown of Aloha Airlines and ATA, which previously represented 15-20% of the available seats to Hawaii. Hawaii's unemployment rate rose to 3.5% in June 2008 on a seasonally-adjusted basis, while job growth slowed to a few tenths of one percent, well below the rate necessary to generate enough labor force absorption to prevent the unemployment rate from rising. Since then, Hawaii's unemployment rate has continued to rise and as of September 2008, hit 4.5%. Honolulu's inflation rate was 4.9 percent in first half 2008, up slightly from the 4.8 percent for all of 2007. While shelter costs began to moderate, energy costs rose significantly. Household fuels and utilities costs rose 36.4 percent, year-over-year.

The most recent estimate of the ex-vessel value of fish sold by the Hawaii-based longline fishery amounts to a small percentage of Gross State Product, in fact, less than 1%. On the other hand, the seafood industry is an important component of local and tourist consumption, and recreational and subsistence fishing represent a substantial proportion of the local population (estimated at 109,000 participants, 8.6% of Hawaii's population; DBEDT 2005). An additional 41,000 tourists are also reported to go fishing while in Hawaii, and total fishing expenditures (resident and tourist combined) were estimated at $125 million (DBEDT 2005).

The most recent estimate of the total economic contribution of Hawaii's demersal and pelagic commercial, charter, and recreational fishing sectors to the state economy indicated that in 1992, these sectors contributed $118.79 million of output (production) and $34.29 million of household income, employing 1,469 people (Sharma et al. 1999.) These contributions accounted for 0.25 percent of total State output ($47.4 billion), 0.17 percent of household income ($20.2 billion), and 0.19 percent of employment (757,132 jobs). Recreational, subsistence and sport (e.g., charter) fisheries provide additional but unquantified economic benefits in terms of angler satisfaction, protein sources, and tourism revenues.

Hawaii's pelagic fisheries are responsible for the largest share of annual commercial landings and ex-vessel revenue, with 26.3 million pounds of pelagic fish landed in 2007 at an ex-vessel value of $ 71.6 million. The domestic longline fishery for tuna, swordfish, and other pelagic species is the largest component of the fishery, landing 24.7 million pounds in 2007 with an ex-vessel value of $62.7 million. Among the demersal fisheries, commercial harvests of coral reef species dominate, with MHI and NWHI bottomfish relatively close behind (Table 33). The remainder of Hawaii's commercial fisheries are relatively small, with annual fishery ex-vessel revenues of less than $150,000.

Table 33: Ex-vessel revenues from Hawaii's fisheries

	Pounds Sold	Ex-vessel Revenue
Pelagics (2007)	26,391,000	$71,639,000
Coral reef species (2005)	701,624	$1,796,764
MHI bottomfish (2003)	272,569	$1,460,000
NWHI bottomfish (2003)	222,000	$851,219
MHI crustaceans (2005)	10,091	$110,927
Precious corals (1997)	415	$10,394
Total	29,590,699	$74,866,304

Source: Pelagics WPRFMC 2007 Annual Report; State of Hawaii-WPacFIN

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Chapter 4: Environmental Impacts

For each alternative, the potential direct and indirect impacts on each of the affected components of the human environment are described in Sections 4.1 through 4.3. Also discussed are the potential cumulative impacts of the alternatives in Section 4.4 as well as environmental justice in Section 4.5.

4.0 Analytical Methodology

Data used in this analysis were provided by NMFS. Protected species and seabird interactions, recorded by Federal observers aboard all Hawaii-based swordfish longline vessels between 2005 and the 1st quarter of 2008, were used to calculate average interaction rates per set, by species and quarter (Table 34). Quarter 1 (Q1) includes all fishing effort and interactions observed during January–March of each year, Quarter 2 is April-June, Quarter 3 is July-September, and Quarter 4 is October-December.

Table 34: Observed quarterly interaction rates (number of interactions per set) for Hawaii longline swordfish vessels, 2005-2008*

Species	Q1	Q2	Q3	Q4
Leatherbacks: released injured	0.0020	0.0045	0.0000	0.0048
Loggerheads: released injured	0.0118	0.0015	0.0073	0.0144
Olive Ridleys: released injured	0.0003	0.0007	0.0000	0.0000
Unidentified hardshell turtles: released injured	0.0000	0.0000	0.0000	0.0000
Green turtles: released injured	0.0003	0.0000	0.0000	0.0000
Bryde's whales: released injured	0.0003	0.0000	0.0000	0.0000
Bottlenose dolphins: released injured	0.0014	0.0000	0.0000	0.0000
Risso's dolphins: released injured or dead	0.0027	0.0000	0.0000	0.0000
Unidentified whales: released injured	0.0000	0.0000	0.0000	0.0000
Humpback whales: released injured	0.0007	0.0000	0.0000	0.0000
Black-footed albatrosses: released injured or dead	0.0037	0.0045	0.0000	0.0000
Laysan albatrosses: released injured or dead	0.0135	0.0195	0.0000	0.0000

Source: PIRO Observer Program data
* 2008 includes 1st quarter data only
Note: The above estimates may change as new fishery and observer data is received

These quarterly rates were then applied to the quarterly swordfish effort levels (number of sets) anticipated under each alternative to yield predicted numbers of protected species interactions for each alternative. Quarterly rates were used as turtle interactions vary substantially within each year. Data from 2005-2007 were used because prior to 2004 sea turtle mitigation measures were not required and interaction rates were more than double what they are now (Gilman and Kobayashi 2007). A total of 88 swordfish sets was observed in 2004; however, protected species data are not available from PIRO on a quarterly basis for that year.

Interaction rates for protected species and seabirds per 1,000 hooks are provided in Table 35. The interaction rates were calculated by taking the total number of observed interactions for each species divided by the total number of hooks observed and then multiplied by 1,000. The number of hooks set by quarter was not available at the time of drafting the DEIS, so Table 35 presents information from the period of 2004 to the first quarter of 2008.

In the second quarter of 2008, an interaction between a shallow-setting longline boat and a false killer whale was observed within EEZ waters around Hawaii approximately 150 nm northeast of Molokai. Based on the geographic location of the interaction, it does not appear to have involved an animal from the false killer whale insular stock. The addition of this interaction to the data set raises the expected annual interactions with false killer whales under all alternatives. This result is analogous to that for Bryde's whales for which a single interaction was recorded in the dataset. Although complete fishery information is not available to completely update the analysis presented here, an annual interaction estimate of up to one false killer whale was added to the expected impacts of each of the alternatives so as to allow consideration of this interaction.

Table 35: Observed interaction rates per thousand hooks for Hawaii longline swordfish vessels, 2004-2008

Species	Interactions per thousand hooks
Leatherback turtles: released injured	0.0041
Loggerhead turtles: released injured	0.0110
Olive Ridley turtles: released injured	0.0005
Green turtles: released injured or unknown	0.0002
Byrde's whale: released injured	0.0002
Bottlenose dolphin: released injured	0.0010
Risso's dolphin: released injured or dead	0.0020
Humpback whales: released injured	0.0005
Black-footed albatross: released injured or dead	0.0046
Laysan albatross: released injured or dead	0.0283

Note: 2008 includes 1st quarter data only

Predicted fish catch rates (number of fish caught per set) are based on quarterly logbook data provided by NMFS (PIFSC 2008) for Hawaii-based longline swordfish trips since the 2004 implementation of regulatory requirements to use circle hooks and mackerel-type bait, which may have affected catch rates for swordfish and other species. These 2004-2007 average quarterly rates (Table 36) were again applied to the respective quarterly swordfish effort levels (number of sets) anticipated under each alternative to yield fish catches for each alternative.

Table 36: 2004-2007 Hawaii longline average catches (number of fish) per set by quarter

Species	Q1	Q2	Q3	Q4
Swordfish	15.15	12.22	8.89	9.78
Striped marlin	0.11	1.24	0.63	0.11
Blue marlin	0.01	0.34	0.19	0.01
Bigeye tuna	1.51	0.58	1.01	0.49
Albacore tuna	1.04	0.03	0.01	2.14
Yellowfin tuna	0.11	0.13	0.06	0.01
Blue shark	12.41	5.04	8.09	10.04
Mahimahi	0.55	5.08	5.74	0.27
Opah	0.05	0.01	0.02	0.22
Ono	0.02	0.14	0.06	0.00
Pomfret	0.14	0.05	0.02	0.14
Mako shark	0.70	0.40	0.33	1.21
Oceanic whitetip shark	0.00	0.24	0.19	0.00
Oilfishes	0.73	2.29	3.01	0.56
Other pelagics	0.04	0.17	0.02	1.09
Other sharks	0.03	0.06	0.01	0.07
Other tuna	0.01	0.00	0.29	0.18
Shortbilled spearfish	0.03	0.18	0.04	0.01
Skipjack tuna	0.04	0.03	0.01	0.01
Thresher sharks	0.02	0.05	0.10	0.02

Source: PIFSC 2008

These catches were converted from numbers of fish to pounds using 2005-2006 average weight recorded per fish for each species (WPRFMC 2006, Table 37). In some cases, average weights are not available. This is either because virtually all catches of certain species are discarded (e.g., oceanic whitetip sharks) or because related species caught in small numbers have been aggregated into groups (e.g., other pelagics, sharks, and tunas). See Table 12 for recent catches of these species and groups.

Table 37: 2005-2006 average weight per fish

Species	2005-2006 average weight per fish (lb)
Albacore Tuna	51
Bigeye Tuna	87
Blue Marlin	163
Blue Shark	100
Mahimahi	14
Mako Shark	177
Oceanic Whitetip Shark	n/a

Species	2005-2006 average weight per fish (lb)
Oilfishes	17
Ono	30
Opah	83
Other Pelagics	n/a
Other Sharks	n/a
Other Tunas	n/a
Pomfret	13
Shortbilled Spearfish	31
Skipjack Tuna	16
Striped Marlin	68
Swordfish	166
Thresher Sharks	198
Yellowfin Tuna	64

Source: WPRFMC 2006
n/a = not available

The catch data presented for each alternative begins with the pounds of fish predicted to be caught ("pounds caught") then reduces this number by the discard rates recorded by Federal observers (see Table 10) for that species to arrive at "pounds kept." The next column indicates the pounds of fish discarded dead (again from NMFS observer data). Total species impacts ("total mortality") can be regarded as the sum of the pounds kept plus the pounds discarded dead, plus some portion of those discarded alive that subsequently perish due to their experience.

Average annual ex-vessel species specific prices received by Hawaii-based swordfish longline vessels between 2004 and 2007 (PIFSC 2008) were applied to "pounds kept" to calculate predicted ex-vessel revenues. The one exception to this is swordfish which is the fishery's target species and accounts for approximately 90 percent of its revenue. Because swordfish prices are known to vary within years, swordfish ex-vessel revenues are based on recent quarterly average prices (2004-2007, PIFSC 2008) rather than a single annual average price (Table 38). This provides explicit consideration of temporal swordfish price effects under each alternative.

Table 38: 2004-2007 Hawaii longline average swordfish ex-vessel prices

	Q1	Q2	Q3	Q4
Price per pound	$2.38	$2.11	$2.59	$2.21

Source: PIFSC 2008

Predicted quarterly effort levels for each alternative utilize three temporal effort distributions. The first is that observed in the current "tightly constrained" regulatory environment which restricts annual effort to 2,120 sets (approximately 50 percent of the 1994-1999 average). Swordfish effort data from NMFS (PIFSC 2008) for 2004-2007 revealed that Hawaii-based vessels made the majority of their annual sets in the first quarter, with another third made in the second quarter and smaller amounts in the last two quarters (Table 39). At the other extreme the fishery can be considered to be “unconstrained “prior to 2001 when there was no limitation on the number of annual sets allowed or sea turtle hard caps. In the prior regulatory environment, before 2001, Hawaii-based swordfish vessels made the majority of their sets in the second quarter. By comparison, the current regulatory environment (“tightly constrained”) exhibits signs of a “race to the fish” as participants likely seek to complete trips before either the effort limit or turtle cap is reached. Because the effort limit of 2,120 sets has not been reached in any calendar year since 2004, it appears the sea turtle hard caps of 17 loggerheads and 16 leatherbacks are driving the observed increase in percentage of first quarter effort relative to the historical fishery prior to 2001.

Quarterly shallow-set effort data from 2004-2007 were used to estimate quarterly effort distributions under differing regulatory regimes (Table 39). In calculating effort distributions in response to varying regulatory restrictions under the alternatives for Topic 1, first quarter 2006 effort data were inputted while recognizing that the second, third, and fourth quarters of 2006 did not experience effort because the fishery was closed after reaching the loggerhead turtle cap. Entering first quarter 2006 effort data as 100% annual effort for that year skews the predicted effort distributions toward the first quarter for Alternatives 1A, 1B, and 1C. This allows the analysis to present “worst-case” scenarios in terms of sea turtle impacts as interactions are highest in the first quarter of the year. As first quarter catch rates for swordfish are also highest in the first quarter, predicted catches of swordfish similarly presented as well as predicted economic impacts. A strictly objective statistical approach was not possible because data only exist for two full years of fishing effort at the time of conducting this analysis.

Table 39: Hawaii shallow-set fishery quarterly effort (sets) distribution, 2004-2007

Year	Q1	Q2	Q3	Q4	Annual Total
2004	0	5	3	127	135
2005	539	871	54	181	1,645
2006	850	0	0	0	850
2007	949	465	83	27	1,497

Source: NMFS PIFSC 2008
n/a = not available

Due to their relatively restrictive natures, Alternatives 1A and 1B (allow 2,120 and 3,000 sets respectively) are analyzed under the “tightly constrained” temporal effort distribution (see Table 40). Alternative 3 (allow 4,240 sets) is analyzed under a “moderately constrained” distribution which lies halfway between the two extremes described above (see Table 40). Under this scenario, vessels again make the majority of their sets in the first quarter; however, it is a smaller majority than that shown in the “tightly constrained” scenario. Alternatives 1D and 1E (allow 5,500 and 9,925 sets respectively) would allow swordfish fishing levels around the fishery’s historical maximum, and are therefore analyzed under the “unconstrained” distribution shown below in Table 40.

Table 40: Swordfish effort distributions for each alternative based 2004-2007 logbook data

Alternative: scenario	Percent of annual swordfish effort per quarter			
	Q1	Q2	Q3	Q4
Alternatives 1A and 1B: tightly constrained	57%	32%	3%	7%
Alternative 1C: moderately constrained	43%	34%	11%	12%
Alternatives 1D, 1E: unconstrained	29%	36%	19%	17%

Note: Alternative 1F is predicted to lie between 1C and 1D in terms of regulatory constraints.

If 2006 first quarter effort data were to be omitted from the calculations, the tightly constrained alternatives (1A, 1B) would be analyzed based on the following effort distribution: Q1= 45%, Q2= 41%, Q3= 4%, Q4=9% and the moderately constrained alternative (1C) would be analyzed based on the following effort distribution: Q1=37%, Q2= 38%, Q3=11%, Q4=13%. As compared to the "worst case" methodology and effort distributions used here (Table 40), this approach would be expected to result in lower numbers of sea turtle interactions as effort would shift out of the first quarter which is when interactions are most likely to occur. Effort distributions for Alternatives 1D and 1E would be unchanged as historical (1991-2001) fishery effort data are used to represent the "unconstrained" fishery under these alternatives.

As the number of allowable sets increase under the alternatives, the predicted protected species interactions must be increasingly regarded as worst-case scenarios as the Hawaii-based longline fleet has not made 8,500 sets in any one year since 1991 and, in fact, the average between 1991 and 2000 was 5,600 annual swordfish sets. More recently, since the 2004 implementation of the set certificate program and 2,120 set limit, the fleet has averaged fewer than 1,400 sets per year (in 2006 the fishery closed in March after 850 sets due to the turtle cap being reached, see Tables 7-10). Anecdotal information indicates that the necessity of buying set certificates under the existing program has acted as a deterrent to fishermen and limited total effort. High demand and established market channels for bigeye tuna have also limited fishing effort. The true reactions of fishery participants and their resultant effort distributions under the alternatives considered here remain uncertain and will likely include considerations of prevailing weather, oceanographic, economic and market conditions. However, resultant effort is not expected to yield higher numbers of protected species interactions than the worst case scenarios presented here which assume that all available sets are used under each alternative.

The anticipated sea turtle mortality rates depend on the type of turtle and severity of hookings or entanglements. Based on an evaluation of the 2004-2007 observer data and notes on sea turtle interactions recently conducted by NMFS, an average of 20.5 percent of loggerhead sea turtle interactions are expected to result in post-hooking mortalities and 22.9 percent for leatherbacks. A recent study using satellite tagging methods to track loggerheads released after an interaction suggests that the loggerhead post-release mortality rate may be lower than that currently estimated by NMFS and may only amount to about 9.5 percent of all interactions (Y. Swimmer, NMFS, pers. comm. December 2007).

4.0.1 Example Analysis

The calculation of expected annual loggerhead interactions under Alternative 1B is provided here as an example. As described above, expected interactions (interactions per set) are calculated on a quarterly basis so as to include seasonal variations in fishing effort and interaction rates. With 3,000 sets allowed each year, Alternative 1B is included in the tightly constrained effort distribution as shown in Table 40. Thus, if the annual entire effort (sets) were to be expended, the expected number of quarterly fishing sets would be as follows:
Q1 = 3,000 * 56.7% = 1,701
Q2 = 3,000 *32.5% = 975
Q3 = 3,000 * 3.4% = 102
Q4 = 3,000 * 7.5% = 225

Observed quarterly loggerhead interaction rates are as shown in Table 34. These rates, when multiplied by the above expected sets per quarter, yield the following expected interactions per quarter under Alternative 1B:
Q1 = 0.0118 * 1,701 = 20.11
Q2 = 0.0015 * 975 = 1.46
Q3 = 0.0073 * 102 = 0.74
Q4 = 0.0144 * 225 = 3.23

Finally these expected quarterly interactions are added together to equal the 25.54 annual interactions expected under Alternative 1B.

The same process was used to calculate expected catches of target and nontarget fish, as well as interactions with marine mammals and seabirds. In the case of fish, expected annual catches (numbers of fish) were converted into pounds using the average weights shown in Table 37.

Anticipated Effects on the Short-tailed Albatross

There has never been an observed interaction in any Hawaii-based fishery and a short-tailed albatross (STAL). In order to estimate the effects of the various alternatives on the STAL population, the methods employed in the 2004 BiOp[18] were used. The expected number of STAL interactions was estimated by using a proxy species with similar biological characteristics. Black-footed albatross (BFAL) was used as the proxy species in this case.

The following model was used to predict the estimated number of short-tailed albatross interactions per effort alternative under Topic 1.

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[18] USFWS Biological Opinion on the Effects of the Reopened Shallow-set Sector of the Hawaii-based Longline Fishery on the Short-tailed Albatross (*Phoebastria albatrus*). 2004. Formal Consultation Log Number 1-2-1999-F-02.2.

T = M x A x N x E[19]

Where:

T = total interactions (total take of short-tailed albatross (STAL)

M = Fishery interaction rate of proxy species, black-footed albatross (BFAL)[20] = 0.000048/year

Note: The estimated portion of the BFAL population affected annually is based on a 2-year average of observed mortality and injury observed by NMFS observers aboard shallow-set vessels operating with seabird deterrents. The final number of black-footed albatross interactions was adjusted for drop-offs or removal at a 31% rate as per the 2004 BiOp.

The data used here to get the average were from the 2005 and 2007 fishing years. 2006 was excluded because it did not represent a full year of fishing effort and would have skewed the results toward the first quarter of the fishing year. In 2005, the fishery made 1,641 sets and there were 7 BFAL mortalities. In 2007, a total of 1,570 sets were made with 8 BFAL mortalities.

Average number of sets per year (effort) = 1,606 sets per year
2005 and 2007 observed average = 8 black-footed albatross/year
2005 and 2007 observed average adjusted for drop-offs[21] = 11
BFAL Population in 1999 = 227,675 birds
Fishery take (M) = 11/227,675 = 0.000048/year (fraction of black-footed albatross population affected by shallow-set fishery 2005-2007)

A = At-risk area (fraction of short-tailed albatross range overlapping with shallow-set fishery) = 0.245

N = Current short-tailed albatross population = 2,771[22]

E = Extent of proposed action (calculated for each alternative under Topic 1) = 1.32-6.17 times current level.

Estimated Effects on the Proxy Population

In the 2004 BiOp, the portion of the BFAL population estimated to be affected by the shallow-set fishery was 0.0082/year (0.82%/year). Incorporating actual observer data for 2005 and 2007 into the model gives much smaller estimates of the effect on the BFAL population by the

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[19] Unlike the 2004 BiOp, the estimated effectiveness of deterrents does not need to be considered in the model. Their effectiveness is reflected in the number of black-footed albatross interactions.
[20] Because there have never been any observed interactions of short-tailed albatross, black-footed albatross interaction rates are used a proxy to estimate short-tailed albatross interactions.
[21] Fraction was rounded up.
[22] Latest estimate 2,400-2,600 birds (Greg Balogh, USFWS, 2008 email to L. Van Fossen, NMFS).

different alternatives considered. The portion of the BFAL population affected by alternative 1E (i.e., greatest fishing effort) is estimated to be an order of magnitude smaller than that predicted in the 2004 BiOp (i.e., 0.03%/year).

Using the 2004 model and current BFAL interaction rates, one interaction with a STAL would be expected every 5 – 24 years at current STAL population levels depending on the alternative chosen. Therefore, the shallow-set fishery would be anticipated to take no more than one STAL in a given year.

STAL Population Trend

The number of breeding pairs[23] at Torishima has been increasing indicating that the population does not appear to be in decline (Figure 35).

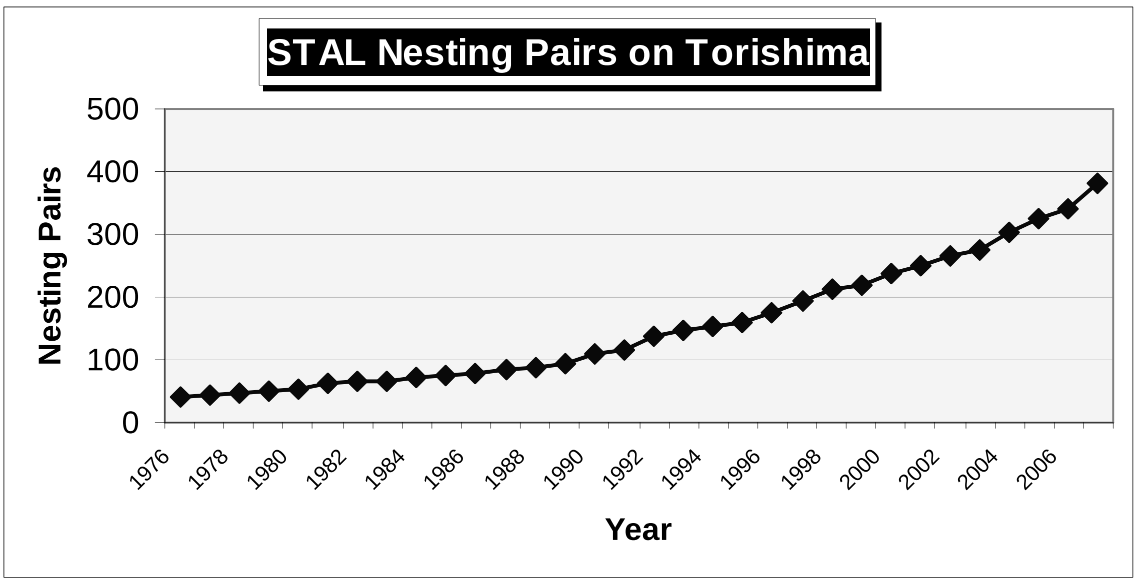

Figure 35: **Nesting pairs of short-tailed albatross on Torishima (1978-2008)**

In 2008, the STAL population estimate from USFWS was reported as 2,717 birds (Balogh 2008).

4.1 Topic 1: Shallow-set Longline Fishing Effort Levels

4.1.1 Alternative 1A: No Action: Continue Current Annual Set Limit

Under this alternative the maximum annual limit on the number of shallow-sets would remain at 2,120.

[23] The number of breeding pairs is used a proxy indicator of population since it is impossible to count all STALs. Immature birds and some mature birds may not return to Torishima where they can be counted during the breeding season.

4.1.1.1 Impacts of Alternative 1A to Target Stocks

Target stocks are defined as those species which are normally retained, non-target stocks are those which are usually discarded.

Under Alternative 1A, the shallow-set swordfish segment of the Hawaii longline fishery would continue to operate with a maximum effort limit of 2,120 sets and existing hard caps on sea turtle interactions (17 loggerheads or 16 leatherbacks). Based on the 2004 - 2007 fishing seasons, it is unlikely that all this effort will be expended in every year and swordfish landings (retained catches) would then be likely to remain between the 226,000 and 3.1 million pounds retained in 2004 and 2005 respectively (Tables 7 and 8). This would represent between 0.5 and 6.3 percent of the estimated MSY for North Pacific swordfish (22,284 metric tons or 49,024,800 pounds) (K. Bigelow, PIFSC, pers. comm. based on Kleiber and Yokawa 2004). If the fishery were to utilize all 2,120 sets, the total retained swordfish catch would be anticipated to be 4.3 million pounds, with another 349,000 pounds discarded dead for a total annual fishing mortality of 4.6 million pounds (Table 41), which is approximately 9.4 percent of MSY. Other (non-swordfish) species would continue to comprise a small fraction of the catch with bigeye tuna accounting for approximately four percent of total fishing mortality and striped marlin and mahimahi each comprising another one percent of fishing mortality within the shallow-set fishery. Other commercial species such as albacore, blue marlin, and yellowfin tuna would contribute smaller amounts to the remainder of the retained catch. Catches of these non-swordfish target species under this and all the remaining alternatives would be a negligible fraction of total Pacific-wide catches and known MSY values of these species. For example, 194,911 pounds of bigeye is estimated to be 0.096 percent of the WCPO bigeye MSY.

Table 41: Predicted annual catches and fishing mortality of major species under Alternative 1A (2,120 sets made)

Species	Annual pounds caught	Annual pounds kept	Annual pounds discarded dead	Total annual mortality: pounds kept + discarded dead
Swordfish	4,779,870	4,263,648	348,869	4,612,518
Bigeye Tuna	205,713	188,900	6,010	194,911
Striped Marlin	70,840	60,267	2,445	62,711
Mahimahi	64,639	53,431	1,817	55,248
Albacore Tuna	82,000	51,531	13,114	64,645
Blue Marlin	43,289	36,501	1,673	38,173
Yellowfin Tuna	14,827	13,594	451	14,045
Opah	7,973	5,105	756	5,861
Oilfishes	46,816	4,903	11,002	15,905
Ono	3,560	3,432	100	3,531
Shortbilled Spearfish	4,857	3,211	742	3,953
Pomfret	2,952	2,249	374	2,623
Thresher Sharks	12,816	1,282	2,163	3,444
Skipjack Tuna	1,134	990	114	1,104

Species	Annual pounds caught	Annual pounds kept	Annual pounds discarded dead	Total annual mortality: pounds kept + discarded dead
Blue Shark	2,054,864	0	121,442	121,442
Mako Shark	234,400	0	54,381	54,381
Oceanic Whitetip Shark	NA	NA	NA	NA
Other Pelagics	NA	NA	NA	NA
Other Sharks	NA	NA	NA	NA
Other Tunas	NA	NA	NA	NA

Note: NA entries indicate species which are caught in low numbers and for which average pounds per fish are not available because the majortity are discarded (alive). See Table 12 for available information on catches and discards of these species.

4.1.1.2 Impacts of Alternative 1A to Non-target Stocks

Non-target species are those which are normally discarded, either due to low commercial value or by regulations regarding retention. Detailed information on recent catches and discards of these species is provided in Table 12.

Prior to 2001, the majority of blue sharks caught in this fishery were killed and finned but this is no longer the case since the implementation of a national ban on shark finning. Under Alternative 1A catches of blue sharks would be anticipated to remain between the 1,392 sharks caught in 2004 (Table 7) and the 14,901 caught in 2005 (Table 8). If all available 2,120 sets were utilized, an estimated 2,054,864 pounds of blue sharks (20,560 sharks assuming an average weight of 100 pounds per blue shark caught) would be expected to be caught (Table 41), with the majority released alive for a total annual fishing mortality of 121,442 pounds (12,142 blue sharks). The most recent estimate of the MSY for North Pacific blue sharks is about 60,000 metric tons or 132 million pounds (Kleiber et al. 2007), and fishing mortality under Alternative 1A would represent approximately 0.09 percent of this MSY. The catch of other sharks would remain relatively small and consist primarily of mako, oceanic white-tip and thresher sharks, with the majority of these also released alive.

Among the bony fishes, the most commonly non-target species caught cumulatively on all 4,127 sets observed between 2004-2007 (Table 12) were long-nose lancetfish (5,683 individuals caught by the fishery over the entire time period), snake mackerel (1,086 individuals), remoras (923 individuals), pelagic stingrays (303 individuals) and lesser numbers of common and slender molas, knifetail and brilliant pomfrets, pelagic puffers, great barracuda, manta rays, mobula rays, hammerjaws, tapertail ribbonfish, driftfish, roudi escolars, louvars and black mackerel. Collectively, 2004-2007 observed non-target bony fish catches amounted to 8,141 individuals, which is about six percent of the total observed catch (Table 12) and was mostly discarded. Discard conditions (alive vs. dead) were mixed, with the majority (93 percent) of long-nose lancetfish discarded dead, but only nine percent of remoras discarded dead.

Because Alternative 1A is not expected to significantly alter existing fishing operations, catch and discard rates of non-target species would be anticipated to remain as observed between 2004 and 2007 (Table 12), and these species would be expected to form between six and seven percent of the fishery's total annual catch, with the specific volume proportional to the number of sets actually made. Relative discard conditions would also be expected to remain as observed. Resultant fishing mortality to non-target species would be expected to be a very minor fraction of Pacific-wide catches, and well below known MSY levels.

4.1.1.3 Impacts of Alternative 1A to Protected Species and Seabirds

The information utilized in this analysis on protected species interactions was collected by NMFS observers who have been on 100 percent of Hawaii longline shallow-set fishing trips since 2004, when the fishery reopened under its present regulations. The Observer Program defines an "interaction" to be a hooking or entanglement and categorizes condition at release as injured, unknown, or dead (Table 42).

Table 42: Predicted annual protected species and seabird interactions under Alternative 1A (2,120 sets)

Species	Number of interactions	Number of mortalities
Loggerheads: released injured or unknown	18.05	3.70
Leatherbacks: released injured	6.29	1.44
Olive Ridleys: released injured	0.92	unknown, <1
Greens: released injured or unknown	0.41	unknown, < 1
Bryde's whale: released injured	0.41	unknown, <1
Bottlenose dolphin: released injured	2.44	unknown, <3
Risso's dolphin: released injured or dead	3.25	0.65 – 3.25
Humpback whales: released injured	0.81	0.20
False killer whales: released injured	<1	unknown, <1
Black-footed albatross: released injured or dead	7.56	4.23 -7.56
Laysan albatross: released injured or dead	29.66	7.41 – 29.66
Short-tailed albatross: released injured or dead	0.043	unknown, <0.007826

Note: Using 2005-2007 observer data, the following percentages of interactions are estimated to result in dead animals of Risso's dolphin, black-footed albatross, and Laysan albatross: 19%, 56%, and 25%, respectively. Loggerhead and leatherback post-hooking mortality rates are currently estimated to be 20.5% and 22.9%, respectively. Short-tailed albatross estimated mortalities are based on a factor of 0.182, which is the proportion of black-footed albatross interactions that resulted in mortalities in the shallow-set fishery based on an average of observations made in 2005 and 2007. The 2008 NMFS BiOp conservatively estimated that 25% of humpack whale interactions result in serious injury leading to mortality and that mortality rate has been used here. As described in Section 4.0, based on an observed interaction with the fishery in the second quarter of 2008, an estimate of up to one false killer whale interaction annually was added to Table 42.

4.1.1.3.1 Impacts to Marine Mammals

Marine mammal interactions in the shallow-set fishery primarily involve Risso's dolphins, with up to four interactions expected per year under Alternative 1A, assuming that all 2,120 sets are made (Table 42). Other anticipated marine mammal interactions consist of two bottlenose dolphins, and less than one interaction per year for all others. Of the four potential Risso's dolphin interactions, one would be expected to be released dead each year. If the fishery does not make all 2,120 sets under Alternative 1A, annual interactions would be expected to be in the range of those observed during 2005-2007 (Table 26), with actual number depending on effort levels. The impact of Alternative 1A on marine mammals is not likely to cause a significantly adverse effect on marine mammal populations (see Section 4.4.2.2 for more information).

4.1.1.3.2 Impacts to Sea Turtles

Under Alternative 1A, 18 loggerhead turtle interactions would be anticipated each year assuming all 2,120 sets were made (Table 42). This estimate is greater than the 17 interactions anticipated by NMFS in its 2004 BiOp and associated Incidental Take Statement. The difference in estimates is likely due to differences in methodology as well as the fact that the 2004 Opinion did not have interaction data from the Hawaii fishery using the new circle hooks and mackerel-type bait, and thus had to rely on Atlantic data. An analysis of data from the 2004-2007 Hawaii longline shallow-set fishery establishes that turtle interaction rates have decreased significantly since the new gear and bait requirements were implemented (Gilman and Kobayashi 2007); however, interaction rates have also been highly variable depending on the time and area fished, as well as prevailing oceanographic conditions (see Section 3.1.1). Therefore there is likely to be substantial variation around the point estimates presented here, and number of actual interactions would likely be below these estimates in some years and above them in others.

Interactions with leatherback turtles under Alternative 1A would be expected to total up to 7 per year if all 2,120 sets were utilized, which is fewer than the 16 anticipated by NMFS. The reasons for this difference are probably the same as those described for loggerheads above. Again there is likely to be significant variation around the point estimates presented here and actual interactions would likely be below these estimates in some years and above them in others. Similarly, if the fishery does not make all 2,120 sets under Alternative 1A, annual interactions would be expected to be in the range of those observed during 2005-2008 (Table 14), with actual number depending on effort levels.

Under Alternative 1A there is anticipated to be up to one interaction per year with olive ridley turtles assuming all 2,120 sets are made, and numbers of interactions in the range of those observed during 2005-2008 (Table 14) if not all sets are utilized. Less than one interaction with a green sea turtle each year is expected under Alternative 1A and no hawksbill turtle interactions would be expected under Alternative 1A, regardless of the number of sets utilized. The impact of Alternative 1A on sea turtles is not likely to cause a significantly adverse effect on sea turtle populations (see Section 4.4.2.1 for more information).

4.1.1.3.3 Impacts to Seabirds

Under Alternative 1A there would be an anticipated 7.56 interactions with black-footed albatrosses if all 2,120 sets were made, with around four of these released dead (Table 42). There would also be expected to be 29.66 interactions with Laysan albatrosses, with approximately 8 of these released dead. Serious interactions with adult albatrosses during the time when chicks are being fed and reared may also result in chick mortality due to the loss of a parent. Interactions in the range of those observed during 2005-2008 (Table 27) would be expected if not all sets are utilized, with actual interactions depending on effort levels.

Short-tailed albatross interactions are predicted to be 0.043 per year under Alternative 1A. This level of interactions is not expected to cause a significant impact to short-tailed albatross populations and the interaction rate is lower than the 2004 BiOp anticipated. The impact of Alternative 1A on seabirds is not likely to cause a significant adverse effect on seabird populations (see Section 4.4.2.3, cumulative impacts, for more information).

4.1.1.4 Impacts of Alternative 1A to Fishery Participants, Fishing Communities, and the Regional Economy

Under Alternative 1A the Hawaii-based swordfish fishery would be expected to continue operating as described in Chapter 3, with fluctuations in effort, catch ex-vessel revenues and profits depending on environmental, economic and market conditions. If all 2,120 sets were utilized, the fleet would be anticipated to retain and sell 4.3 million pounds of swordfish for $9.7 million in ex-vessel revenues. Sales of 424,000 pounds of other species would yield an additional $1.1 million in ex-vessel revenues (Table 43). Currently, there are approximately 30 vessels participating in the fishery and under this alternative, that number is not expected to increase as the current sea turtle interaction limits seem to constrain any growth in the fishery.

Table 43: Predicted annual ex-vessel revenues under Alternative 1A (2,120 sets made)

Species	Annual pounds kept	Annual ex-vessel revenue	Percent of annual revenue
Swordfish	4,263,648	$ 9,781,758	90.22%
Bigeye Tuna	188,900	$ 622,742	5.74%
Mahimahi	53,431	$ 119,507	1.10%
Striped Marlin	60,267	$ 98,838	0.91%
Albacore Tuna	51,531	$ 97,738	0.90%
Blue Marlin	36,501	$ 45,215	0.42%
Yellowfin Tuna	13,594	$ 36,891	0.34%
Oilfishes	4,903	$ 9,904	0.09%
Opah	5,105	$ 9,902	0.09%
Ono	3,432	$ 9,173	0.08%
Pomfret	2,249	$ 5,366	0.05%
Shortbilled Spearfish	3,211	$ 3,629	0.03%

Species	Annual pounds kept	Annual ex-vessel revenue	Percent of annual revenue
Skipjack Tuna	990	$ 877	0.01%
All Other Pelagics*			
Annual Total	4,687,763	$ 10,841,538	100.00%
* All other pelagics account for less than two percent of total annual fish kept, detailed weight and price, information not available for all species.			

Utilizing the methodology and model presented by Leung and Pooley (2002) for the Hawaii longline fishery, the anticipated ex-vessel revenues under Alternative 1A ($10.8 million, Table 43) would generate $26.3 million in direct and indirect business sales, $11.7 million in personal and corporate income, 362 jobs, and $2 million in state and local taxes (Table 44).

Table 44: Predicted regional impacts under Alternative 1A (2,120 sets made)

Variable	Impact
Predicted Ex-vessel Revenue ($ million)	10.84
Direct Effects	
Business Sales ($ million)	10.84
Income ($ million)	5.25
Employment (jobs)	151.36
State & Local Taxes ($ million)	0.88
Indirect and Induced Effect From Local Purchases of Goods & Services	
Business Sales ($ million)	7.69
Income ($ million)	3.05
Employment (jobs)	95.56
State & Local Taxes ($ million)	0.51
Indirect and Induced Effect From Direct Income of Longline Fishing	
Business Sales ($ million)	7.75
Income ($ million)	3.38
Employment (jobs)	115.57
State & Local Taxes ($ million)	0.56
Total Effect	
Business Sales ($ million)	26.28
Income ($ million)	11.68
Employment (jobs)	362.48
State & Local Taxes ($ million)	1.95

Source: Based on Leung and Pooley (2002)

4.1.1.5 Impacts of Alternative 1A to Administration and Enforcement

Under Alternative 1A, impacts to administration would remain related to issuing shallow-set certificates, which is estimated to cost $4,430 annually as well as for administering the observer program to maintain 100 percent coverage for the shallow-set fishery, which is estimated to cost $1,856,059 annually. Currently, it costs NMFS PIFSC approximately $74,710 per year to process shallow-set logbooks provided by fishery participants. Enforcement impacts would continue to be related to monitoring participation in the shallow-set fishery for compliance with regulations that include seabird and sea turtle mitigation measures, and set certificates. Vessel monitoring systems (VMS) would continue to be used as the primary tool for enforcing closed areas as well as knowing where the fleet is operating.

4.1.2 Alternative 1B: Allow 3,000 Shallow Sets per Year

Under Alternative 1B, the Hawaii longline swordfish fishery would be allowed to make 3,000 shallow sets each year.

4.1.2.1 Impacts of Alternative 1B to Target Stocks

Based on the 2004 - 2007 fishing seasons and assuming that all 3,000 sets were utilized, under Alternative 1B the shallow-set fishery would be expected to realize the catches and fishing mortality levels presented in Table 45. The total retained swordfish catch would be anticipated to be 6 million pounds, with another 485,000 pounds discarded dead for a total annual fishing mortality of 6.5 million pounds (Table 45), which is approximately 13 percent of the estimated North Pacific swordfish MSY. Other (non-swordfish) species would continue to comprise a small fraction of the catch with bigeye tuna fishing mortality comprising 276,000 pounds (0.17 percent of WCPO MSY), striped marlin 89,000 pounds and mahimahi 78,000 pounds. Other commercial species such as albacore, blue marlin, and yellowfin tuna would contribute smaller amounts to the remainder of the retained catch and fishing mortality as shown below. Anticipated catches of these non-swordfish target species under this alternative are a negligible fraction of total Pacific-wide catches and known MSY values of these species. As compared to Alternative 1A with 2,120 sets made, this alternative would represent a 42 percent increase in fishing mortality for each and all species if all sets were made. However, it is uncertain whether all 3,000 sets would be utilized every year under Alternative 1B. If not, catches and fishing mortality to target species would be some fraction of the numbers presented in Table 45. Because the Hawaii longline fisheries (shallow-set and deep-set) are regulated under a limited entry program (maximum 164 permits combined), any increased effort in the shallow-set fishery would be from vessels that primarily target bigeye tuna in the deep-set fishery. It is expected that such a shift would reduce bigeye catches by the Hawaii deep-set fishery and thus relieve some pressure (albeit insignificant in terms of overall WCPO bigeye catch and stock status) on bigeye stocks.

Table 45: Predicted annual catches and fishing mortality of major species under Alternative 1B (3,000 sets made)

Species	Annual pounds caught	Annual pounds kept	Annual pounds discarded dead	Total annual mortality: pounds kept + discarded dead
Swordfish	6,763,967	6,033,465	484,761	6,518,226
Bigeye Tuna	291,103	267,312	8,505	275,817
Striped Marlin	100,245	85,283	3,459	88,742
Mahimahi	91,470	75,610	2,571	78,180
Albacore Tuna	116,038	72,922	18,557	91,479
Blue Marlin	61,258	51,652	2,367	54,019
Yellowfin Tuna	20,982	19,237	638	19,875
Opah	11,283	7,224	1,070	8,295
Oilfishes	66,249	6,938	15,569	22,507
Ono	5,038	4,856	141	4,997
Shortbilled Spearfish	6,873	4,544	1,050	5,594
Pomfret	4,177	3,183	529	3,712
Thresher Sharks	18,135	1,814	3,060	4,874
Skipjack Tuna	1,605	1,401	161	1,563
Blue Shark	2,907,827	0	171,853	171,853
Mako Shark	331,698	0	76,954	76,954
Oceanic Whitetip Shark	NA	NA	NA	NA
Other Pelagics	NA	NA	NA	NA
Other Sharks	NA	NA	NA	NA
Other Tunas	NA	NA	NA	NA

NA entries indicate species which are caught in low numbers and for which average pounds per fish are not available because the majority are discarded (alive). See Table 12 for available information on catches and discards of these species.

4.1.2.2 Impacts of Alternative 1B to Non-target Stocks

Assuming all 3,000 sets were made under Alternative 1B, catches of blue sharks would be anticipated to total 2.9 million pounds, with the majority released alive for an annual fishing mortality of 172,000 pounds (Table 45) or approximately 0.13 percent of MSY. The catch and fishing mortality of other sharks would remain relatively small and consist primarily of mako, oceanic white-tip and thresher sharks, with the majority of these also released alive as shown above.

As described under Alternative 1A, among the bony fishes the most commonly non-target species caught cumulatively on all 4,127 sets observed between 2004-2007 (Table 12) were long-nose lancetfish (5,683 individuals caught by the fishery over the entire time period), snake mackerel (1,086 individuals), remoras (923 individuals), pelagic stingrays (303 individuals) and lower numbers of common and slender molas, knifetail and brilliant pomfrets, pelagic puffers, great barracuda, manta rays, mobula rays, hammerjaws, tapertail ribbonfish, driftfish, roudi escolars, louvars and black mackerel. Collectively, 2004-2007 observed non-target bony fish catches amounted to 8,141 individuals, which is about six percent of the total observed catch (Table 12) and was mostly discarded. Discard conditions (alive vs. dead) were mixed, with the majority (93 percent) of long-nose lancetfish discarded dead, but only nine percent of remoras discarded dead.

Because Alternative 1B is not expected to significantly alter fishing operations, catch and discard rates of non-target species would be anticipated to remain as observed between 2004 and 2007 (Table 12), and these species would be expected to form between six and seven percent of the fishery's total annual catch, with the specific volume proportional to the number of sets actually made. Relative discard conditions would also be expected to remain as observed. Resultant fishing mortality to non-target species would be expected to be a very minor fraction of Pacific-wide catches, and well below known MSY levels.

4.1.2.3 Impacts of Alternative 1B to Protected Species and Seabirds

Table 46: Predicted annual protected species and seabird interactions and mortalities under Alternative 1B (3,000 sets made)

Species	Number of interactions	Number of mortalities
Loggerheads: released injured or unknown	25.54	5.23
Leatherbacks: released injured	8.90	2.04
Olive Ridleys: released injured	1.30	Unknown, <1
Greens: released injured or unknown	0.57	Unknown, <1
Bryde's whale: released injured	0.57	Unknown, <1
Bottlenose dolphin: released injured	2.30	Unknown, <3
Risso's dolphin: released injured or dead	4.60	0.87- 4.60
Humpback whales: released injured	1.15	0.29
False killer whales	<1	Unknown, <1
Black-footed albatross: released injured or dead	10.70	5.99 – 10.70
Laysan albatross: released injured or dead	41.97	10.49 - 41.97
Short-tailed albatross: released injured or dead	0.061	Unknown, <0.011102

Note: Using 2005-2007 observer data, the following percentages of interactions are estimated to result in dead animals of Risso's dolphin, black-footed albatross, and Laysan albatross: 19%, 56%, and 25%, respectively. Loggerhead and leatherback post-hooking mortality rates are currently estimated to 20.5% and 22.9%, respectively. Short-tailed albatross estimated mortalities are based on a factor of 0.182, which is the proportion of black-footed albatross interactions that resulted in mortalities in the shallow-set fishery based on an average of observations made in 2005 and 2007. The 2008 NMFS BiOp conservatively estimated that 25% of humpback whale interactions result in serious injury leading to mortality and that mortality rate has been used here. As described in Section 4.0, based on an observed interaction with the fishery in the second quarter of 2008, an estimate of up to one false killer whale interaction annually was added to Table 46.

4.1.2.3.1 Impacts to Marine Mammals

Marine mammal interactions in the shallow-set fishery primarily involve Risso's dolphins, with up to five interactions expected per year under Alternative 1B, assuming that all 3,000 sets are made (Table 46). Other marine mammal interactions anticipated under Alternative 1B consist of three bottlenose dolphins, and less than one interaction per year for all others. Of the five potential interactions with Risso's dolphins, one would be expected to be released dead each year. If the fishery does not make all 3,000 sets under Alternative 1B, annual interactions would be expected to be some fraction of those presented in Table 46 with the actual number depending on effort levels. The impact of Alternative 1B on marine mammals is not likely to cause a significantly adverse effect on marine mammal populations (see Section 4.4.2.2 for more information).

4.1.2.3.2 Impacts to Sea Turtles

Under Alternative 1B, 25.54 loggerhead turtle interactions would be anticipated each year assuming all 3,000 sets were made (Table 46). Because observed interaction rates have been highly variable depending on the time and area fished, as well as prevailing oceanographic conditions (see Section 3.1.1), there is likely to be substantial variation around the point estimates presented here and actual interactions would be likely to be below the estimates in some years and above them in others.

Interactions with leatherback turtles under Alternative 1B would be expected to total up to 9 per year if all 3,000 sets were utilized, but again there is likely to be substantial variation around the point estimates presented here. Thus actual interactions would be likely to be below them in some years and above them in others. Similarly, if the fishery does not make all 3,000 sets under Alternative 1B, annual interactions would be expected to be a fraction of those presented in Table 46, with the actual number depending on effort levels.

Under Alternative 1B there is anticipated to be approximately 1.3 interactions per year with olive ridley turtles assuming all 3,000 sets are made and a fraction of this number if not all sets are utilized. Approximately 0.57 green turtle interactions and no hawksbill turtles would be expected under Alternative 1B. The impact of Alternative 1B on sea turtles is not likely to cause a significantly adverse effect on sea turtle populations (see Section 4.4.2.1 for more information).

4.1.2.3.3 Impacts to Seabirds

Under Alternative 1B it is anticipated that there would be up to 11 interactions each year with black-footed albatrosses if all 3,000 sets were made, with six of these released dead (Table 46). There would be expected to be 41.97 interactions with Laysan albatrosses with up 10.49 of these released dead, if all 3,000 sets are used. Lethal interactions with adult albatrosses during the time when chicks are being fed and reared may also result in chick mortality. Short-tailed albatross interactions are predicted to be approximately 0.061 per year under Alternative 1B. This level of interactions is not expected to cause a significant impact to short-tailed albatross populations and is less than the 2004 BiOp anticipated.

If the fishery does not make all 3,000 sets under Alternative 1B, annual seabird interactions would be expected to be a fraction of these numbers, with actual numbers depending on the levels of effort. The impact of Alternative 1B on seabirds is not likely to cause a significant adverse effect on seabird populations (see Section 4.4.2.3, cumulative impacts, for more information).

4.1.2.4 Impacts of Alternative 1B to Fishery Participants, Fishing Communities, and the Regional Economy

Under Alternative 1B and assuming that all 3,000 allowable sets were made, the Hawaii-based swordfish fishery would be expected to retain and sell 6 million pounds of swordfish for $13.8 million in ex-vessel revenues (Table 47). Sales of 600,162 pounds of other species would yield an additional $1.5 million in ex-vessel revenues. As compared to anticipated catches and revenues if all 2,120 sets were made under Alternative 1A, this represents a 41.5 percent increase in retained catch with a directly associated 41.5 percent increase in ex-vessel revenues, for individual and aggregate species. Currently, there are approximately 30 vessels participating in the fishery and, under this alternative, that number would be expected to increase by approximately 5-10 vessels.

Table 47: Predicted annual ex-vessel revenues under Alternative 1B (3,000 sets made)

Species	Annual pounds kept	Annual ex-vessel revenue	Percent of annual revenue
Swordfish	6,033,465	$ 13,842,110	90.22%
Bigeye Tuna	267,312	$ 881,239	5.74%
Mahimahi	75,610	$ 169,113	1.10%
Striped Marlin	85,283	$ 139,865	0.91%
Albacore Tuna	72,922	$ 138,309	0.90%
Blue Marlin	51,652	$ 63,984	0.42%
Yellowfin Tuna	19,237	$ 52,204	0.34%
Oilfishes	6,938	$ 14,015	0.09%
Opah	7,224	$ 14,012	0.09%
Ono	4,856	$ 12,980	0.08%
Pomfret	3,183	$ 7,594	0.05%
Shortbilled Spearfish	4,544	$ 5,135	0.03%
Skipjack Tuna	1,401	$ 1,241	0.01%
All Other Pelagics*			
Annual Total	6,633,627	$ 15,341,799	100.00%
* All other pelagics account for less than two percent of total annual fish kept, detailed weight and price information not available for all species			

Utilizing the methodology and model presented by Leung and Pooley (2002) the anticipated ex-vessel revenues under Alternative 1B ($15.3 million, Table 47) would be predicted to have impacts to the regional economy as depicted in Table 48. In summary, it is estimated that under Alternative 1B the Hawaii longline swordfish fishery would generate $37.2 million in direct and indirect business sales, $16.5 million in personal and corporate income, 513 jobs, and $2.8 million in state and local taxes.

Table 48: Predicted regional impacts under Alternative 1B (3,000 sets made)

Variable	**Impact**
Predicted Ex-vessel Revenue ($ million)	15.34
Direct Effects	
Business Sales ($ million)	15.34
Income ($ million)	7.43
Employment (jobs)	214.18
State & Local Taxes ($ million)	1.24
Indirect and Induced Effect From Local Purchases of Goods & Services	
Business Sales ($ million)	10.88
Income ($ million)	4.32
Employment (jobs)	135.23
State & Local Taxes ($ million)	0.72
Indirect and Induced Effect From Direct Income of Longline Fishing	
Business Sales ($ million)	10.97
Income ($ million)	4.78
Employment (jobs)	163.54
State & Local Taxes ($ million)	0.80
Total Effect	
Business Sales ($ million)	37.19
Income ($ million)	16.52
Employment (jobs)	512.95
State & Local Taxes ($ million)	2.76

Source: Based on Leung and Pooley 2002

4.1.2.5 Impacts of Alternative 1B to Administration and Enforcement

Under Alternative 1B, impacts to administration would be related to issuing shallow-set certificates which is estimated to cost $6,077 annually, as well as for administering the observer program to maintain 100 percent coverage for the shallow-set fishery, which is estimated to cost $2,768,732 annually (an increase of $912,673 from status quo). Increases in shallow-set effort from this alternative are predicted to cost $105,722 per year for NMFS PIFSC to process shallow-set logbooks—an estimated $31,012 increase per year from status quo. Enforcement impacts would continue to be related to monitoring participation in the shallow-set fishery for compliance with regulations that include seabird and sea turtle mitigation measures, and set certificates. VMS would continue to be used as the primary tool for enforcing closed areas as well as knowing where the fleet is operating.

4.1.3 Alternative 1C: Allow 4,240 Shallow Sets per Year

Under Alternative 1C, the Hawaii longline swordfish fishery would be allowed to make 4,240 shallow sets each year, which is the average number of shallow sets made by Hawaii longline vessels each year between 1994 and 1999.

4.1.3.1 Impacts of Alternative 1C to Target Stocks

Based on the 2004 - 2007 fishing seasons and assuming that all 4,240 sets were utilized under Alternative 1C, the Hawaii shallow-set longline swordfish fishery would be expected to realize the catches and fishing mortality levels presented in Table 49. The total retained swordfish catch would be anticipated to be 8 million pounds, with another 647,000 pounds discarded dead for a total annual fishing mortality of 8.7 million pounds (Table 49), which is approximately 18 percent of the estimated North Pacific swordfish MSY. Other (non-swordfish) species would continue to comprise a small fraction of the catch with bigeye tuna fishing mortality comprising 354,000 pounds (approximately 0.17 percent of MSY), striped marlin 140,000 pounds and mahimahi 133,000 pounds. Other commercial species such as albacore, blue marlin, and yellowfin tuna would contribute smaller amounts to the remainder of the retained catch and fishing mortality as shown below. Expected catches of these non-swordfish target species under this alternative are a negligible fraction of total Pacific-wide catches and known MSY values of these species. As compared to Alternative 1A with 2,120 sets made, this would represent an 88 percent increase in fishing mortality for swordfish, and an 81 percent increase for bigeye tuna. As compared to Alternative 1A, catches and fishing mortality for other species would also increase by varying amounts. These percentage increases would not be uniform, as under Alternative 1C the “moderately constrained” fishing effort distribution (Table 40) is utilized and annual catch rates for each species would change as effort moved into different quarters, each with its own catch rate (Table 36). Because the Hawaii longline fisheries (shallow-set and deep-set) are regulated under a limited entry program (maximum 164 permits combined), any increased effort in the shallow-set fishery would be from vessels that primarily target bigeye tuna in the deep-set fishery. It is expected that such a shift would reduce bigeye catches by the Hawaii deep-set fishery and thus relieve some pressure (albeit insignificant in terms of overall WCPO bigeye catch and stock status) on bigeye stocks.

It is uncertain, however, whether all 4,240 sets would be utilized every year under Alternative 1C. If not, catches and fishing mortality to target species would be some fraction of the numbers presented in Table 49.

Table 49: Predicted annual catches and fishing mortality of major species under Alternative 1C (4,240 sets made)

Species	Annual pounds caught	Annual pounds kept	Annual pounds discarded dead	Total annual mortality: pounds kept + discarded dead
Swordfish	9,011,471	8,038,241	645,836	8,684,077
Bigeye Tuna	373,577	343,045	10,915	353,960
Striped Marlin	158,591	134,921	5,473	140,393
Mahimahi	156,507	129,370	4,399	133,769
Albacore Tuna	154,524	97,107	24,712	121,819
Blue Marlin	99,759	84,115	3,855	87,970
Yellowfin Tuna	27,302	25,031	831	25,862
Opah	17,881	11,449	1,680	32,833
Oilfishes	107,545	11,263	2,075	13,338
Ono	7,695	7,418	5,810	13,228
Shortbilled Spearfish	10,037	6,636	1,534	8,170
Pomfret	5,315	4,050	673	4,723
Thresher Sharks	31,674	3,167	5,345	8,512
Skipjack Tuna	2,013	1,757	202	1,959
Blue Shark	3,870,531	0	228,748	228,748
Mako Shark	461,928	0	107,167	107,167
Oceanic Whitetip Shark	NA	NA	NA	NA
Other Pelagics	NA	NA	NA	NA
Other Sharks	NA	NA	NA	NA
Other Tunas	NA	NA	NA	NA

NA entries indicate species which are caught in low numbers and for which average pounds per fish are not available because the majority are discarded (alive). See Table 12 for available information on catches and discards of these species.

4.1.3.2 Impacts of Alternative 1C to Non-target Stocks

Assuming all 4,240 sets were made under Alternative 1C, catches of blue sharks would be anticipated to total 3.9 million pounds, with the majority released alive for an annual fishing mortality of 229,000 pounds (Table 49) or approximately 0.17 percent of MSY. The catch and fishing mortality of other sharks would remain relatively small and consist primarily of mako, oceanic white-tip and thresher sharks, with the majority of these also released alive as shown above.

As described under Alternative 1A, among the bony fishes, the most commonly caught non-target species caught on all 4,127 sets observed between 2004-2007 (Table 12) were long-nose lancetfish (5,683 individuals caught by the fishery over the entire time period), snake mackerel (1,086 individuals), remoras (923 individuals), pelagic stingrays (303 individuals) and smaller numbers of common and slender molas, knifetail and brilliant pomfrets, pelagic puffers, great barracuda, manta rays, mobula rays, hammerjaws, tapertail ribbonfish, driftfish, roudi escolars, louvars and black mackerel. Collectively, 2004-2007 observed non-target bony fish catches amounted to 8,141 individuals, which is about six percent of the total observed catch (Table 12) and was mostly discarded. Discard conditions (alive vs. dead) were mixed, with the majority (93 percent) of long-nose lancetfish discarded dead, but only nine percent of remoras discarded dead.

Because Alternative 1C is not expected to significantly alter fishing methods, catch and discard rates of non-target species would be anticipated to remain as observed between 2004 and 2007 (Table 12), and these species would be expected to form between six and seven percent of the fishery’s total annual catch, with the specific volume proportional to the number of sets actually made. Relative discard conditions would also be expected to remain as observed. Resultant fishing mortality (Table 49) to non-target species would be expected to be a very minor fraction of Pacific-wide catches, and well below known MSY levels.

4.1.3.3 Impacts of Alternative 1C to Protected Species and Seabirds

Table 50: Predicted annual protected species and seabirds interactions under Alternative 1C (4,240 sets made)

Species	Number of interactions	Number of mortalities
Loggerheads: released injured or unknown	34.42	7.05
Leatherbacks: released injured	12.65	2.89
Olive Ridleys: released injured	1.70	Unknown, <2
Greens: released injured or unknown	0.61	Unknown, <1
Bryde's whale: released injured	0.61	Unknown, <1
Bottlenose dolphin: released injured	2.45	Unknown, <3
Risso's dolphin: released injured or dead	4.89	0.93 - 5
Humpback whales: released injured	1.22	0.31
False killer whales: released injured	<1	Unknown, <1
Black-footed albatross: released injured or dead	13.23	7.41 - 13.23
Laysan albatross: released injured or dead	52.65	13.16 - 52.65
Short-tailed albatross: released injured or dead	0.086	Unknown, <0.9156

Note: Using 2005-2007 observer data, the following percentages of interactions are estimated to result in dead animals of Risso’s dolphin, black-footed albatross, and Laysan albatross: 19%, 56%, and 25%, respectively. Loggerhead and leatherback post-hooking mortality rates are currently estimated to be 20.5% and 22.9%, respectively. Short-tailed albatross estimated mortalities are based on a factor of 0.182, which is the proportion of black-footed albatross interactions that resulted in mortalities in the shallow-set fishery based on an average of observations made in 2005 and 2007. The 2008 NMFS BiOp conservatively estimated that 25% of humpback whale interactions result in serious injury leading to mortality and that mortality rate has been used here. As described in Section 4.0, based on an observed interaction with the fishery in the second quarter of 2008, an estimate of up to one false killer whale interaction annually was added to Table 50.

4.1.3.3.1 Impacts to Marine Mammals

Marine mammal interactions in the shallow-set fishery primarily involve Risso's dolphins, with up to 5 interactions expected per year under Alternative 1C, assuming that all 4,240 sets are made (Table 50). Other marine mammal interactions anticipated under Alternative 1C consist of up to three bottlenose dolphins, and approximately one or less than one interaction per year for all others. Of the potential five interactions with Risso's dolphins, one would be expected to be released dead each year. If the fishery does not make all 4,240 sets under Alternative 1C, annual interactions would be expected to be some fraction of those presented in Table 50 with the actual number depending on effort levels. The impact of Alternative 1C on marine mammals is not likely to cause a significantly adverse effect on marine mammal populations (see Section 4.4.2.2 for more information).

4.1.3.3.2 Impacts to Sea Turtles

Under Alternative 1C, 34.42 loggerhead turtle interactions would be anticipated each year assuming all 4,240 sets were made (Table 50). Because observed interaction rates have been highly variable depending on the time and area fished, as well as prevailing oceanographic conditions (see Section 3.1.1) there is likely to be substantial variation around the point estimates presented here and actual interactions would be likely to be below these numbers in some years and above them in others.

Interactions with leatherback turtles under Alternative 1C would be expected to total 12.65 per year if all 4,240 sets were utilized, but again there is likely to be substantial variation around the point estimates presented here. Thus actual interactions would be likely to be below these numbers in some years and above them in others. Similarly, if the fishery does not make all 4,240 sets under Alternative 1C, annual interactions would be expected to be a fraction of those presented in Table 50, with the actual number depending on effort levels.

Under Alternative 1C there are anticipated to be up to 2 interactions per year with olive ridley turtles assuming all 4,240 sets are made, and a fraction of this number if not all sets are utilized. Interactions with green turtles are expected to be up to one per year and no hawksbill turtle interactions would be expected under Alternative 1C. The impact of Alternative 1C on sea turtles is not likely to cause a significantly adverse effect on sea turtle populations (see Section 4.4.2.1 for more information).

4.1.3.3.3 Impacts to Seabirds

Under Alternative 1C it is anticipated that there would be up to 14 interactions each year with black-footed albatrosses if all 4,240 sets were made, with approximately 7.41 of these released dead (Table 50). There would be expected to be 52.65 interactions with Laysan albatrosses with approximately 14 of these released dead, if all 4,240 sets are used. Serious interactions with adult albatrosses during the time when chicks are being fed and reared may also result in chick mortality. Short-tailed albatross interactions are predicted to be 0.086 interactions per year under

Alternative 1C. This level of interactions is not expected to cause a significant impact to short-tailed albatross populations and is less than the 2004 BiOp anticipated.

If the fishery does not make all 4,240 sets under Alternative 1C, annual seabird interactions would be expected to be a fraction of these numbers, with actual numbers depending on the levels of effort. The impact of Alternative 1C on seabirds is not likely to cause a significant adverse effect on seabird populations. Section 4.4.2.3 provides a discussion on cumulative impacts on seabirds.

4.1.3.4 Impacts of Alternative 1C to Fishery Participants, Fishing Communities, and the Regional Economy

Under Alternative 1C and assuming that all 4,240 allowable sets were made, the Hawaii-based swordfish fishery would be expected to retain and sell 8 million pounds of swordfish for $18.4 million in ex-vessel revenues (Table 51). Sales of 856,000 pounds of other pelagics would yield an additional $2.1 million in ex-vessel revenues. As compared to anticipated catches and revenues, if all 2,120 sets were made under Alternative 1A, this represents an 88 percent increase in swordfish pounds kept and a 90 percent increase in total retained catch as well as total ex-vessel revenues. Currently, there are approximately 30 vessels participating in the fishery and under this alternative, that number would be expected to increase by approximately 20-30 vessels. This increase in vessels, however, is dependent on several factors such as swordfish and bigeye markets, fuel costs, and other operational costs.

Table 51: Predicted annual ex-vessel revenues under Alternative 1C (4,240 sets made)

Species	Annual pounds kept	Annual ex-vessel revenue	Percent of annual revenue
Swordfish	8,038,241	$ 18,408,854	89.84%
Bigeye Tuna	343,045	$ 1,130,906	5.52%
Mahimahi	129,370	$ 289,357	1.41%
Striped Marlin	134,921	$ 221,270	1.08%
Albacore Tuna	97,107	$ 184,180	0.90%
Blue Marlin	84,115	$ 104,197	0.51%
Yellowfin Tuna	25,031	$ 67,929	0.33%
Oilfishes	11,263	$ 22,751	0.11%
Opah	11,449	$ 22,207	0.11%
Ono	7,418	$ 19,829	0.10%
Pomfret	4,050	$ 9,662	0.05%
Shortbilled Spearfish	6,636	$ 7,498	0.04%
Skipjack Tuna	1,757	$ 1,556	0.01%
All Other Pelagics*			
Annual Total	8,894,403	$ 20,490,196	100.00%

Species	Annual pounds kept	Annual ex-vessel revenue	Percent of annual revenue
* All other pelagics account for less than three percent of total annual fish kept, detailed weight and price information not available for all species.			

Utilizing the methodology and model presented by Leung and Pooley (2002) the anticipated ex-vessel revenues under Alternative 1C ($20.53 million, Table 51) would be predicted to have the following impacts to the regional economy (Table 52). In summary, it is estimated that under Alternative 1C the Hawaii longline swordfish fishery would generate $49.7 million in direct and indirect business sales, $22.1 million in personal and corporate income, 685 jobs, and $3.7 million in state and local taxes.

Table 52: Predicted regional impacts under Alternative 1C (4,240 sets made)

Variable	**Impact**
Predicted Ex-vessel Revenue ($ million)	20.49
Direct Effects	
Business Sales ($ million)	20.49
Income ($ million)	9.92
Employment (jobs)	286.07
State & Local Taxes ($ million)	1.66
Indirect and Induced Effect From Local Purchases of Goods & Services	
Business Sales ($ million)	14.53
Income ($ million)	5.77
Employment (jobs)	180.61
State & Local Taxes ($ million)	0.96
Indirect and Induced Effect From Direct Income of Longline Fishing	
Business Sales ($ million)	14.66
Income ($ million)	6.38
Employment (jobs)	218.42
State & Local Taxes ($ million)	1.07
Total Effect	
Business Sales ($ million)	49.67
Income ($ million)	22.07
Employment (jobs)	685.11
State & Local Taxes ($ million)	3.69

Source: Based on Leung and Pooley (2002)

4.1.3.5 Impacts of Alternative 1C to Administration and Enforcement

Under Alternative 1C, impacts to administration would be related to issuing 4,240 shallow-set certificates which is estimated to cost $8,406 annually as well as for administering the observer program to maintain 100 percent coverage for the shallow-set fishery, which is estimated to cost $3,956,350 annually (an increase of $2,100,291 from status quo). Increases in shallow-set effort from this alternative are predicted to cost $ 149,421 per year for NMFS PIFSC to process additional shallow-set logbooks—an estimated $ 74,711 increase per year from status quo. Enforcement agencies would continue to monitor shallow-set fishery compliance with regulations that include seabird and sea turtle mitigation measures, and set certificates. VMS would continue to be used as the primary tool for enforcing closed areas as well as knowing where the fleet is operating.

4.1.4 Alternative 1D: Allow 5,500 Shallow Sets per Year

Under Alternative 1D, the Hawaii longline fishery would be allowed to make 5,500 shallow sets each year, which is about the maximum number of sets by the fishery in the 1994-1999 period.

4.1.4.1 Impacts of Alternative 1D to Target Stocks

Based on the 2004 - 2007 fishing seasons and assuming that all 5,500 sets were utilized under Alternative 1D, the shallow-set swordfish segment of the Hawaii longline fishery would be expected to realize the catches and fishing mortality levels presented in Table 53. The total retained swordfish catch would be anticipated to be 9.8 million pounds, with another 787,000 pounds discarded dead for a total annual fishing mortality of 10.6 million pounds (Table 53), which is approximately 22 percent of the estimated North Pacific swordfish MSY. Other (non-swordfish) species would continue to comprise a small fraction of the catch with bigeye tuna fishing mortality comprising 413,000 pounds (approximately 0.20 percent of MSY), striped marlin 204,000 pounds and mahimahi 204,000 pounds. Other commercial species such as albacore, blue marlin, and yellowfin tuna would contribute smaller amounts to the remainder of the retained catch and fishing mortality as shown below. Expected catches of these non-swordfish target species under this alternative are a negligible fraction of total Pacific-wide catches and known MSY values of these species. As compared to Alternative 1A with 2,120 sets made, this would represent a 129 percent increase in fishing mortality for swordfish, and a 112 percent increase for bigeye tuna. As compared to Alternative 1A, catches and fishing mortality for other species would also increase by varying amounts. These percentage increases would not be uniform as under Alternative 1D the “unconstrained” fishing effort distribution (Table 40) is utilized and annual catch rates for each species would change as effort moved into different quarters, each with its own catch rate (Table 36). Because the Hawaii longline fisheries (shallow-set and deep-set) are regulated under a limited entry program (maximum 164 permits combined), any increased effort in the shallow-set fishery would be from vessels that primarily target bigeye tuna in the deep-set fishery. It is expected that such a shift would reduce bigeye catches by the Hawaii deep-set fishery and thus relieve some pressure (albeit insignificant in terms of overall WCPO bigeye catch and stock status) on bigeye stocks.

However, it is uncertain whether all 5,500 sets would be utilized every year under Alternative 1D, if not catches and fishing mortality to target species would be some fraction of the numbers presented in Table 53.

Table 53: Predicted annual catches and fishing mortality of major species under Alternative 1D (5,500 sets made)

Species	Annual pounds caught	Annual pounds kept	Annual pounds discarded dead	Total annual mortality: pounds kept + discarded dead
Swordfish	10,978,211	9,792,574	786,789	10,579,363
Bigeye Tuna	435,496	399,904	12,724	412,628
Mahimahi	238,338	197,012	6,699	203,711
Striped Marlin	227,656	193,677	7,856	203,711
Blue Marlin	146,502	123,528	5,661	129,189
Albacore Tuna	188,150	118,239	30,090	148,329
Yellowfin Tuna	32,364	29,672	985	30,657
Oilfishes	157,552	16,500	37,026	53,526
Opah	25,704	16,459	2,438	18,897
Ono	10,729	10,343	300	10,643
Shortbilled Spearfish	13,438	8,884	2,054	10,938
Thresher Sharks	48,926	4,893	8,256	13,149
Pomfret	6,130	4,671	776	5,448
Skipjack Tuna	2,279	1,989	229	2,219
Blue Shark	4,710,456	0	278,388	278,388
Mako Shark	590,285	0	136,946	136,946
Oceanic Whitetip Shark	NA	NA	NA	NA
Other Pelagics	NA	NA	NA	NA
Other Sharks	NA	NA	NA	NA
Other Tunas	NA	NA	NA	NA

NA entries indicate species which are caught in low numbers and for which average pounds per fish are not available because the majority are discarded (alive). See Table 12 for available information on catches and discards of these species.

4.1.4.2 Impacts of Alternative 1D to Non-target Stocks

Assuming all 5,500 sets were made under Alternative 1D catches of blue sharks would be anticipated to total 4.7 million pounds, with the majority released alive for an annual fishing mortality of 278,000 pounds (Table 53) or approximately 0.21 percent of MSY. The catch and fishing mortality of other sharks would remain relatively small and consist primarily of mako, white-tip and thresher sharks, with the majority of these also released alive as shown above.

As described under Alternative 1A, among the bony fishes the most commonly non-target species caught cumulatively on all 4,127 sets observed between 2004-2007 (Table 12) were long-nose lancetfish (5,683 individuals caught by the fishery over the entire time period), snake mackerel (1,086 individuals), remoras (923 individuals), pelagic stingrays (303 individuals) and smaller numbers of common and slender molas, knifetail and brilliant pomfrets, pelagic puffers, great barracuda, manta rays, mobula rays, hammerjaws, tapertail ribbonfish, driftfish, roudi escolars, louvars and black mackerel. Collectively, 2004-2007 observed non-target bony fish catches amounted to 8,141 individuals, which is about six percent of the total observed catch (Table 12) and was mostly discarded. Discard conditions (alive vs. dead) were mixed, with the majority (93 percent) of long-nose lancetfish discarded dead, but only 9 percent of remoras discarded dead.

Because Alternative 1D is not expected to significantly alter fishing operations, catch and discard rates of non-target species would be anticipated to remain as observed between 2004 and 2007 (Table 12), and these species would be expected to form between six and seven percent of the fishery's total annual catch, with the specific volume proportional to the number of sets actually made. Relative discard conditions would also be expected to remain as observed. Resultant fishing mortality to non-target species would be expected to be a very minor fraction of Pacific-wide catches, and well below known MSY levels.

4.1.4.3 Impacts of Alternative 1D to Protected Species and Seabirds

Table 54: Predicted annual protected species and seabird interactions and mortalities under Alternative 1D (5,500 sets made)

Species	Number of interactions	Number of mortalities
Loggerheads: released injured	42.46	8.70
Leatherbacks: released injured	16.50	3.77
Olive Ridleys: released injured	2.01	Unknown, <2
Greens: released injured or unknown	0.53	Unknown, <1
Bryde's whale: released injured	0.53	Unknown, <1
Bottlenose dolphin: released injured	2.13	Unknown, <2.13
Risso's dolphin: released injured or dead	4.26	0.81 - 5
Humpback whales: released injured	1.06	0.27
Black-footed albatross: released injured or dead	14.71	8.23 – 14.71
Laysan albatross: released injured or dead	59.66	14.91 – 59.66
Short-tailed albatross: released or dead	0.111	Unknown, <0.02

Note: Using 2005-2007 observer data, the following percentages of interactions are estimated to result in dead animals of Risso's dolphin, black-footed albatross, and Laysan albatross: 19%, 56%, and 25%, respectively. Loggerhead and leatherback post-hooking mortality rates are currently estimated to be 20.5% and 22.9%, respectively. Short-tailed albatross estimated mortalities are based on a factor of 0.182, which is the proportion of black-footed albatross interactions that resulted in mortalities in the shallow-set fishery based on an average of observations made in 2005 and 2007. The 2008 NMFS BiOp conservatively estimated that 25% of humpback whale interactions result in serious injury leading to mortality and that mortality rate has been used here. As described in Section 4.0, based on an observed interaction with the fishery in the second quarter of 2008, it is estimated that up to one false killer whale interaction may occur with the fishery per year.

4.1.4.3.1 Impacts to Marine Mammals

Marine mammal interactions in the shallow-set fishery primarily involve Risso's dolphins, with up to 5 interactions expected per year under Alternative 1D, assuming that all 5,500 sets are made (Table 54). Other marine mammal interactions anticipated under Alternative 1D consist of three bottlenose dolphins, and one or less than one interaction per year for all others. Of the up to five potential interactions with Risso's dolphins, one would be expected to be released dead each year. If the fishery does not make all 5,500 sets under Alternative 1D, annual interactions would be expected to be some fraction of those presented in Table 54 with the actual number depending on effort levels. The impact of Alternative 1D on marine mammals is not likely to cause a significantly adverse effect on marine mammal populations (see Section 4.4.2.2 for more information).

4.1.4.3.2 Impacts to Sea Turtles

Under Alternative 1D, 42.46 loggerhead turtle interactions would be anticipated each year assuming all 5,500 sets were made (Table 54). Because observed interaction rates have been highly variable depending on the time and area fished, as well as prevailing oceanographic conditions (see Section 3.1.1) there is likely to be substantial variation around the point estimates presented here and actual interactions would be likely to be below the estimates in some years and above them in others.

Interactions with leatherback turtles under Alternative 1D would be expected to total up to 16.50 per year if all 5,500 sets were utilized, but again there is likely to be substantial variation around the point estimates presented here. Thus, actual interactions would be likely to be below the estimates in some years and above them in others. Similarly, if the fishery does not make all 5,500 sets under Alternative 1D, annual interactions would be expected to be a fraction of those presented in Table 54, with the actual number depending on effort levels.

Under Alternative 1D there is anticipated to be approximately 2 interactions per year with olive ridley turtles assuming all 5,500 sets are made, and a fraction of this number if not all sets are utilized. Interactions with green turtles are expected to be up to one per year and no hawksbill turtle interactions would be expected under Alternative 1D. The impact of Alternative 1D on sea turtles is not likely to cause a significant adverse effect on sea turtle populations (see Section 4.4.2.1 for more information).

4.1.4.3.3 Impacts to Seabirds

Under Alternative 1D it is anticipated that there would be up to 15 interactions each year with black-footed albatrosses if all 5,500 sets were made, with approximately eight of these released dead (Table 54). There would be expected to be 59.66 interactions with Laysan albatrosses with approximately 15 of these released dead, if all 5,500 sets are used. Serious interactions with adult albatrosses during the time when chicks are being fed and reared may also result in chick mortality. Short-tailed albatross interactions are predicted to be 0.111 interactions per year under Alternative 1D. This level of interactions is not expected to cause a significant impact to short-tailed albatross populations and is less than the 2004 BiOp anticipated.

If the fishery does not make all 5,500 sets under Alternative 1D, annual seabird interactions would be expected to be a fraction of these numbers, with actual numbers depending on the levels of effort. The impact of Alternative 1D on seabirds is not likely to cause a significant adverse effect on seabird populations. Section 4.4.2.3 provides a discussion on cumulative impacts on seabirds.

4.1.4.4 Impacts of Alternative 1D to Fishery Participants, Fishing Communities, and Regional Economy

Under Alternative 1D and assuming that all 5,500 allowable sets were made, the Hawaii-based swordfish fishery would be expected to retain and sell 9.8 million pounds of swordfish for $22.4 million in ex-vessel revenues (Table 55). Sales of 1.1 million pounds of other pelagics would yield an additional $2.7 million in ex-vessel revenues. As compared to anticipated catches and revenues if all 2,120 sets were made under Alternative 1A, this represents a 130 percent increase in swordfish pounds kept and a 130 percent increase in total retained catch as well as total ex-vessel revenues. Currently, there are approximately 30 vessels participating in the fishery and under this alternative, that number would be expected to increase by approximately 30-40 vessels. This increase in vessels, however, is dependent on several factors such as swordfish and bigeye markets, fuel costs, and other operational costs.

Table 55: Predicted annual ex-vessel revenues under Alternative 1D (5,500 sets made)

Species	Annual pounds kept	Annual ex-vessel revenue	Percent of annual revenue
Swordfish	9,792,574	$ 22,381,618	89.41%
Bigeye Tuna	399,904	$ 1,318,349	5.27%
Mahimahi	197,012	$ 440,650	1.76%
Striped Marlin	193,677	$ 317,631	1.27%
Albacore Tuna	118,239	$ 224,261	0.90%
Blue Marlin	123,528	$ 153,020	0.61%
Yellowfin Tuna	29,672	$ 80,523	0.32%
Oilfishes	16,500	$ 33,329	0.13%
Opah	16,459	$ 31,923	0.13%

Species	Annual pounds kept	Annual ex-vessel revenue	Percent of annual revenue
Ono	10,343	$ 27,645	0.11%
Pomfret	4,671	$ 11,145	0.04%
Shortbilled Spearfish	8,884	$ 10,039	0.04%
Skipjack Tuna	1,989	$ 1,762	0.01%
All Other Pelagics*			
Annual Total	10,913,452	$ 25,031,895	100.00%
* All other pelagics account for less than three percent of total annual fish kept, detailed weight and price information not available for all species.			

Utilizing the methodology and model presented by Leung and Pooley (2002) the anticipated ex-vessel revenues under Alternative 1D ($25 million, Table 55) would be predicted to have the following impacts to the regional economy (Table 56 below). In summary, it is estimated that under Alternative 1D the Hawaii longline swordfish fishery would generate $60.7 million in direct and indirect business sales, $27 million in personal and corporate income, 837 jobs, and $4.5 million in state and local taxes.

Table 56: Predicted regional impacts under Alternative 1D (5,500 sets made)

Variable	Impact
Predicted Ex-vessel Revenue ($ million)	25.03
Direct Effects	
Business Sales ($ million)	25.03
Income ($ million)	12.12
Employment (jobs)	349.48
State & Local Taxes ($ million)	2.02
Indirect and Induced Effect From Local Purchases of Goods & Services	
Business Sales ($ million)	17.75
Income ($ million)	7.05
Employment (jobs)	220.65
State & Local Taxes ($ million)	1.18
Indirect and Induced Effect From Direct Income of Longline Fishing	
Business Sales ($ million)	17.90
Income ($ million)	7.79
Employment (jobs)	266.84
State & Local Taxes ($ million)	1.30

Total Effect	
Business Sales ($ million)	60.69
Income ($ million)	26.96
Employment (jobs)	836.98
State & Local Taxes ($ million)	4.50

Source: Based on Leung and Pooley (2002)

4.1.4.5 Impacts of Alternative 1D to Administration and Enforcement

Under Alternative 1D, impacts to administration would be related to issuing 5,500 shallow-set certificates which is estimated to cost $10,771 annually ($6,341 increase from status quo) as well as for administering the observer program to maintain 100 percent coverage for the shallow-set fishery, which is estimated to cost $5,167,881 annually (a $3,311,822 increase from status quo). Increases in shallow-set effort from this alternative are predicted to cost $193,824 per year for NMFS PIFSC to process additional shallow-set logbooks—an estimated $119,114 increase per year from status quo. Enforcement agencies would continue to monitor shallow-set fishery compliance with regulations that include seabird and sea turtle mitigation measures, and set certificates. VMS would continue to be used as the primary tool for enforcing closed areas as well as knowing where the fleet is operating.

4.1.5 Alternative 1E: Set Effort Level Commensurate with the Current Condition of the North Pacific Swordfish Stock

Under Alternative 1E, the allowable effort level for swordfish (number of shallow sets allowed) would be established based on the condition of the swordfish stock in the North Pacific and the MSY for this stock. Establishment of this effort limit takes into account catches by other longline fleets and the fraction of the total swordfish catch realized by the Hawaii fleet.

Current swordfish landings in the North Pacific amount to about 14,500 metric tons (31.9 million pounds), which, according to a recent stock assessment, is about 65 percent of an estimated MSY of 22,284 metric tons (49 million pounds; K. Bigelow, PIFSC pers. comm. based on Kleiber and Yokawa 2004). Thus, there are an additional 17.1 million pounds available for harvest before MSY levels are reached. Hawaii’s fleet has recently landed an annual average of two million pounds of swordfish (Chapter 3 tables), with the remaining 29.9 million pounds harvested by foreign fisheries. Assuming that foreign harvest levels remain stable, the Hawaii fleet could harvest up to 19.1 million pounds of swordfish before MSY levels are reached (the two million pounds currently harvested plus the 17.1 million additional available pounds).

Based on the 2004 - 2007 fishing seasons it would take just over 9,925 sets for the Hawaii longline swordfish fishery to catch the available 8,682 metric tons (19.1 million pounds) of swordfish before total North Pacific swordfish catches reach MSY. Therefore under Alternative 1E, 9,925 Hawaii longline shallow sets would be allowed each year.

Past Hawaii longline shallow-set effort peaked in 1991 when 8,355 sets were made. It is not known whether the shallow-set fishery would rebound to these levels, but the capacity to do so is well within the bounds of current fishery capacity given that there are still 164 longline permits issued (although not all are actively fished every year).

4.1.5.1 Impacts of Alternative 1E to Target Stocks

Based on the 2004 - 2007 fishing seasons and assuming that all 9,925 sets were utilized under Alternative 1E, the shallow-set fishery would be expected to realize the catches and fishing mortality levels presented in Table 57. The total retained swordfish catch would be anticipated to be 17.7 million pounds, with another 1.4 million pounds discarded dead for a total annual fishing mortality of 19.1 million pounds (Table 57). Other (non-swordfish) species would continue to comprise a small fraction of the catch with bigeye tuna fishing mortality comprising 745,000 pounds (approximately 0.37 percent of MSY), striped marlin 364,000 pounds and mahimahi 368,000 pounds. Other commercial species such as albacore, blue marlin, and yellowfin tuna would contribute smaller amounts to the remainder of the retained catch and fishing mortality as shown below. Expected catches of these non-swordfish target species under this alternative are a negligible fraction of total Pacific-wide catches and known MSY values of these species. As compared to Alternative 1A with 2,120 sets made, this would represent a 314 percent increase in fishing mortality for swordfish, and a 282 percent increase for bigeye tuna. As compared to Alternative 1A, catches and fishing mortality for other species would also increase by varying amounts. These percentage increases would not be uniform as under Alternative 1E the "unconstrained" fishing effort distribution (Table 40) is utilized and annual catch rates for each species would change as effort moved into different quarters, each with its own catch rate (Table 36). Because the Hawaii longline fisheries (shallow-set and deep-set) are regulated under a limited entry program (maximum 164 permits combined), any increased effort in the shallow-set fishery would be from vessels that primarily target bigeye tuna in the deep-set fishery. It is expected that such a shift would reduce bigeye catches by the Hawaii deep-set fishery and thus relieve some pressure (albeit insignificant in terms of overall WCPO bigeye catch and stock status) on bigeye stocks.

However, it is uncertain whether all 9,925 sets would be utilized every year under Alternative 1E, if not catches and fishing mortality to target species would be some fraction of the numbers presented in Table 57.

Table 57: Predicted annual catches and fishing mortality of major species under Alternative 1E (9,925 sets made)

Species	Annual pounds caught	Annual pounds kept	Annual pounds discarded dead	Total annual mortality: pounds kept + discarded dead
Swordfish	19,810,681	17,671,145	1,419,796	19,090,941
Bigeye Tuna	785,872	721,644	22,961	744,606
Mahimahi	430,093	355,517	12,089	367,606
Striped Marlin	410,815	349,499	14,176	363,676

Blue Marlin	264,369	222,911	10,215	233,127
Albacore Tuna	339,526	213,368	54,298	267,667
Yellowfin Tuna	58,402	53,545	1,777	55,322
Oilfishes	284,310	29,774	66,816	96,590
Opah	46,384	29,701	4,399	34,100
Ono	19,361	18,664	542	19,206
Shortbilled Spearfish	24,250	16,032	3,706	19,738
Thresher Sharks	88,289	8,829	14,899	23,728
Pomfret	11,062	8,430	1,401	9,831
Skipjack Tuna	4,112	3,590	413	4,003
Blue Shark	8,500,232	0	502,364	502,364
Mako Shark	1,065,197	0	247,126	247,126
Oceanic Whitetip Shark	NA	NA	NA	NA
Other Pelagics	NA	NA	NA	NA
Other Sharks	NA	NA	NA	NA
Other Tunas	NA	NA	NA	NA

NA entries indicate species which are caught in low numbers and for which average pounds per fish are not available because the majority are discarded (alive). See Table 12 for available information on catches and discards of these species.

4.1.5.2 Impacts of Alternative 1E to Non-target Stocks

Assuming all 9,925 sets were made under Alternative 1E catches of blue sharks would be anticipated to total 8.5 million pounds, with the majority released alive for an annual fishing mortality of 502,000 pounds (Table 57) or approximately 0.38 percent of MSY. The catch and fishing mortality of other sharks would remain relatively small and consist primarily of mako, white-tip and thresher sharks, with the majority of these also released alive as shown above.

As described under Alternative 1A, among the bony fishes the most commonly caught non-target species of all 4,127 sets observed between 2004-2007 (Table 12) were long-nose lancetfish (5,683 individuals caught by the fishery over the entire time period), snake mackerel (1,086 individuals), remoras (923 individuals), pelagic stingrays (303 individuals) and lesser numbers of common and slender molas, knifetail and brilliant pomfrets, pelagic puffers, great barracuda, manta rays, mobula rays, hammerjaws, tapertail ribbonfish, driftfish, roudi escolars, louvars and black mackerel. Collectively, 2004-2007 observed non-target bony fish catches amounted to 8,141 individuals, which is about 6 percent of the total observed catch (Table 12) and was mostly discarded. Discard conditions (alive vs. dead) were mixed, with the majority (93 percent) of long-nose lancetfish discarded dead, but only nine percent of remoras discarded dead.

Because Alternative 1E is not expected to significantly alter fishing operations, catch and discard rates of non-target species would be anticipated to remain as observed between 2004 and 2007 (Table 12), and these species would be expected to form between six and seven percent of the fishery's total annual catch, with the specific volume proportional to the number of sets actually made. Relative discard conditions would also be expected to remain as observed. Resultant fishing mortality to non-target species would be expected to be a very minor fraction of Pacific-wide catches, and well below known MSY levels

4.1.5.3 Impacts of Alternative 1E to Protected Species and Seabirds

Table 58: Predicted annual protected species and seabird interactions and mortalities under Alternative 1E (9,925 sets made)

Species	Number of interactions	Number of mortalities
Loggerheads: released injured	76.63	15.70
Leatherbacks: released injured	29.78	6.82
Olive Ridleys: released injured	3.62	Unknown, <4
Greens: released injured or unknown	0.96	Unknown, <1
Bryde's whale: released injured	0.96	Unknown, <2
Bottlenose dolphin: released injured	3.84	Unknown, <4
Risso's dolphin: released injured or dead	7.69	1.46 – 7.69
Humpback whales: released injured	1.92	0.48
False killer whales: released injured	<1	Unknown, <1
Black-footed albatross: released injured or dead	26.54	14.86 - 26.54
Laysan albatross: released injured or dead	107.66	26.91 – 107.66
Short-tailed albatross: released injured or dead	0.200	Unknown, < 0.0364

Note: Using 2005-2007 observer data, the following percentages of interactions are estimated to result in dead animals of Risso’s dolphin, black-footed albatross, and Laysan albatross: 19%, 56%, and 25%, respectively. Loggerhead and leatherback post-hooking mortality rates are currently estimated to be 20.5% and 22.9%, respectively. Short-tailed albatross estimated mortalities are based on a factor of 0.182, which is the proportion of black-footed albatross interactions that resulted in mortalities in the shallow-set fishery based on an average of observations made in 2005 and 2007. The 2008 NMFS BiOp conservatively estimated that 25% of humpback whale interactions result in serious injury leading to mortality and that mortality rate has been used here. As described in Section 4.0, based on an observed interaction with the fishery in the second quarter of 2008, an estimate of up to one false killer whale interaction annually was added to Table 58.

4.1.5.3.1 Impacts to Marine Mammals

Marine mammal interactions in the shallow-set fishery primarily involve Risso’s dolphins, with up to 8 interactions expected per year under Alternative 1E, assuming that all 9,925 sets are made (Table 58). Other marine mammal interactions anticipated under Alternative 1E consist of up to four bottlenose dolphins, and up to two of humpback whales and one Bryde’s whale. Of the eight estimated interactions with Risso’s dolphins, two would be expected to be released dead each year. If the fishery does not make all 9,925 sets under Alternative 1E, annual interactions would be expected to be some fraction of those presented in Table 58 with the actual number depending on effort levels. The impact of Alternative 1E on marine mammals is not likely to cause a significantly adverse effect on the marine mammal populations (see Section 4.4.2.2 for more information).

4.1.5.3.2 Impacts to Sea Turtles

Under Alternative 1E, 76.63 loggerhead turtle interactions would be anticipated each year assuming all 9,925 sets were made (Table 58). Because observed interaction rates have been highly variable depending on the time and area fished, as well as prevailing oceanographic conditions (see Section 3.1.1), there is likely to be substantial variation around the point estimates presented here and actual interactions would likely be below the estimates in some years and above them in others.

Interactions with leatherback turtles under Alternative 1E would be expected to total up to 30 per year if all 9,925 sets were utilized, but again there is likely to be substantial variation around the point estimates presented here. Thus, actual interactions would be likely to be below these estimates in some years and above them in others. Similarly, if the fishery does not make all 9,925 sets under Alternative 1E, annual interactions would be expected to be a fraction of those presented in Table 58, with the actual number depending on effort levels.

Under Alternative 1E there is anticipated to be up to 4 interactions per year with olive ridley turtles, assuming all 9,925 sets are made, and a fraction of this number if not all sets are utilized. Interactions with green turtles are expected to be up to one per year with no hawksbill turtle interactions expected under Alternative 1E.

4.1.5.3.3 Impacts to Seabirds

Under Alternative 1E, it is anticipated that there would be up to 27 interactions each year with black-footed albatrosses if all 9,925 sets were made, with up to 15 of these released dead (Table 58). There would be expected to be up to 108 interactions with Laysan albatrosses, with approximately 27 of these released dead, if all 9,925 sets are used. Serious interactions with adult albatrosses during the time when chicks are being fed and reared may also result in chick mortality. Short-tailed albatross interactions are predicted to be 0.200 interactions per year under Alternative 1E. This level of interactions is not expected to cause a significant impact to short-tailed albatross and is less than the 2004 BiOp anticipated. A more detailed explanation of potential impacts on short-tailed albatross for the highest fishing effort (Alternative 1F) is discussed in section 4.1.6.3.3.

If the fishery does not make all 9,925 sets under Alternative 1E, annual seabird interactions would be expected to be a fraction of these numbers, with actual numbers depending on the levels of effort. The impact of Alternative 1E on seabirds is not likely to cause a significantly adverse effect on seabird populations. Section 4.4.2.3 provides a discussion on cumulative impacts on seabirds.

4.1.5.4 Impacts of Alternative 1E to Fishery Participants and Fishing Communities

Under Alternative 1E and assuming that all 9,925 allowable sets were made, the Hawaii-based swordfish fishery would be expected to retain and sell 17.7 million pounds of swordfish for $40.4 million in ex-vessel revenues (Table 59). Sales of 2 million pounds of other pelagics would yield an additional $4.8 million in ex-vessel revenues. As compared to anticipated catches and revenues if all 2,120 sets were made under Alternative 1A, this represents a 315 percent increase in swordfish pounds kept, a 320 percent increase in total retained catch and a 317 percent increase in total ex-vessel revenues. Currently, there are approximately 30 vessels participating in the fishery and under this alternative, that number would be expected to increase by approximately 50-60 vessels. This increase in vessels, however, is dependent on several factors such as swordfish and bigeye markets, fuel costs, and other operational costs.

Table 59: Predicted ex-vessel revenues under Alternative 1E (9,925 sets made)

Species	Annual pounds kept	Annual ex-vessel revenue	Percent of annual revenue
Swordfish	17,671,145	$ 40,388,647	89.41%
Bigeye Tuna	721,644	$ 2,379,021	5.27%
Mahimahi	355,517	$ 795,173	1.76%
Striped Marlin	349,499	$ 573,179	1.27%
Albacore Tuna	213,368	$ 404,688	0.90%
Blue Marlin	222,911	$ 276,132	0.61%
Yellowfin Tuna	53,545	$ 145,307	0.32%
Oilfishes	29,774	$ 60,144	0.13%
Opah	29,701	$ 57,607	0.13%
Ono	18,664	$ 49,886	0.11%
Pomfret	8,430	$ 20,112	0.04%
Shortbilled Spearfish	16,032	$ 18,116	0.04%
Skipjack Tuna	3,590	$ 3,179	0.01%
All Other Pelagics*			
Annual Total	19,693,820	$ 45,171,191	100.00%

* All other pelagics account for less than three percent of total annual fish kept, detailed weight and price information not available for all species.

Utilizing the methodology and model presented by Leung and Pooley (2002) the anticipated ex-vessel revenues under Alternative 1E ($45.2 million, Table 59) would be predicted to have the following impacts to the regional economy (Table 60). In summary, it is estimated that under Alternative 1E, the Hawaii longline swordfish fishery would generate $109.5 million in direct and indirect business sales, $48.7 million in personal and corporate income, 1,510 jobs, and $8.1 million in state and local taxes.

Table 60: Predicted regional impacts under Alternative 1E (9,925 sets made)

Variable	Impact
Predicted Ex-vessel Revenue ($ million)	45.17
Direct Effects	
Business Sales ($ million)	45.17
Income ($ million)	21.87
Employment (jobs)	630.64
State & Local Taxes ($ million)	3.65
Indirect and Induced Effect From Local Purchases of Goods & Services	
Business Sales ($ million)	32.03
Income ($ million)	12.71
Employment (jobs)	398.16
State & Local Taxes ($ million)	2.12
Indirect and Induced Effect From Direct Income of Longline Fishing	
Business Sales ($ million)	32.31
Income ($ million)	14.06
Employment (jobs)	481.51
State & Local Taxes ($ million)	2.35
Total Effect	
Business Sales ($ million)	109.51
Income ($ million)	48.65
Employment (jobs)	1510.32
State & Local Taxes ($ million)	8.12

Source: Based on Leung and Pooley (2002)

4.1.5.5 Impacts of Alternative 1E to Administration and Enforcement

Under this alternative the annual effort limit would be set at 9,925 sets, which is greater than the maximum number of sets ever made by the fishery. It is anticipated that setting this limit on the level of effort would not require the current issuance of and near real-time monitoring of set certificates. Maintaining 100 percent observer coverage would cost $12,724,358 to administer on an annual basis, an increase of $10,868,299. Increases in shallow-set effort from this alternative are predicted to cost $349,764 per year for NMFS PIFSC to process additional shallow-set logbooks—an estimated $275,054 increase per year from status quo.

4.1.6 Alternative 1F: Remove Effort Limit (Preferred)

Under this alternative, the annual effort limit would be removed and fishery would not be managed under an annual set limit cap. Anticipated fishing effort is expected to gradually increase to historic levels between 4,000 and 5,000 sets per year (3.4 - 4.2 million hooks/yr).

4.1.6.1 Impacts of Alternative 1F to Target Stocks

If anticipated fishing effort incrementally increases under Alternative 1F, impacts to target stocks would be similar in range to those described for Alternatives 1A through 1D and would likely vary by year. For example, in the first 1-3 years after implementation of this alternative, the fishery is expected to expand, and its annual production of swordfish is predicted to be between 4.6 and 6.5 million lb (2,085-2,950 mt). Depending on various factors including fuel prices and market demands, swordfish harvests in the near term could further increase to historical levels between 8.6 and 10.6 million pounds (3900-4809 mt) under this alternative. Non-swordfish catches of target species by the shallow-set fishery for species such as bigeye would be expected to also increase as effort increases, with anticipated harvests similar those described under Alternatives 1A through 1D. Because the Hawaii longline fisheries (shallow-set and deep-set) are regulated under a limited entry program (maximum 164 permits combined), any increased effort in the shallow-set fishery would be from vessels that also primarily target bigeye tuna in the deep-set fishery. It is expected that such a shift would reduce bigeye catches by the Hawaii deep-set fishery and thus relieve some pressure (albeit insignificant in terms of overall WCPO bigeye catch and stock status) on bigeye stocks. This alternative will likely increase fishing mortality on stocks which there is little population data for such as striped marlin. As information on these stocks become available, the Council may take additional conservation and management measures to protect these stocks

4.1.6.2 Impacts of Alternative 1F to Non-target Stocks

Assuming that effort will gradually increase in the near term and then potentially increase to historical levels, impacts to non-targets species would be similar to those described for Alternatives 1A-1D. Because Alternative 1F is not expected to significantly alter fishing operations, catch and discard rates of non-target species would be anticipated to remain as observed between 2004 and 2007 (Table 12), and these species would be expected to form between six and seven percent of the fishery's total annual catch, with the specific volume proportional to the number of sets actually made. Relative discard conditions would also be expected to remain as observed. Resultant fishing mortality to non-target species would be expected to be a very minor fraction of Pacific-wide catches, and well below known MSY levels.

4.1.6.3 Impacts of Alternative 1F to Protected Species and Seabirds

4.1.6.3.1 Impacts to Marine Mammals

Under this alternative, the number of marine mammal interactions is expected to be low, with Risso's dolphin anticipated to have the highest number of interactions. Depending on the amount of fishing effort expended, Risso's dolphin interactions are expected to range between three and six interactions per year, with one or less dead upon retrieval. Other marine mammal impacts would similar to those described for Alternatives 1A-1D (see Tables 42, 46, 50, 54), whereby the number of predicted interactions are related to the amount of expected fishing effort. The 100 percent observer coverage that will be maintained under this and all alternatives allows all marine mammal interactions and release conditions to be recorded. The impact of Alternative 1F on marine mammals is not likely to cause a significantly adverse effect on the marine mammal populations (see Section 4.4.2.2 for more information).

4.1.6.3.2 Impacts to Sea Turtles

Under this alternative, loggerhead and leatherback sea turtle hard caps would be set at 46 and 16, respectively, which is consistent with the 2008 BiOp.

Impacts to olive ridley turtles are anticipated to be less than 2 interactions per year, with one interaction or less with green turtles, and no expected interactions with hawksbill turtles, which is consistent with the impacts described for Alternatives 1A-1D (see Tables 42, 46, 50, 54).

4.1.6.3.2.1 Discussion and Impacts of Multi-year ITS

The Council has recommended and HLA has requested that the applicable sea turtle ITS for the proposed action cover a three year period given the interannual variability in the rate of interactions and the best available empirical data. NMFS may decide to issue a 3-year sea turtle ITS in its BiOp on the proposed expansion of the HI-based shallow-set longline fishery. If a 3-year ITS is used, it would be implemented in conjunction with annual hard caps for loggerhead and leatherback interactions (46 for loggerheads, 16 for leatherbacks). That is, the ITS would cover a 3-year period and thus allow up to triple the annual hard cap over 3 calendar years (138 for loggerheads, 48 for leatherbacks). But since the annual hard caps would still be in place, the number of turtles taken in any given year is not expected to be different than under a 1-year ITS.

There could be a situation where the fleet exceeds the hard cap before NMFS is able to properly notify participants that the fishery is closed for the remainder of the calendar year. Although all observers carry satellite phones and closure notice is near immediate, there remains a potential for exceeding annual hard caps while the fleet is fishing on the swordfish grounds during the time of a closure. Under a 3-year ITS, accidental exceedance of either hard cap during a fishery closure would not require reinitiation of consultation. In the event that the hard cap is exceeded, the number of interactions over the hard cap would be subtracted from the following year's hard cap. However, the hard caps for future years could <u>not</u> be increased in response to low number of interactions in previous years. Thus, the 3-year ITS would provide administrative flexibility without increasing effects on turtles, as illustrated in the examples and figure below.

Interactions between loggerhead and leatherback sea turtles and the shallow-set fishery are currently regulated by annual hard caps and a 1-year ITS. When either hard cap is reached, the fishery is closed for the remainder of the calendar year, and if either hard cap is exceeded, reinitation of ESA section 7 consultation is required. A 3-year ITS of 138 loggerhead interactions in combination with an annual hard cap of no more than 46 interactions would allow for the accidental exceedance of the annual hard cap, as long as the 3-year total was not exceeded – see Years 3 and 5 in Figure 36 below. That is, under a 3-year ITS, the fishery could exceed the annual turtle hard cap, but without triggering reinitation of ESA section 7 consultation. The following year's hard cap would be adjusted downward by the same number that it was exceeded by the preceding year – see Years 4 and 6 in Figure 36. The hard cap would not be adjusted upward, regardless of how few interactions there were in any given year. Exceeding 138 loggerhead interactions during a 3-year period would require reinitiation of consultation – see Years 5-7 in Figure 36.

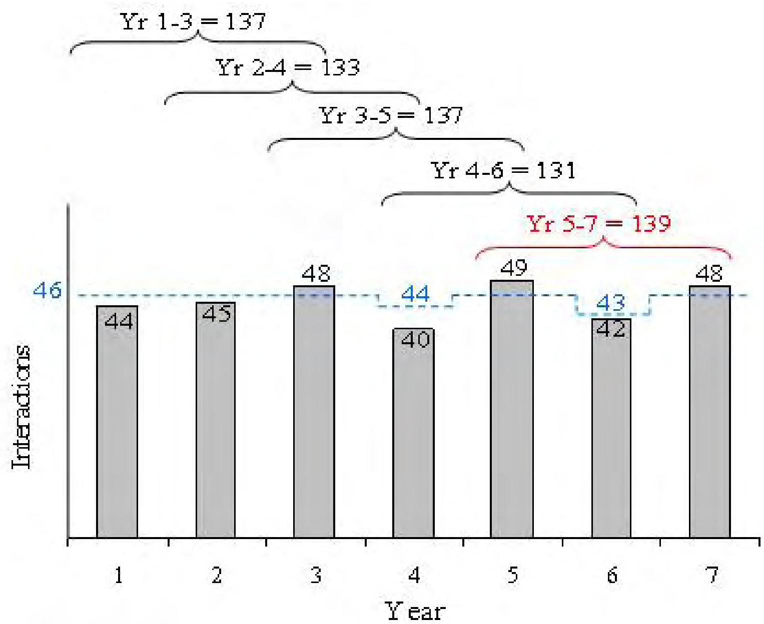

Figure 36: Hypothetical interactions with loggerhead turtles in the Hawaii shallow-set fishery showing three year totals

The effects of a 1-year vs. a 3-year ITS are indistinguishable at the population level for loggerhead and leatherbacks when considered over a 3-year period or longer. This is because both ITSs would include an annual hard cap, resulting in the same mean annual maximum level of interactions for each affected population. However, the 3-year ITS provides a management benefit by allowing some administrative flexibility, as explained above.

Sea Turtle Population Impacts from Multi-year ITS

The following describes impacts to sea turtles populations based on the 2008 SQE analysis (Snover 2008). Using population simulations, SQE assess actual risk (in terms of a binary assessment of at risk or not at risk) to sea turtle populations. The SQE analysis uses long time frames of 3 generations (following IUCN criteria) which clarify that SQE values are primarily useful as an index for comparing populations and assessing the impacts of increased mortalities by comparing SQE values between perturbed and non-perturbed populations (See Section 4.4.2.1.5 for more information).

Loggerhead impacts

The proposed action would implement an annual sea turtle hard cap of 46 loggerhead interactions. As seen below, 46 loggerhead interactions are estimated to result in 2.51 adult female mortalities.

(46 interactions)(0.205 mortalities/interactions)(0.65 female sex ratio)(0.41 adult equivalent) = 2.51 adult female mortalities

An additional two loggerhead interactions in the calendar year is estimated to result in an additional 0.168 adult female mortalities as calculated below.

(2 interactions)(0.205 mortalities/interactions)(0.65 female sex ratio)(0.41 adult equivalent) = 0.168 adult females mortalities

If the loggerhead sea turtle hard cap were to be exceeded by two interactions prior to close of fishing in any given year, it would result in 2.68 (2.51 + 0.168) adult female mortalities (AFM). A recent extinction risk analysis (Snover 2008) indicates that for the Japanese loggerhead population, AFM of less than seven would have a minimal impact on the population's risk of extinction. Therefore, it is not expected that significant loggerhead population impacts would occur if an additional two loggerhead interactions, or 0.168 AFM, occurred prior to the closure of the fishery in any given year. Moreover any overages in the turtle interactions would be subtracted from the following year's annual sea turtle hard cap so any additional impacts from the previous year's interactions should be made up the following year.

Leatherback impacts

The proposed action would implement an annual sea turtle hard cap of 46 loggerhead and 16 leatherback interactions. Snover (2008; Appendix II) examined the effects of the existing hard caps (17 loggerheads and 16 leatherbacks) as well as those preliminarily preferred by the Council and contained in the DSEIS for this proposed action (46 loggerheads and 19 leatherbacks) on loggerhead and leatherback sea turtle populations. This analysis assumed that the fishery primarily interacts (94 percent) with leatherbacks of the Western Pacific population and rarely interacts (6 percent) with Eastern Pacific leatherback populations. Recent evaluations of genetic samples from interactions in the fishery, however, suggest that 100 percent of the leatherbacks that interact with the fishery derive from Western Pacific nesting aggregations. Based on the size of the Jamursba-Medi nesting aggregation in Papua, Indonesia, 69 percent of the total Western Pacific leatherback interactions are estimated to occur with turtles from with the Jamursba-Medi nesting aggregation. If 69 percent of Western Pacific leatherback interactions are believed to be Jamursba-Medi, then the remainder (31 percent) are believed to be from the Western Pacific metapopulation.

As seen below, 19 leatherback interactions are estimated to result in 2.40 adult female mortalities.

(19 interactions)(0.229 mortalities/interactions)(0.65 females)(0.85 adult equivalent) = 2.40 adult female mortalities

Of the 2.40 AFM expected to result from 19 leatherback interactions, 1.65 AFM (2.40 x 0.69) would be expected from the Jamursba-Medi nesting aggregation, 0.74 (2.40 x 0.31) from the remaining western Pacific metapopulation.

An additional two leatherback interactions (i.e. 21) in the calendar year are estimated to result in AFM as calculated below.

(2 interactions)(0.229 mortalities/interactions)(0.65 females)(0.85 adult equivalent) = 0.25 adult female mortalities

Out of an additional 0.25 AFM, 0.172 AFM (0.25 x 0.69) would be expected to be from the Jamursba-Medi population, 0.077 AFM (0.25 x .31) from the remaining Western Pacific metapopulation. Therefore, an additional two leatherback interactions would result in 1.82 AFM from the Jamursba-Medi nesting aggregation. The recent extinction risk analysis indicates that adult female leatherback mortalities of less than 4 would have a minimal impact on SQE for the Jamursba-Medi leatherback nesting population (Snover 2008; Appendix II).

Olive Ridley, Green, and Hawksbill impacts

These three species are rarely caught in the shallow-set fishery. Since the fishery re-opened in 2004, a total of three olive ridleys, one green, and no hawksbills have been caught. There are no hard caps for these species. A 3-year ITS may be issued for these species, but since there would not be hard caps, the 3-year ITS for them would operate differently than for loggerheads and leatherbacks. The 3-year ITS for olive ridleys, greens and hawksbills would be an estimated number of interactions for each species over a 3-year period, and would not be managed on an annual basis. This 3-year ITS would address inter-annual variability in the interaction rates, and our inability to predict those on an annual basis. This would prevent minor interactions from exceeding the ITS and requiring reinitiation of consultation. For example, in the 2004 BiOp, the 1-year ITS for the shallow-set fishery was set at 5 olive ridleys, 1 green, and 0 hawksbills. But 1 green was caught in early 2008 in this fishery, so another green interaction anytime in 2008 would require reinitiation of consultation, even though only 1 turtle was caught in the previous 3 years. Because of the very small numbers of these species that are caught this fishery, and also because turtles are rarely seriously injured by this fishery, the effects of a 1-year vs. a 3-year ITS are indistinguishable at the population level for these 3 species when considered over a 3-year period or longer.

4.1.6.3.3 Impacts to Seabirds

Under this alternative, impacts to seabirds are dependent on the amount of fishing effort expended, which is predicted to incrementally increase in the coming years. It is expected that impacts to seabirds would vary by year, but be in the range as described for Alternatives 1A-1D (see Tables 42, 46, 50, 54). Serious interactions with adult albatrosses during the time when chicks are being fed and reared may also result in chick mortality. The impact of Alternative 1F on seabirds is not likely to cause a significant adverse effect on seabird populations (see Section 4.4.2.3 for more information).

A brief analysis using the methods found in the 2004 BiOp has shown that the anticipated effects of the fishery on short-tailed albatross populations under Alternative 1F (the highest level of fishing effort) are likely to be less than in the 2004 BiOp.

Estimated Effects on the Proxy Population

In the 2004 BiOp, the portion of the BFAL population estimated to be affected by the shallow-set fishery was 0.0082/year (0.82%/year). Incorporating actual observer data for 2005 and 2007 into the model gives much smaller estimates of the effect on the BFAL population by the different alternative considered (Table 61). The portion of the BFAL population by Alternative 1E (i.e. greatest fishing effort) is estimated to be an order of magnitude smaller than was estimated in the 2004 BiOp (0.03%/year).

Table 61: Estimated portion of black-footed albatross (BFAL) population affected by alternatives considered

Alternative	Effort (sets)	Effort (E)[24]	Estimated Portion of BFAL Population Affected (M)
1A (No Action)	2120	1.32	0.000063
1B	3000	1.87	0.000090
1C	4240	2.64	0.000130
1D	5500	3.42	0.000164
1E	9925	6.17	0.000300
1F (Preferred)	2120-5500	1.32 – 3.42	0.000063-0.000164

Table 62: Estimated short-tailed albatross (STAL) take using black-footed albatross (BFAL) as a proxy species

Alternative	Effort (sets)	Effort (E)	Estimated STAL Take (birds per year)	Estimated STAL population needed for one take per year
1A (No Action)	2120	1.32	0.043	64,420
1B	3000	1.87	0.061	45,473
1C	4240	2.64	0.086	32,705
1D	5500	3.42	0.111	24,864

[24] Effort is the average in number of sets for 2005 and 2007. 2006 was excluded because it did not represent a full year of fishing effort and would have skewed the results towards the first quarter of the fishing year.

1E	9925	6.17	0.200	13,782
1F (Preferred)	2120-5500	1.32 – 3.42	0.042 – 0.111	24,864 – 64,420

Using the 2004 model and current BFAL interaction rates, one interaction with a STAL would be expected every 5 – 24 years at current STAL population levels depending on the alternative chosen (Table 62). Therefore, the shallow-set fishery would be anticipated to take no more than one STAL in a given year.

4.1.6.4 Impacts of Alternative 1F to Fishery Participants and Regional Economy

Under this alternative, impacts to fishery participants and regional economy would depend on the amount of fishing effort expended and the revenues generated. Impacts would be similar to those described for Alternatives 1A-1D (see Tables 43, 44, 47, 48, 51, 52, 55, 56). Currently, there are approximately 30 vessels participating in the fishery and under this alternative, that number would be expected to incrementally increase by approximately 10-30 vessels. This increase in vessels, however, is dependent on several factors such as swordfish and bigeye markets, fuel costs, and other operational costs.

4.1.6.5 Impacts of Alternative 1F to Administration and Enforcement

Under this alternative, impacts to administration would be associated with paying for 100 percent observer cost and the elimination of the need to track effort in the fishery. Observer costs associated with this alternative depend on the amount of expected fishing effort, which is predicted to incrementally increase to historic levels similar to those described for Alternatives 1C and 1D. Costs for administering the observer program for this alternative are estimated to be $1.8 million to $5.1 million, depending on the amount of fishing effort to be observed. Costs to process additional shallow-set logbooks are estimated to be approximately $100,000 - $194,000 per year. See additional discussion for Alternative 2B regarding impacts on administration and enforcement from removing the set limit and discontinuing the set certificate program.

4.2 Topic 2: Fishery Participation

4.2.1 Alternative 2A: No Action: Continue Set Certificate Program

Under this alternative, shallow-set certificates would continue to be made available and issued to Hawaii longline vessels or permit holders. For each shallow-set made north of the equator, vessel operators would continue to be required to submit and possess one valid shallow-set certificate for each shallow-set made.

4.2.1.1 Impacts of Alternative 2A to Target Stocks

Under alternative 2A, the certificates would be issued in the same manner as current regulations dictate; however, depending on the effort limit, there may or may not be a race to fish type scenario. For example, the status quo set limit of 2,120 sets and corresponding sea turtle interaction hard caps have appeared to motivate fishery participants to expend their highest fishing effort in the first quarter, whereas, when the effort was not limited nor sea turtle interactions capped, the fleet fished more during the second quarter. Arguably, this is a result of a race to the turtles rather than a race to the fish, where participants are motivated to expend effort in the first quarter while sea turtle interactions under the caps are still low. Swordfish CPUE is highest in the first quarter; however, as described in Sections 3.2.1 and 3.2.2, target stocks are being fished at levels below MSY or are caught in minor quantities to affect their stock status, therefore no major adverse impacts to target stocks are anticipated from this alternative. Under a regulatory regime that restricts effort through limits on sets, fishery managers can track participation through the fishery year, thus ensuring that expected effort is not exceeded, and unconsidered impacts are not realized.

4.2.1.2 Impacts of Alternative 2A to Non-target Stocks

Similar to the impacts on target stocks, Alternative 2A is not expected to result in major adverse impacts to non-target species as fishing gear and operations would also be maintained.

4.2.1.3 Impacts of Alternative 2A to Protected Species and Seabirds

Alternative 2A would not result in any changes to fishery operations or gear and therefore would not impact protected species. Continuing the set certificate program appears to have no effect on the timing of fishing effort, rather, the sea turtle interaction hard caps may be motivating participants to expend effort in the first quarter while sea turtle interactions under the caps are still low, but when there are the highest sea turtle interaction rates. Under this alternative, fishery managers would be able track participation through the fishery year, ensuring that expected effort is not exceeded and unconsidered impacts to protected species are not realized.

4.2.1.4 Impacts of Alternative 2A to Fishery Participants and Fishing Communities

Maintaining the set certificate requirement under Alternative 2A allows potential participants the opportunity to obtain set certificates for that year from which they could either fish their certificates themselves, trade, sell, or give them to other Hawaii longline limited access permit holders for use during that year.

Financial impacts could be imposed on potential participants that do not apply and obtain set certificates from NMFS and are forced to buy certificates from other participants. On the other hand, financial gains may be obtained by those participants willing to sell their certificates to other participants.

Fishing communities are unlikely to be impacted by implementation of alternative 2A because it will not cause any major changes in fishing activity, except possibly to reduce a race to fish and extend fish landings throughout the year.

4.2.1.5 Impacts of Alternative 2A to Administration and Enforcement

Administering the set certificate program produces costs for NMFS that included printing, mailing, handling, and tracking the certificates. Annual costs are estimated to be $4,430. Under the status quo, enforcement agencies such as USCG must verify set certificates when conducting boarding of fishing vessels on shallow-set trips.

4.2.2 Alternative 2B: Discontinue Set Certificate Program (Preferred)

Under this alternative, shallow-set certificates would no longer be issued or required and the annual set-certificate solicitation would be ended. Under alternatives which include effort limits, sets would be cumulatively accounted for on a fleetwide basis and the fishery would close for the remainder of the year when and if the annual set limit was reached.

4.2.2.1 Impacts of Alternative 2B to Target Stocks

Eliminating set certificates would not be a catalyst for changes in the amount of overall fishing effort; however, there may be some shift of fishing effort to the 1st quarter when Swordfish CPUE is highest if effort was tightly constrained and fishery participants were motivated to fish in the first quarter to ensure landings. Swordfish CPUE is highest during the first quarter which could result in increased landings; however, as described in previous sections, the North Pacific swordfish stock is currently being fished below MSY.

4.2.2.2 Impacts of Alternative 2B to Non-target Stocks

Under Alternative 2B, eliminating the need for certificates may affect fishing behavior if effort was tightly constrained causing there to be increased effort in the 1st quarter and perhaps less or no effort later in the fishing year. None of the major non-target species (e.g., blue sharks) are showing signs of being overfished, therefore implementation of Alternative 2B would be unlikely to result in significant impacts to non-target species.

4.2.2.3 Impacts of Alternative 2B to Protected Species and Seabirds

Alternative 2B would eliminate the need for certificates but would not be a catalyst for changes in the amount of overall fishing effort; however, there may be some shift of fishing effort to the 1st quarter if effort or sea turtle interaction hard caps are tightly constrained, which could potentially lead to an increased number of sea turtle interactions during that period. Sea turtle interactions would not exceed annual sea turtle interaction hard caps instituted from Topic 1, therefore, no significant adverse impacts to sea turtles populations would occur. Impacts to marine mammals and seabirds are not expected to increase from discontinuing the set certificate program as fishing operations and gear would not change.

4.2.2.4 Impacts of Alternative 2B to Fishery Participants and Fishing Communities

Eliminating the requirement for certificates in the shallow-set fishery as described under Alternative 2B, would benefit current shallow-set participants by eliminating the burden to provide written notice by November 1 of each year to obtain certificates. Potential revenue from selling set certificates to other participants would be eliminated and vice versa, potential costs of buying certificates from other participants would also be eliminated. Fishery participants would likely expend effort on a “first come, first served” basis and therefore there may be increased competition for swordfish during the beginning of the year, which is also the time of typically greatest CPUE values, thus leading to higher supply and decreasing ex-vessel revenue.

With international longline quotas already in place for bigeye catches in both the EPO and the WCPO, there is expected to be interest from some Hawaii based tuna-directed fishing vessels to shift their effort into the swordfish-directed fishery. This may also increase competition among participants which could have some market effects. This anticipated effort shift would be facilitated by removing the set certificate requirement through implementation of Alternative 2B because deep-set vessels could switch to shallow-setting without the need to possess certificates.

4.2.2.5 Impacts of Alternative 2B to Administration and Enforcement

Implementing alternative 2B would also relieve NMFS of the annual administrative burden of processing the certificate requests and issuing the certificates. This would reduce administrative of costs of $4,430 per year. Alternative 2B would relieve the U.S. Coast Guard, NMFS OLE, and other enforcement entities the burden of having to enforce the requirement to possess and use shallow-set certificates for each set made. However, if an annual limit on sets is still being used, NMFS must develop a method to track effort in the fishery and enforcement agencies would need to ensure closure of the fishery if the effort limit is exceeded.

4.3 Topic 3: Time-Area Closures

Time-area closures are being considered as a way to increase annual fishery profits through reductions in the number of turtle interactions that occur in the first quarter of each year. As shown in Table 34, interaction rates are significantly higher during this period and it has been hypothesized that reducing fishing effort would increase fishery profits by reducing the risk of exceeding a turtle hard cap very early when there are still many more shallow-sets allowed to be made, as occurred in 2006. On the other hand, fishermen have stated that missing the high swordfish catch rates and prices in the first quarter cannot be compensated for by a longer fishing season with more fishing trips.

4.3.1 Alternative 3A: No Action: Do Not Implement Time-Area Closures (Preferred)

Under this alternative, the fishery would continue to operate under the current regulations with no time-area closures.

4.3.1.1 Impacts of Alternative 3A to Target Stocks

Under this alternative, impacts to target stocks would be similar to those described in section 4.1.1.1.

4.3.1.2 Impacts of Alternative 3A to Non-target Stocks

Under this alternative, impacts to non-target stocks would be similar to those described in section 4.1.1.1.

4.3.1.3 Impacts of Alternative 3A to Protected Species and Seabirds

Under this alternative, impacts to protected species would be similar to those described in section 4.1.1.1. The TurtleWatch program, which would be maintained under this alternative, has seemed to be effective in providing fishery participants with the locations of the temperature bands that are recommended to be avoided so as to reduce potential turtle interactions.

4.3.1.4 Impacts of Alternative 3A to Fishery Participants and Fishing Communities

Under Alternative 3A, the no-action alternative, the fishery would continue to operate as it has been since re-opening in 2004. This is not expected to result in any new impacts to participants or communities. If a hard cap were to be reached, the fishery would be closed for the remainder of the year which could result in some negative impacts to participants who would be unable to derive any further income from swordfish harvest; or who might have to switch gear configuration to continue longline fishing by shifting to deep-setting; potential market flooding as occurred in 2006 when the fishery closed which can result in lower prices, time waiting to offload and a reduction in quality of fish onboard; and potentially having to cut a trip short if the closure were to occur while at sea. An early closure that causes shallow-set vessels to switch to targeting tuna could impact those fishermen already targeting tuna, thus increasing competition in a fishery now regulated by annual quotas. This would potentially impact all longline fishery participants.

4.3.1.5 Impacts of Alternative 3A to Administration and Enforcement

Under this alternative, impacts to administration and enforcement would be similar to those described in section 4.1.1.5.

4.3.2 Alternative 3B: Implement January Time-Area Closure

Under Alternative 3B, an area closure would be implemented during January of each calendar year. The area closure would be located between 175° W and 145° W longitude and encompass the sea surface temperature band of 17.5°-18.5° C. The latitudinal location of this temperature band varies inter-and intra-annually; however, in January it is generally located near 31°-32° N latitude. Research has suggested that the area between sea surface temperatures of 17.5-18.5 C may be a loggerhead sea turtle "hotspot" based on historical and contemporary distribution and foraging studies, as well as location data for observed loggerhead sea turtle interactions with the fishery (Howell, PIFSC, pers. comm., December 2007). The month of January was selected because it may be that the number of loggerhead interactions during January is pivotal to whether or not the fishery will reach its annual sea turtle interaction hard cap before all allowable sets are used. For example, in 2006, the fishery interacted with eight loggerheads in January and the fishery reached the cap of 17 on March 17, 2006. In 2007, the fishery did not interact with any loggerheads during January, but ended the first quarter with only 15 loggerhead interactions and did not reach the sea turtle cap.

4.3.2.1 Impacts of Alternative 3B to Target Stocks

The impacts of Alternative 3B to target stocks have not been quantified; however ongoing work by PIFSC appears to indicate that all such closures examined to date would reduce annual fishery revenues (M. Pan, PIFSC, pers. comm. February 2008). This could occur as a result of decreases in annual catches or decreases in prices received or a combination of the two. If either the first or last scenario is the true case, it can be concluded that Alternative 3B would be likely to reduce impacts to target stocks.

4.3.2.2 Impacts of Alternative 3B to Non-target Stocks

The impacts of Alternative 3B to non-target stocks have not been quantified; however, it would seem reasonable that if impacts to target stocks are reduced under Alternative 3B, impacts to non-target stocks will also decrease as these species are caught incidentally to targeted fishing effort.

4.3.2.3 Impacts of Alternative 3B to Protected Species and Seabirds

Under Alternative 3B, the use of hard caps to limit interactions with loggerhead and leatherback turtles would remain (but modified to 46 loggerheads and 17 leatherbacks as indicated in Alternative 1F), ensuring that an unacceptable number of interactions occur with the fishery and thereby ensuring that the fishery is not jeopardizing the continued existence and recovery of such species. Although impacts to protected species have not been quantified, Alternative 3B would be expected to reduce the number of sea turtle interactions in January of each year. It is unknown whether the displaced fishing effort would be relocated to other areas or to other months, and what impacts this displacement would have on turtles and other protected species. Gilman et al. (2006) considered the closure of two specific five degree areas considered to be loggerhead "hotspots" and concluded that further study would be needed before recommending any area closures. This is due to the fact that area closures normally displace fishing effort and that without detailed study and planning, such closures could inadvertently displace fishing operations into areas with nearly equal turtle interaction rates and/or with higher interaction rates for other protected species. In addition, Gilman et al. (2006) note that some domestic fishery closures or reductions have been found to result in increased domestic consumption of seafood imported from countries with fewer controls to protect sea turtles or other marine species. Termed “transferred effects” these reactions can actually increase harm to sea turtles rather than reducing risks (see Section 4.4.2.1.1).

4.3.2.4 Impacts of Alternative 3B to Fishery Participants and Fishing Communities

A range of time-area and seasonal fishery closures have been examined to date. NMFS scientists at PIFSC examined the use of seasonal closures, a time-area closure combined with a fixed seasonal closure and multiple area and seasonal closures to examine their combined biological and economic impacts. Although this work is ongoing, a preliminary draft appears to indicate that none of the scenarios examined would decrease sea turtle interactions without simultaneously decreasing fishery revenues and presumably profits in the months when the time-area closure is imposed, as fishing effort would be pushed into less productive or less profitable times and areas. However, a large time-area closure may reduce the risk of exceeding a turtle hard cap very early, as occurred in 2006 so that swordfish fishing may continue later in the year (S. Li, PIFSC, pers. comm. Jan. 2008). However, fishery participants have indicated that missing the high swordfish catch rates and prices in the first quarter cannot be compensated for by a longer fishing season with more fishing trips. Furthermore, fishery participants would likely find it difficult to comply with changes in closed areas based on sea surface temperatures which can vary in location on a daily basis.

4.3.2.5 Impacts of Alternative 3B to Administration and Enforcement

There would be minimal impact on administration to implement a time-area closure as described under Alternative 3B. Enforcement agencies such as the USCG and NMFS OLE would find it difficult to enforce time-area closures based on sea surface temperatures that have temporal and geographic variability. Based on changing environmental conditions, the area closure boundaries may also likely change within the month of January. Temporary, short-term closures can be difficult to enforce as well as to communicate to the fishing fleet. Closed areas that geographically shift through a season may also cause confusion and makes at-sea enforcement more difficult because fishing trips have to be reviewed in sections based on closed areas in force during specific segments of a fishing trip. The mandatory VMS on all Hawaii-based longline vessels would facilitate monitoring the closed area; however, there may be some at-sea or air surveillance necessary especially if a violation was suspected.

4.3.3 Alternative 3C: Implement In-season Time-area Closures

Under Alternative 3C, the sea surface temperature-based (17.5° – 18.5° C) area closure described for Alternative 3B would be implemented in those years for which 75 percent of the annual loggerhead turtle cap was reached and the closure would remain in effect for the remainder of the first quarter. As with Alternative 3B, this alternative is being considered as a way to increase annual fishery profits through reductions in the number of turtle interactions that occur in the first quarter of each year. This alternative differs from Alternative 3B in that it is contingent on high numbers of interactions during the first quarter.

4.3.3.1 Impacts of Alternative 3C to Target Stocks

Impacts to target stocks from Alternative 3C would be similar to those described for Alternative 3B above in that the impacts to target stocks have not been quantified; however, ongoing work by PIFSC appears to indicate that all such closures examined to date would reduce annual fishery revenues. This could occur as a result of decreases in annual catches or decreases in prices received or a combination of the two. If either the first or last scenario is the true case, it can be concluded that Alternative 3C would be likely to reduce impacts to target stocks.

4.3.3.2 Impacts of Alternative 3C to Non-target Stocks

Impacts to non-target stocks from Alternative 3C would be similar to those described for Alternative 3B above in that if impacts to target stocks are reduced under Alternative 3C, impacts to non-target stocks would also decrease as these species are caught incidentally to targeted fishing effort.

4.3.3.3 Impacts of Alternative 3C to Protected Species and Seabirds

Under Alternative 3C, the use of hard caps to limit interactions with loggerhead and leatherback turtles would remain (but modified to 46 loggerheads and 17 leatherbacks as indicated in Alternative 1F) in place and ensure that the continued existence and recovery of these species was not jeopardized. Although impacts to protected species have not been quantified, Alternative 3C would be expected to potentially reduce the number of sea turtle interactions in the first quarter of each year. It is unknown whether the displaced fishing effort would be relocated to other areas or to other months, and what impacts this displacement would have on turtles and other protected species. Gilman et al. (2006) considered the closure of two specific five degree areas considered to be loggerhead “hotspots” and concluded that further study would be needed before recommending any area closures. This is due to the fact that area closures normally displace fishing effort and that without detailed study and planning, such closures could inadvertently displace fishing operations into areas with nearly equal turtle interaction rates and/or with higher interaction rates for other protected species. In addition, Gilman et al. (2006) note that some domestic fishery closures or reductions have been found to result in increased domestic consumption of seafood imported from countries with fewer controls to protect sea turtles or other marine species. Termed “transfer effects” these reactions can actually increase harm to sea turtles rather than reducing risks (see Section 4.4.2.1.1).

4.3.3.4 Impacts of Alternative 3C to Fishery Participants and Fishing Communities

A range of time-area and seasonal fishery closures have been examined to date. NMFS scientists at PIFSC examined the use of seasonal closures, a time-area closure combined with a fixed seasonal closure and multiple area and seasonal closures to examine their combined biological and economic impacts. Although this work is ongoing, a preliminary draft appears to indicate that none of the scenarios examined would decrease sea turtle interactions without simultaneously decreasing fishery revenues and presumably profits in the months when the time-area closure is imposed, as fishing effort would be pushed into less productive or less profitable times and areas. However, a large time-area closure may reduce the risk of exceeding a turtle hard cap very early when there are still many more shallow-sets allowed to be made, as occurred in 2006 so that swordfish fishing may continue later in the year (S. Li, PIFSC, pers. comm. Jan. 2008). Fishery participants have indicated that missing the high swordfish catch rates and prices in the first quarter cannot be compensated for by a longer fishing season with more fishing trips. Furthermore, fishery participants would likely find it difficult to respond to changes of closed areas based on sea surface temperatures which can vary in location on a daily basis.

4.3.3.5 Impacts of Alternative 3C to Administration and Enforcement

Impacts to administration and enforcement from Alternative 3C would be similar to those described for Alternative 3B above in that, enforcement agencies such as the USCG and NMFS OLE would find it difficult to enforce time-area closures based on sea surface temperatures.

4.4 Cumulative Impacts

The MSA and NEPA require that the potential cumulative effects of a proposed action, as well as the cumulative effects of the alternatives to the proposed action, be analyzed in an EIS or FMP amendment. Under NEPA, cumulative effects are defined as those combined effects on the human environment that result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions, regardless of what Federal or non-Federal agency or person undertakes such other actions (40 CFR 150.8.7). The following cumulative effects analysis is organized by the following issues: target and non-target species, protected species, fishery participants and communities.

The geographic scope of this analysis is the North Pacific Ocean where the shallow-set fishery operates (generally 20° – 40° N, 175°-145° W), the Hawaiian Islands, as well as sea turtle nesting beaches in the western Pacific including Papua Indonesia, PNG, and Japan and in the eastern Pacific including Mexico and Costa Rica. For the purposes of this analysis, past management action for target and non-target species refer to previous Council/NMFS actions as well as those made by international RFMOs. External factors or actions consider non Council/NMFS actions. This analysis is not limited to anthropogenic impacts and summarizes potential impacts from natural ecosystem variability (e.g., Pacific Decadal Oscillation), as well as discusses impacts related to human-caused climate change associated with greenhouse gases. For impacts that have unquantified effects, qualitative discussions of the impacts are provided, and to the extent practicable, the impacts are qualitatively considered in the conclusions presented in the analysis.

4.4.1 Cumulative Effects to Target and Non-Target Species

4.4.1.1 Past Management Actions Contributing to Cumulative Effects

Pelagics FMP

As described in Section 1.1.2, the Pelagics FMP was approved and implemented by the Secretary of Commerce in 1987. The primary management actions under the FMP that have contributed to cumulative effects to North Pacific swordfish include: the establishment of the Hawaii-based limited entry longline permit program that limits the number of permits (e.g., limits fleet capacity) in the entire fishery to 164. Also included in the limited entry program is a restriction on vessel size of no greater than 101 ft, which limits the harvest capacity of individual vessels. Another management action that has likely contributed to cumulative effects of swordfish is the reopening of the shallow-set fishery in 2004 after a three year closure. Under the current regulations, the fishery is restricted to 2,120 sets per year, which is half of its 1994-1999 historical effort and about of a quarter of its all time highest annual effort. The shallow-set fishery is carefully managed through the use of observers, VMS, gear restrictions and other management measures. Fish stock assessments used in assessing MSY take into account fishing mortality and available stock biomass.

RFMO Management of Pacific Bigeye

The stock structure of bigeye tuna in the Pacific Ocean is unresolved. Bigeye tuna in the Pacific has been assessed using two different approaches, one that treats it as a single Pacific-wide stock and the other that treats it as two stocks, one in the WCPO, corresponding to the area of Western and Central Pacific Fisheries Commission (WCPFC), and the other in the EPO corresponding to the area of authority of the Inter-American Tropical Tuna Commission (IATTC). The 2004 overfishing determination relied on assessment results from both of these approaches, but it does not rely on any assumptions or conclusions about stock structure. The most recent stock assessments continued the separate stock approach used by IATTC and SPC. Assessments for the western and central Pacific (Langley et al. 2008) and eastern Pacific (Aires de Silva and Maunder 2008) were completed in 2008. A Pacific-wide stock assessment, including comparisons with results from separate stock assessments, was completed in July 2003 (Hampton et al. 2004). The 2008 WCPO assessment found that overfishing of bigeye in the WCPO is occurring with high probability and that while not yet overfished (B/Bmsy (1.37), both adult and total biomass are predicted to become over-fished at 2003-2006 levels of fishing mortality and long term average levels of recruitment.

In the EPO, the IATTC adopted conservation and management measures in 2004 for purse seine and longline fisheries in response to concerns about the condition of EPO bigeye tuna. The longline fleets of member nations of the IATTC were allocated a bigeye quota equivalent to their 2001 catches. The U.S. longline fleet-wide bigeye quota was set at 150 mt, the majority of which was taken by Hawaii-based longline vessels in 2004. Other U.S. fisheries based on the West Coast in 2004 caught 488 mt of yellowfin and 22 mt of bigeye tuna in 2004. The IATTC-mandated EPO annual bigeye quota for the U.S. longline fleet for 2005-2007 was 500 mt. No bigeye conservation measures have been agreed upon by IATTC for 2008 or 2009 and beyond.

In the WCPO, the WCPFC adopted conservation and management measures in 2006 that included a cap on bigeye catches by longline fisheries, based either on their average 2001-2004 catches for most members of the Convention, or based on their 2004 catches for China and the U.S. These limits were replaced in 2008 with an amended conservation and management measure that calls for the U.S. to limit its longline bigeye tuna catches in the WCPF Convention Area to 10% less than the amount caught in 2004, effective for the years 2009 through 2011. Cooperating non-members and participating territories, including American Samoa, Northern Mariana Islands and Guam, are exempt from the limit.

4.4.1.2 Reasonably Foreseeable Future Actions Contributing to Cumulative Effects

Council Shift Toward an Ecosystem Approach

The Council is currently undergoing a shift toward an ecosystem approach to fisheries management and transitioning from its five species-based FMPs to five place-based Fishery Ecosystem Plans, which are currently under review by the Secretary of Commerce. At this stage the shift only includes the implementation of five place-based FEPs and an associated reorganization of existing regulations by area, in lieu of by FMP, as is done currently. The FEPs are expected to be considered for approval by the Secretary of Commerce in the near future. In subsequent years, ecosystem fisheries management will likely include actions that will consider the dynamic variability of ocean ecosystems and may include the use of physical or biological indicators. As more scientific information becomes available, future management actions may also include expanding MUS lists to include food web linkages such as predator-prey relationships.

RFMO Management of North Pacific Swordfish

International management of North Pacific swordfish is under the purview of the WCPFC and the IATTC. A North Pacific stock assessment is currently under development by the Interim Science Committee and is expected to be completed in 2010. At this time, the North Pacific swordfish stock appears healthy and is experiencing fishing mortalities levels well below MSY (see Section 3.2.1.3).

RFMO Management of Pacific Bigeye Tuna

Pacific-wide, bigeye overfishing is still occurring. A conservation and management measure was agreed to by the WCPFC in December 2008 for implementation in 2009 for both longline and purse seine fisheries. Both the longline and purse seine restrictions are aimed at reducing fishing mortality, and specifically require longline fisheries to reduce their catches by 30% over a three year period and reduce purse seine bigeye catches by implementing a three month closure and require catch retention. For 2009 and beyond, the IATTC has not yet agreed on a conservation measure for bigeye, although some countries have chosen to implement their own voluntary closures for purse seine fishing in the EPO.

4.4.1.3 Exogenous Factors Affecting Target Species and Non-Target Species

Five major exogenous factors were identified as having the potential to contribute to cumulative effects on pelagic target and non-target stocks:

- Fluctuations in the pelagic ocean environment focusing on regime shifts
- Pacific-wide fishing effort and swordfish catches focusing on longline fisheries
- Ocean noise
- Marine debris
- Ocean productivity related to go global climate change and greenhouse gases

Fluctuations in the pelagic ocean environment

Catch rates of pelagic fish species fluctuate in a time and space in relation to environmental factors (e.g. temperature) that influence the horizontal and vertical distribution and movement patterns of fish. Cyclical fluctuations in the pelagic environment affect pelagic habitats and prey availability at high frequency (e.g., seasonal latitudinal extension of warm ocean waters) and low-frequency (e.g., ENSO-related longitudinal extension of warm ocean waters). Low or high levels of recruitment of pelagic fish species are also strongly related to fluctuations in the ocean environment.

The effects of such fluctuations on the catch rates of PMUS obscure the effects of the combined fishing effort from Pacific pelagic fisheries. During an El Niño, for example, the purse seine fishery for skipjack tuna shifts over 1,000 km from the western to central equatorial Pacific in response to physical and biological impacts on the pelagic ecosystem (Lehodey et al. 1997). Future ocean shifts are likely to cause changes in the abundance and distribution of pelagic fish resources, which could contribute to cumulative effects. For this reason, accurate and timely fisheries information is need to produce stock assessments that allow fishery managers the ability to regulate harvests based on observed stock conditions.

North Pacific-wide fishing effort and catches of swordfish

As described in Section 3.2.1, there are directed swordfish fisheries that operate out of Japan and Chinese Taipei. However, it is likely that most of the swordfish catch in the North Pacific is caught incidentally in tuna longline fisheries (e.g. bigeye, albacore) by countries such as Japan, Korea, China, and Chinese Taipei. In recent years, Spanish longline vessels have been conducting exploratory targeting of swordfish in the North Pacific, which is a change from their historical effort in the southeastern Pacific. Current (domestic and foreign) swordfish landings in the North Pacific are estimated to be about 14,500 mt, which amounts to about 60 percent of an estimated MSY of 22,284 mt (Kleiber and Yokawa 2004; Bigelow, PIFSC, pers. comm., January 2008).

Oceanic noise pollution

In the last 50 years, there have been significant increases in sound producing ocean activities such as commercial shipping, hydrocarbon exploration and research, military sonar and other defense related-actions (Hildebrand 2005). Ambient noise from shipping in the Pacific Ocean has doubled every decade for the last 40 years (McDonald et al. 2006). Commercially important fish stocks and marine mammals can be affected by noise pollution by making it more difficult to find food and mates, avoid predators, navigate and communicate (Popper 2003). Studies of bluefin tuna in the Mediterranean suggest that noise pollution from shipping results in changes to schooling behavior, which could impact migration (Sara et. al 2007). The effects of noise pollution on swordfish stocks are unknown, but given the above information, increases in oceanic noise levels could potentially impact swordfish stocks. However, there is no anticipated increase in fleet size above the currently established limit entry amount of 164 vessels. The use of boat engines and other onboard gear would result in localized noise. The Hawaii swordfish fleet operates on the open ocean far from most other maritime traffic. There is no indication that the noise that would be generated from additional swordfish vessels that may participate in the fishery in the future under any of the alternatives would result in significant adverse contributions to oceanic noise levels. It is not likely that the noise generated by the Hawaii-based swordfish fleet has adverse cumulative impacts to sea creatures or that this level of noise would make it more difficult for fish stocks to locate food, mates, or avoid predators.

Marine debris

As discussed in Section 3.1.1, the area where the shallow-set fishery operates lies within the NPTZ is an area of current convergence. While the NPTZ is a dynamic area that supports the pelagic food web, it is also an area that aggregates large amounts of marine debris from many countries including derelict fishing gear and small plastics. Derelict fishing gear such as drift-nets have the ability to ghost fish, that is, continue to catch and kill fish and other animals long after they have been lost or discarded. The amount of derelict fishing gear in the NPTZ has not been quantified nor has the amount of swordfish and other fish species killed by ghost nets, although given that the fleet encounters derelict fishing gear while in the NPTZ suggest that some ghost-net fishing mortality is occurring. The proposed action could result in additional gear in the form of lines, buoys, hooks, and lightsticks being lost. However, Hawaii longline fishermen make efforts to prevent gear loss as well as participate in a voluntary derelict fishing net retrieval program based in Honolulu. Shallow-set fishery participants often encounter such derelict nets while targeting swordfish in the ocean current convergence zones of the North Pacific, an area know to accumulate marine debris. Retrieved derelict nets are brought back to Honolulu Harbor and placed in a receptacle which is transported to Schnitzer Steel where the nets are cut up for incineration at Honolulu City and County’s H-Power plant. Although the proposed action would allow an increased number of longline shallow sets, this is not expected to contribute substantially to the amount of marine debris because of the efforts the fishery makes to reduce gear loss, including participation in derelict gear retrieval

Ocean productivity related to global climate change

The seasonal north-south movements of many large pelagics in the NPTZ appear to track the similar peak migration of primary productivity. Using remotely-sensed chlorophyll concentrations from satellite observations, Polovina et. al (2008) have found that over the past decade primary productivity in the subtropical and transition zone has declined an average of 1.5 percent per year with about a 3 percent per year decline occurring at the southern limit of the NPTZ. The expansion of the low chlorophyll waters is consistent with global warming scenarios based on increased vertical stratification in the mid-latitudes. Expanding oligotrophic[25] portions of the subtropical gyres in the world's oceans in time will lead to a reduction in chlorophyll density and carrying capacity in the larger subtropical gyres, thus impacting the abundance of target and non-target species.

There are no specific studies about the potential impacts on swordfishes of ocean circulation pattern or nutrient changes. In general, it has been shown that large scale climate cycles can impact winds, currents, ocean mixing, temperature regimes, nutrient recharge, and affect the productivity of all trophic levels in the North Pacific Ocean (Polovina et al. 1994). These impacts are expressed as variability in stock size, recruitment, growth rates, or other factors. Swordfish stocks and the fishery, as well as non-target fishes and protected species that interact with the fishery are currently affected by these large-scale climate fluctuations and would continue to be affected in the same way regardless of which alternatives are selected for implementation.

The Hawaii-based swordfish fishery operates with gear and bait restrictions, 100 percent observer coverage, and fishermen are required to report on catch, effort, and protected resources interactions. These measures will continue regardless which alternative is implemented. The information collected in the course of the fishery will allow fishery managers and scientists to detect and respond to any changes in target and non-target species, bycatch, as well as protected resources. In addition, ongoing research on fish stocks and protected species including sea turtles, marine mammals and seabirds will continue under all of the alternatives, and that information will be used by scientists and fishery managers to detect changes in the status, distribution, and interactions between the fishery and species of management concern. Adjustments to the fishery would be made, as needed, to ensure that the fishery is sustainable.

Therefore, changes in marine environment due to climate change are not expected to adversely affect the Council's ability to achieve the management objectives of the proposed amendment. Future impacts of climate change have been considered when evaluating the potential impacts of the alternatives on fishery target and non-target species and protected resources. Continuing research, improved fishery data collection and analysis, continuing required coordination with NMFS with respect to the impact of fisheries on protected resources, and adaptive fishery management will help to ensure long-term sustainability of the fishery, even in light of potential climate changes.

4.4.1.4 Impacts of the Alternatives Considered in Detail

The impacts from Alternatives 1A-1F to target species from fishing mortality range from 4.61 to 119.1 million pounds. Other (non-swordfish) species would continue to comprise a small fraction of the catch with bigeye tuna fishing mortality comprising 190,000 - 745,000 pounds, striped marlin 62,700-364,000 pounds and mahimahi 55,500-368,000 pounds. Because the

[25] Meaning waters where relatively little plant life or nutrients occur, but which are rich in dissolved oxygen.

Hawaii longline fishery is regulated under a limited entry program with a maximum of 164 permits, any increased effort in the shallow-set fishery would be from vessels that primarily target bigeye tuna in the deep-set fishery. It is expected that such a shift would reduce bigeye catches by the Hawaii deep-set fishery and thus relieve some pressure (albeit insignificant in terms of overall WCPO bigeye catch) on bigeye stocks. Other commercial species such as albacore, blue marlin, and yellowfin tuna would contribute smaller amounts to the remainder of the retained catch and fishing mortality. Expected catches of these non-swordfish target species under all alternatives are a negligible fraction of total Pacific-wide catches and known MSY values of these species.

4.4.1.5 Overall Cumulative Effects to Target Species and Non-Target Species

Given that North Pacific swordfish stocks are currently healthy, it is not anticipated that exogenous factors coupled with the impacts of the proposed alternatives would have significant cumulative impacts to target and non-target species. The one exception could be Alternative 1E, which if all the sets were used then harvests of swordfish stocks in North Pacific could be at or near MSY, leaving little buffer against any increased effects from exogenous factors. The impacts of the proposed action in terms of swordfish are considered in light of past and current swordfish fishing elsewhere, and it was determined that the proposed increases would not exceed MSY. Impacts to other target species that have been showing signs of overfishing such as bigeye tuna, albacore, yellowfin, and striped marlin are very small are not anticipated to exceed thresholds that would lead to overfished conditions. Stocks of other target and non-target species are not subject to overfishing and the cumulative impacts including the impacts of the proposed action are not believed to result in overfishing of these fish stocks.

4.4.2 Cumulative Effects to Protected Species and Seabirds

4.4.2.1 Sea Turtles

4.4.2.1.1 Past Management Actions Potentially Contributing to Cumulative Effects

NMFS Listings Under the ESA
In the late 1970’s, NMFS and the USFWS listed all five sea turtles species that occur in the U.S. EEZ as either threatened or endangered pursuant to the ESA (43 FR 32800). The ESA offers Federal protection to species that are displaying population trends that make them vulnerable to extinction.

NMFS ITS For Various U.S. Fisheries
The following tables (63 and 64) provide various levels of sea turtle interactions as allowed for under incidental take statements (ITS) for U.S. fisheries.

Table 63: U.S. Atlantic Fisheries with sea turtle ITS

Region	Fishery/ FMP	Date	Loggerhead	Leatherback	Others	Notes
NERO	Scallop-dredge gear Trawl gear	12/04	929/595 biennially 154/20	 1 take/yr	2 or 2 KR 2 or 2 GR 1/0 KR 1/0 GR	’03 BiOp had 88 LH takes w/ 25 mortalities (morts).
NERO	Virginia (state waters) pound net	04/04	505		101 KR <1 GR	All expected to be alive; no takes of injured or mort authorized
NERO	Bluefish	07/99	6/3	--	6 or 6 KR	
NERO	Mackerel, squid, butterfish	04/99	6/3	1 or 1	2 or 2 GR 2 or 2 KR	
NERO	Spiny dogfish	06/01	3/2	1 or 1	1 or 1 GR 1 or 1 KR	
NERO	Multispp. groundfish	06/01	1 or 1	1 or 1	1 or 1 GR 1 or 1 KR	
NERO	Monkfish	04/03	3 for gillnet gear; 1 turtle any spp. for trawl gear		1 of any spp. for gillnet gear	5-yr ITS for 25 any spp. w/ 15 max LH
NERO	Tilefish	03/01	6/3	1 or 1		
NERO	Skate	07/03				1 of any spp./yr
NERO	Summer flounder, scup, black sea bass	12/01	19/5 LH or KR		2 or 2 GR	
NERO	Herring	09/99	6/3	1 or 1	1 or 1 GR 1 or	

					1 KR	
NERO	Experimental Jonah crab	08/02	6 or 6 over 3-yr period			
NERO	Horseshoe Crab EFP	09/01	43/0	1/0	3/0 KR 1/0 GR	
NERO	Lobster	10/02	2 or 2	9 or 9 biennially		
NERO	Deep-sea red crab	02/02	1 or 1	1 or 1		
SERO	Atl. HMS Pelagic Longline	06/04	575/182 in '04 635/143 thereafter	805/266 in '04 588/198 thereafter	35/ 8 of GR, HB, KR, & OR combined	'04 is 'pre-rule'
SERO	Gulf Reef Fish	02/05	203/78	20/9	51/21 of GR; 44/13 HB; 3/1 KR	Over 3-yr period

OR = Olive Ridley
HB = Hawksbill
KR = Kemp's ridley
GR = Green
X/Y means X takes with Y mortalities
1 or 1 means 1 lethal or non-lethal interaction
NERO = Northeastern Regional Office; HMS = Highly Migratory Species
EFP= Experimental Fishing Permit

Table 64: U.S. Pacific Fisheries with sea turtle ITS

Region	**Fishery**	**Date**	**Loggerhead**	**Leatherback**	**Others**	**Notes**
SWR	HMS Longline	02/04	126-195 35-90 morts.	23-57 3-25 morts.	1-11 OR 1-2 morts. 0 GR	Without Rule
	HMS Longline	02/04	0	0	0	With rule

SWR	CA/OR Drift Gillnet (HMS FMP 2004)	10/00	5/2 per El Nino year	3/2	4/1 OR 4/1 GR	Takes of OR and Greens only under specific ocean conditions
SWR	ETP Purse Seine	12/99	3 (1 mort every 7 yrs or 0.14 per year)	2 (1 mort every 10 yrs)	35 GR (2 mort/yr) 2 HB (1 mort/10 yrs) 133 OR (7 morts/yr)	
PIRO	WCPO Purse Seine	11/06	11	11	14 GR 14 HB 11 OR	No mortalities expected
PIRO	Deep set LL	10/05	6/3	13/6	7/6 GR; 41/39 OR	ITS is over 3 yr period
PIRO	Shallow set LL	02/04	17/3	16/2	1/1 GR 5/1 OR	LH & LB: hard caps

OR = Olive ridley
HB = Hawksbill
KR = Kemp's ridley
GR = Green
X/Y means X takes with Y mortalities
1 or 1 means 1 lethal or non-lethal interaction
SWR = Southwest Region
PIRO = Pacific Islands Regional Office
CA/OR = California/Oregon
ETP = Eastern Tropical Pacific
WCPO = Western and Central Pacific Ocean

Pelagics FMP Amendment Circle Hooks/Mackerel Bait

As described in Section 1.2.3, the 2004 FMP amendment to require 18/0 circle hooks and mackerel bait in the fishery has reduced sea turtle interaction rates by 89 percent in comparison to historical interaction rates. Deep hooking (thought to result in higher levels of sea turtle mortality) rates have also declined to 15 percent of all loggerhead sea turtle captures and zero percent of leatherback sea turtle captures. Prior to requiring the use of circle hooks and mackerel-type bait in the Hawaii-based longline shallow-set fishery, 51 percent of the sea turtles were believed to have been deeply hooked. Furthermore, the 2004 regulations instituted annual interaction caps on loggerhead (17) and leatherback (16) sea turtles, which if reached, close the fishery for the remainder of the calendar year. Figure 37 shows the significant reduction in sea turtle interactions in the Hawaii longline fisheries as a result of management measures under the FMP.

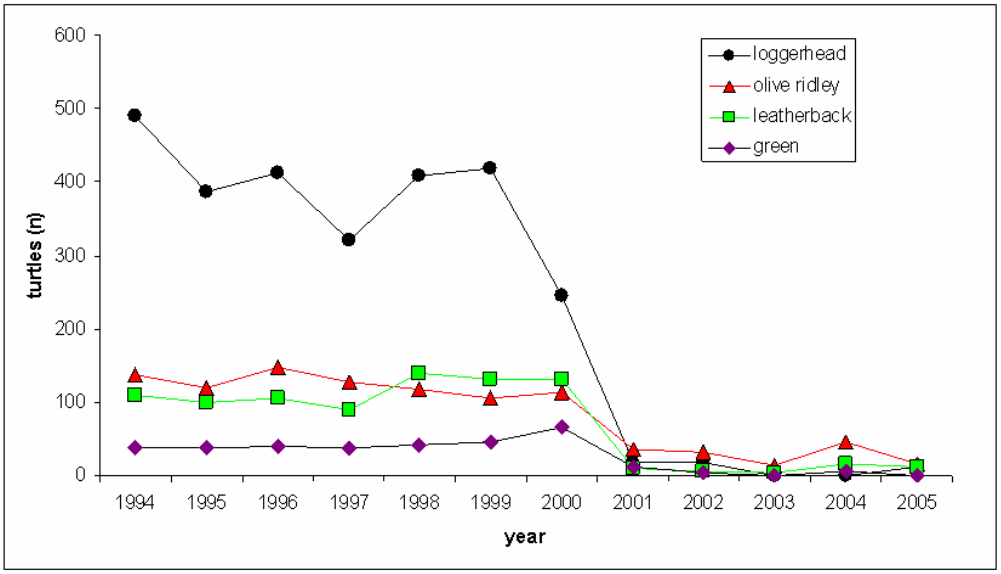

Figure 37: Estimated Annual Sea Turtle Interactions in the Hawaii-based Longline Fishery (deep-set and shallow-set combined), 1994-2005
Source: NMFS Unpublished Data

Council Sea Turtle Conservation Projects
The Pacific loggerhead and leatherback recovery plans identify several activities that can be taken to assist in recovering Pacific loggerhead and leatherback turtles (NMFS and USFWS 1998a; NMFS and USFWS 1998b). Among these are eliminating turtle and egg harvest, reducing nest predation by domestic and feral animals, protecting nesting beaches from erosion and human disturbance, collecting biological information on nesting turtle populations, educating local communities on the value of conserving sea turtles, and monitoring nesting activity to identify important nesting beaches (NMFS and USFWS 1998a; NMFS and USFWS 1998b). Both plans recognize that increasing hatchling production at nesting beaches is “[o]ne of the simplest means to enhance populations….” (NMFS and USFWS 1998a; NMFS and USFWS 1998b).

To that end, the Council has funded and partnered with several sea turtle conservation projects to assist in the long-term enhancement and recovery of loggerhead and leatherback sea turtles. Protection of nesting beaches in Japan and reducing bycatch and mortality in Baja California Mexico, for example, are specifically intended to benefit the loggerhead population that interacts with the fishery. Similarly, protecting nesting beaches and reducing mortality in Papua Indonesia and Papua New Guinea is designed to benefit the leatherback populations that primarily interact with the fishery.

The Council's conservation projects are increasing hatchling production to varying degrees and reducing juvenile or adult mortality, and, consistent with their recovery plans, are making contributions to the recovery of loggerhead and leatherback turtles in the Pacific (see Tables 16-18, 20). For example, as shown in Appendix IV and discussed in Section 3.3.1.1.3, it is generally accepted that only 1 turtle out of 1,000 eggs will reach adulthood. As seen in Table 16, the Council's leatherback nesting beach conservation project in Wermon, Papua Indonesia is estimated to have conserved 397 adult leatherback turtles since 2004. Such nesting beach projects in Papua have been shown to produce over 10 times as many adult females for the same cost as the cost of protecting female sea turtles through current Hawaii shallow-set longline regulations aimed at reducing bycatch (Gjertsen 2008). Similarly, the Council's loggerhead nesting beach conservation project in Japan is estimated to have conserved 181 adult loggerhead turtles since 2004. In addition, the Council's conservation project in Baja Sur, Mexico has, in 2007, resulted in several highline fishermen agreeing to not fish within the high density sea turtle area with gillnets and longline gear (see Figure 19). It is estimated that approximately 700-900 loggerheads may be spared per year because of this agreement (Peckham, Pro Peninsula, pers. comm. December 2007).

As such, these important conservation accomplishments are assisting in fulfilling the goals of each ESA turtle recovery plan. Moreover, the population-level benefits of these conservation measures can be logically inferred based on the many similar programs associated with documented recovering population trends. Indeed, the applicable sea turtle recovery plans explain that increases in hatchling survival "enhance populations," and recognize such increases as important steps to achieving recovery (NMFS and USFWS 1998a; NMFS and USFWS 1998b). Based on the successful results of the projects, the Council's conservation projects are likely contributing positively to cumulative impacts on the loggerhead and leatherback populations with which the shallow-set fishery interacts, and the Council has requested that NMFS develop a policy to take into account the Council's conservation measures as offsets against turtle interactions occurring in the shallow-set longline fishery. It is NMFS' current practice that the Council's off-site conservation measures cannot be used in ESA Section 7 analyses to directly offset fishery take. Any available information concerning conservation measures should be used to confirm and quantify the benefits of conservation measures, particularly reductions in adult female mortality, and quantified and verified benefits would likely be considered in ESA Section 7 analyses under the status of the species sections of a BiOp.

Transferred Effects of Regulatory Regimes

A major impact of past (and likely current) regulatory regimes is that of transferred effects. 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 adverse impacts on other populations. 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. For example, the Council and NMFS PIFSC are currently carrying out a project to distribute circle hooks in Central and South American fisheries that likely interact with sea turtles.

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 West Coast, North Atlantic and Hawaii fisheries. Countries exporting fresh swordfish to the U.S. market are fishing North Atlantic, South Atlantic, eastern Pacific, South Pacific and Mediterranean swordfish stocks.

When North Atlantic swordfish catch restrictions 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.

It is believed that the adverse transferred effects related to the 2001-2004 closure of the Hawaii swordfish fishery, and the current highly restrictive annual sea turtle hard caps, increased reliance on imported swordfish supplies from areas with unknown protected species monitoring and management efforts. 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. 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.

Rausser et al. (2008) studied fishing effort in U.S. and global swordfish markets to determine whether an adverse transferred effect occurred after the fishery was entirely closed by NMFS in 2001. After taking into account changes in fresh and frozen swordfish demand, they concluded that, beginning in 2001, restrictions on fishing effort in the fishery resulted in “a substantial transferred effect,” with 77 percent of the lost Hawaii-based effort shifting to international markets. According to Rausser et al. (2008), the principle beneficiaries of the transferred effort were Panama, Ecuador, New Zealand/Cook Islands and Vietnam. During the fishery closure, Rausser et al. (2008) found that the average annual level of U.S. fresh swordfish imports increased over 100-fold in Panama, from 6 mt to 950 mt, and 280 percent in Ecuador, from 215 mt to 815 mt, together accounting for 88 percent of the transferred effort (Rausser et al. 2008). Vietnam and the New Zealand/Cook Islands region accounted for an additional 217 mt annual increase in swordfish imports (Rausser et al. 2008).

Sarmiento (2006) arrived at similar conclusions using different methods. Sarmiento (2006) found that Ecuador and Panama significantly increased exports to the U.S. following the 2001 fishery closure, and estimated an overall transferred effect of 80 percent of fresh swordfish catch – very similar to the 77 percent estimated by Rausser et al. (2008).

After comparing bycatch rates, Rausser et al. (2008) found that the 2001 closure had paradoxically resulted in substantially greater sea turtle bycatch suggesting a significant impact on sea turtle populations. Recognizing limitations in data for foreign fishery bycatch, Rausser et al. (2008) conservatively estimated a turtle bycatch rate per 1,000 hooks of 2.35 in Ecuador, 1.8 in Panama, 0.0031 in New Zealand, and 0.0613 in Vietnam. Compared to the fishery's pre-2004 regulation bycatch rate of 0.1738, Rausser et al. (2008) concluded that the 2001 fishery closure led to a net increase of 1,835 interactions and 660 turtle mortalities per year.[26] Assuming that, absent a closure, the fishery would have operated during that time under the types of gear and operational restrictions now in place (catching just 0.019 turtles per 1,000 hooks), the closure resulted in a net increase of 2,237 interactions and 805 turtle mortalities per year (Rausser et al. 2008). Broken out by species, NMFS' closure of the fishery resulted in an estimated net increase in mortalities of 541 olive ridley, 230 loggerhead, 85.3 green and 9.1 leatherback turtles each year when compared to the negligible number of mortalities that would have occurred had the Hawaii fishery continued to operate at full effort with conservation measures in place (Rausser et al. 2008 unpublished manuscript). As documented by Rausser et al. (2008) and Sarmiento (2006), the paradoxical result of such regulatory restrictions imposed in the interest of sea turtle conservation is, conservatively, hundreds of additional sea turtle mortalities per year.

NMFS Pacific Islands Region Protected Resources Division

During 2008, NMFS' Pacific Islands Region- Protected Species Division (PRD) supported sea turtle related research, conservation, and management programs in: Hawaii, the Commonwealth of the Northern Marianas, American Samoa, Marshall Islands, Federated States of Micronesia (Yap State), Palau, New Caledonia, Palmyra, Fiji, Cook Islands, Indonesia, and Vietnam. In Hawaii, PIRO PRD sea turtle management activities were promoted through the publication of a hawksbill turtle informational brochure, outreach activities at Laniakea beach for the protection of green sea turtles, and continued collaborations with stakeholders to enhance public outreach and awareness initiatives. PRD continues to consult with the State of Hawaii on their application for an ESA section 10 Incidental Take Permit for nearshore State managed fisheries, and facilitates continued implementation of nesting beach monitoring and conservation activities for endangered hawksbill turtles along the Ka`u coast, Island of Hawaii.

[26] Rausser et al. (2008) assumed a mortality rate for foreign fleets similar to that assumed for the Hawaii fishery prior to the 2004 regulations, when in fact they are likely higher where turtles are often kept as food.

4.4.2.1.2 Reasonably Foreseeable Future Actions

NMFS Pacific Islands Region Protected Resources Division

The current level of PIRO PRD supported sea turtle program activities is expected to continue during 2009 with additional focus and expansion of effort for leatherback, loggerhead and hawksbill sea turtles, including the development of projects to quantify habitat use, distribution and abundance of turtles in Hawaii and U.S. territories. Additional funding will be provided to enhance and expand public relations and outreach efforts for protected resources in Hawaii.

NMFS Pacific Islands Fisheries Science Center

The Pacific Islands Fisheries Science Center conducts sea turtle monitoring, analysis and research in several areas pertaining to sea turtle biology and ecology and to interactions with fisheries. This work is carried out by all five of the Center's research divisions:

- Marine turtle assessments include studies of turtle population biology and population status across the U.S. Pacific islands for four main species: green, leatherback, loggerhead, and olive ridley. Research includes: demography and population dynamics; assessment of natural and anthropogenic factors affecting turtle populations; evaluation of management strategies influencing marine turtle recovery; and development of simulation models to identify data gaps, study demographic trends and design and evaluate management strategies.
- Hawaiian green turtle research includes long-term monitoring of green turtle population trends in Hawaii, research on turtle diseases (e.g., fibropapilloma), and administering a stranding network that responds to turtle stranding incidents by rehabilitating sick and stranded turtles and recording the apparent causes of stranding. This program also works with other Pacific island territories and countries on their green turtle populations. Both areas include extensive outreach to the public on sea turtle issues.
- Oceanographic influences on sea turtle distribution is also a major research topic with an emphasis on loggerhead turtles that interact with the longline fisheries. This research also includes analysis of seasonal and temporal variability in swordfish, the primary target of interest in this component of the shallow-set longline fishery. One key applied research element of this program is TurtleWatch, an on-line, real-time map providing up-to-date information about the thermal habitat of loggerhead sea turtles in the Pacific Ocean north of the Hawaiian Islands. It was created as an experimental product to help reduce inadvertent interactions between Hawaii-based longline fishing vessels and loggerhead turtles. Derived from satellite sensing information and correlative algorithms, the TurtleWatch map displays sea surface temperature and ocean current conditions and the predicted location of waters preferred by loggerhead turtles. This program includes outreach to the commercial fishing industry by providing convenient access to TurtleWatch information and assisting the industry in interpreting its implications.
- In conjunction with the underlying research supporting TurtleWatch, an economic model of the Hawaii shallow-set longline fishery has been produced for evaluating the socio-economic effects of combinations of potential geographic (area-based) and temporal (time-based) closures of the fishery.
- To reduce sea turtle by-catch in the longline fisheries, a variety of mitigation techniques are investigated. These include gear experiments and demonstrations with improved

fishing gear, including testing of circle hooks and fish bait in the Hawaii fisheries and the international export of new technology through active outreach programs. Captive turtle behavioral and physiological responses to longline gear and bait are also studied to better understand the factors affecting interactions with fishing gear.

Initiation of U.S. West Coast Shallow-set Longline Fishery

As a result of successful gear technology that has reduced sea turtle interactions and mortalities in the Atlantic Ocean and the Hawaii shallow-set longline fishery, NMFS recommended at the April 2007 meeting of the West Coast Highly Migratory Species Management Team (HMSMT) that the Pacific Fishery Management Council (PFMC) re-visit the disapproved portion of the Highly Migratory Species FMP. In September 2007, PFMC Council directed the HMSMT to develop alternatives for the following categories to establish a west coast-based shallow-set fishery on the high seas:

1. Status quo – Shallow-set longline fishing seaward of 200 nm and east of 150° W longitude allowed by Hawaii-permitted vessels only; landings can occur on the West Coast by Hawaii-permitted vessels.

2. Implement a West Coast limited entry program for shallow-set longline fishery seaward of 200 nm.

Also to be considered is the number of permits that would be eligible under a West Coast shallow-set limited entry program such as:

- Small program: 1–25 permits issued
- Intermediate program: 25–50 permits issued
- Large program: >50 permits issued

In August 2008, NMFS put out a Notice of Intent to prepare an EIS on Amendment 2 for the West Coast HMS FMP (73 FR 45967). In that notice, NMFS identifies the following alternatives that the Pacific Council will be considering at its March 2009 meeting:

Alternative 1: status quo or no-action alternative, which would continue to prohibit the use of shallow-set longline gear to fish for or target swordfish on the high seas north of the equator by West Coast-based vessels, unless a vessel has both a Western Pacific Fishery Management Council Pelagics limited entry permit and a Pacific Fishery Management Council HMS permit.

Alternative 2 would implement a West Coast-based limited entry permit program for shallow-set longline fishing on the high seas seaward of the West Coast EEZ. (There would be several implementation options associated with a limited entry permit program). Two area closure options will also be considered under this alternative. The fishery would either be constrained to east of 150 W longitude, or east of 140 W longitude; analyses developed in conjunction with the HMS FMP suggested that loggerhead takes were lower the farther east fishing occurred up to the West Coast EEZ boundary.

Alternative 3 would establish a management framework for a West Coast-based shallow-set longline fishery seaward of the U.S. EEZ without a limited entry permit program. The management framework would contain the following provisions: (1) the fishery would be constrained to east of 140° W. longitude; (2) owners of a Hawaii Pelagics limited entry permit would not qualify for the West Coast limited entry permit; and (3) sea turtle take mitigation measures (e.g., gear requirements, 100 percent observer coverage, take caps) would be required.

If a West Coast longline limited entry program is developed, it is likely that it will harvest swordfish and other target and non-target species as well as interact with loggerhead and leatherback sea turtles. Impacts on target and non-target species as well as protected species will need appropriate consideration in the development of a West Coast longline limited entry program.

NMFS Action Regarding ESA Listing of North Pacific Loggerhead Sea Turtles

On July 16, 2007, NMFS received a petition from the Center for Biological Diversity and the Turtle Island Restoration Network requesting that loggerhead turtles in the North Pacific Ocean be reclassified as a Distinct Population Segment with endangered status and that critical habitat be designated. The petitioners assert that the North Pacific loggerhead is discrete from loggerhead populations found elsewhere due to physical, genetic, physiological, ecological, and behavioral factors, and they provide information they believe supports this assertion. The petitioners further assert that the North Pacific loggerhead population is both biologically and ecologically significant relative to the species. The petitioners maintain that the North Pacific loggerhead nesting population has undergone a marked decline in recent decades, and cite coastal development, bycatch in fisheries, marine pollution, illegal take, and global warming as primary threats to the population. NMFS found that the petition presents scientific information indicating that the petitioned action warrants a review of the status of the species to determine whether the petitioned action is warranted and to determine whether any additional changes to the current listing of the loggerhead turtle are warranted (72 FR 64585). A potential redesignation from “threatened” to ”endangered” for North Pacific loggerhead turtles is not expected to affect the proposed action as impacts to North Pacific loggerhead sea turtles from interactions with the fishery were quantified, assessed, and found to not result in significant adverse impacts to the North Pacific loggerhead population (See Section 4.4.2.1.5).

NMFS TurtleWatch Project

NMFS currently conducts a project entitled, “TurtleWatch” which is an outreach effort that includes a publicly available online map of longline fishing grounds which is continuously updated to show temperature breaks as well as chlorophyll concentrations. These have been found to correlate with areas of potentially high rates of loggerhead interactions and the maps provide information for fishery participants to avoid them. NMFS’ scientists also record the locations of all turtle interactions to increase understanding of their spatial distribution and preferred habitat. In addition, ongoing modeling work by NMFS is attempting to understand the costs and benefits of potential time-area closures to sea turtles, fishery participants and Hawaii’s economy. Given the public availability, use of the TurtleWatch maps for purposes of avoiding sea turtle interactions by the fishery participants is thusfar unquantifiable.

4.4.2.1.3 Exogenous Factors Affecting Sea Turtles

Existing threats that are common to all species of sea turtles include:

- human use and consumption- legal and illegal harvest of adults, juveniles and/or eggs
- sea turtle nesting and marine environments, including directed takes, predation, and coastal habitat development
- marine debris (entanglement and ingestion)
- incidental capture in fisheries (trawl, gillnet and longline);
- fluctuations in the ocean environment
- climate change

Human Use and Consumption

Globally, 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 *in* WPRFMC 2004 Woodrom-Luna 2003b, Lutcavage et al. 1997, McCoy 1997, Nietschmann 1973). The oldest archaeological evidence of uses of turtles by human comes from the Arabian Peninsula dating about 5000 B.C. (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 list of countries that have been documented to consume sea turtle eggs in the past few decades, both legally and illegally, includes: 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 percent for decades (Chan and Liew 1996). In Indonesia, over 80 percent 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 and Starbird 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 et al. 1996). In contrast, it is believed that that 70 percent of eggs need to be preserved to sustain population size (Limpus 1994, Chan and Liew 1996). The level of current harvests of sea turtles around the globe is unknown.

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. Stuffed dead 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, 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).

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 there to the over-harvest for commercial purposes (Batibasaga 2002). In the 1970's, between 16,494 and 37,651 sea turtles were harvested each year in Bali, Indonesia (Barr 1991). Limpus (1994) states that 30,000 green sea turtles were harvested annually in Bali, and collected from areas throughout the western Pacific region. Salm (1984) estimated at least 50,000 green sea turtles are killed every year in Indonesia. In Manus, Papua New Guinea, every nesting female found is killed by local people (Suarez and Starbird 1996). In 2 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 and Starbird 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 1920's when fewer than 250 were caught each year (Horikoshi et al. 1995). Since 1973, annual harvest rates have fluctuated between 45 to 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 suggests 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 1960's the exploitation of olive ridleys contributed more than 80% of the total world market production, or nearly 14,500 tons (Marquez 2002). This level of exploitation was not sustainable and stocks collapsed in the early 1970s, leading 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). 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 to 100,000 eggs (Mohanty-Hejmadi 2000). The estimated legal egg harvest during the 1974-75 nesting season was 800,000 eggs (Mohanty-Hejmadi 2000).

Impacts on sea turtle nesting and marine environments

The Recovery Plans for Pacific sea turtles (NMFS and USFWS, 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 increased 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. raccoons, 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 eat jellyfish, 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 killer whales, 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.

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 are brought about through habitat degradation from 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.

Beach armoring consists of hardening structures (concrete sea walls, wooden walls, rock revetments, and sandbag structure) meant to protect coastlines from erosion; however, it also results in the elimination of nesting habitat (Schroeder et al. 2000, Mosier and Witherington

2002). Artificial lighting disrupts critical adult nesting behavior and the nocturnal sea-finding behavior of hatchlings (Lutcavage et al. 1997).

Pollution, Marine Debris and Entanglement

Sea turtles can achieve life spans longer than 50 years and thus 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, which may function to compromise a turtle's immune system, have been found in eggs, gonads, fat liver, muscle, scutes, and tissues of turtles, and pollutants are further implicated in disease expression such as fibropapilloma (Seminoff et al. 1999, Work and Balazs 1998, Ceron et al. 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). Balazs (1985) documented 79 cases of ingested plastics and 60 cases of entanglement in marine debris by sea turtles. 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).

Pollution and marine debris on beaches can cause physical obstructions and prevent beach access by adults or inhibit hatchlings from reaching the sea (Sarti et al. 1996). 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 et al. 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, breathe, 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 percent 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).

International agreements such as the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL), and domestic regulations under the U.S. Act to Prevent Pollution from Ships prohibit the intentional discard of plastic fishing gear such as the monofilament line used by Hawaii's longline fleet. These measures are enforced by the U.S. Coast Guard. In addition, current federal fishery regulations require all longline gear to be marked with the vessel's documentation number. To date, a voluntary derelict fishing net gear retrieval program has led to the removal of more than 50,000 pounds of derelict nets and other fishing gear (included spent monofilament longline held on board Hawaii longline vessels for appropriate disposal) since its inception in 2006 which represents a serious commitment to environmental stewardship by Hawaii's longline fishery participants. NOAA is also currently holding workshops and meetings to discuss research and assessments associated with the prevention and removal of marine debris.

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 overlap of fishing effort and foraging animals may result in increased interactions (NMFS 2000). The magnitude of potential effects is uncertain but this factor could contribute to cumulative effects on sea turtles.

Global climate change and increasing sea surface temperatures

As discussed in Section 3.3.1.6, the major ways climate change is likely to affect sea turtles are: 1) changes in hatchling sex ratios as a species that exhibits temperature-dependent sex determination; 2) loss of nesting beach habitat due to sea level rise; 3) changes in nesting behavior that correlate with fluctuations in sea surface temperature; and 4) alterations to foraging habitats and prey abundance resulting from global climate change. It is not possible to predict what specific impacts will occur to affect sea turtles. However, these effects would be considered in future management of the shallow-set longline fishery. Research will continue to track the status of sea turtle populations, nesting success, migration and foraging habits, and on the impacts of fisheries on sea turtles. Information from the Hawaii-based shallow-set longline fishery will continue to be collected and analyzed through observer reports, and fishery participant logbooks. If there are changes to the status of sea turtles or the fishery interactions with sea turtles, NMFS would reinitiate consultation. Therefore, the potential impacts of climate change on sea turtles has been considered and will continue to be part of the environment affecting sea turtles and the longline fishery that must be addressed through adaptive management regardless of which alternative is selected for implementation.

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 USFWS 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 (Heppell et al. 1996).

An important consideration 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 depletion 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.

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 principle 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 not utilizing TEDs from importing shrimp to the U.S. 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. For example, Europe, which exports to the U.S., accepts shrimp harvested without TEDs (Epperly 2003). The effectiveness of the embargo has recently come under severe criticism, as noncompliance and improper use of TEDs (e.g., Costa Rica) remain 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 estimated 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). Additionally, Arauz et al. (1998) estimates that the Costa Rican shrimp fleet catches approximately 20,000 turtles per year with a mortality rate around 50 percent.

Leatherbacks and loggerhead turtles 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 and 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 turtles on shelf breaks (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.

Information gathered from a Council funded project on coastal gillnet fisheries in Baja Sur, Mexico, suggests that seasonal halibut gillnetting coincides with loggerhead foraging activity in a loggerhead hotspot (Punta Abreojos to Cabo San Lorenzo) and results in significantly high loggerhead mortality. In 2005 and 2006, bottom-set gillnet operations were observed. The results indicate that all loggerhead interactions occur when bottom-set gillnets are set at depths between 20-23 fathoms or 120-138 ft. When fishing at those depths, the fishermen were observed to catch 0.65 loggerheads per day, of which 73% caught are dead. It is conservatively estimated that at least 400 juveniles loggerheads are killed each year in Baja Sur’s coastal gillnet fishery (Peckham, ProPennisula, pers. comm. December 2007). This is a conservative estimate because the data are derived from observing one fishing fleet in the area where there are 13 other fishing communities, therefore actually loggerhead mortalities from gillnet fisheries in Baja Sur, Mexico could be much greater than 400 mortalities per year.

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 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 in a period of six years

(Wright and Mohanty 2002). In one example, 205 olive ridley turtles were found dead in one multifilament gill net (Wright and Mohanty 2002).

Coastal driftnets

The California/Oregon drift gillnet fishery targets swordfish and thresher shark. Between July 1990 and December 2001, NMFS 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 were 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. However, loggerhead interactions occurred south of Point Conception and occurred primarily during El Niño events.

Asian Set Nets or Pound/Pond Nets

Off the coast of Japan, gillnets and pound nets are very common and are categorized as large vs. small. There are likely well over 1000 large size pound nets and about 12,000 small pound nets anchored in coastal waters around Japan. Pound nets also vary by type, such as open vs. closed, middle layer or bottom-set. Open nets have the lowest sea turtle bycatch mortality because sea turtles can swim to the top to breath. Bottom-set or middle-layer pound nets have the highest sea turtle mortality rates at over 95 percent per capture, with 16 turtles caught in one day being the highest number of captures observed. It is estimated that over 1,000 thousand loggerheads are killed each year in Japanese coastal pound net fisheries (Ishihara, STAJ, pers. comm., December 2007). Alarmingly, there is an apparent trend in Japan to convert open nets to closed or middle-layer nets as they may have higher fish catch rates.

Taiwanese have harvested sea turtles for many years for their meat, their bones for use in Chinese medicine, and eggs for profit. In Taiwan, sea turtle bycatch in fisheries occurs, although little information is available for fisheries operating in the Pacific Ocean (Cheng 2002). Researchers investigated the incidental capture of sea turtles by the coastal setnet and gillnet fisheries in the eastern waters of Taiwan from 1991 through 1995. Setnets used in the coastal waters off Taiwan are near-shore sedentary trap nets, and rarely extend below 20 meters. During the time of the study, there were 107 setnets in Taiwan, and they provided the second largest total fish yields, after gillnets. According to interviews with fishermen, incidentally caught sea turtles are either sold to dealers in the market or are butchered for meat (subsistence). Fishing grounds including set nets and gillnets were observed from 1991 through 1992, and the fish market was visited once or twice per month from 1991 through 1995 to corroborate bycatch data (Cheng and Chen 1997). Of the sea turtles caught, 82% were caught in setnets, and of these, all were alive. 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, 5 olive ridley, 8 hawksbill and 1 leatherback turtle were captured (Cheng and Chen 1997). Green turtles accounted for 70% of the sea turtles taken, and captured turtles represented all age classes (large juvenile, subadult and adults). Most captured loggerheads were either subadults or adult females (only one male was unidentified), and most of the captured olive ridleys were subadults. The one captured leatherback was released alive.

Bottom-set longlines

In 2005, seven observer trips were made on bottom-set longline vessels operating in Baja Sur, Mexico as part of a Council funded project. The observers reported that 26 loggerheads caught on a total of 1200 hooks set, or a bycatch rate of 19.3 per 1000 hooks. Of the turtles caught, 24 of 27 were dead when retrieved, providing an 89% mortality rate. One bottom-set longline trip was observed in 2006, where 21 loggerheads were caught dead from fishing 236 hooks, resulting in a kill rate of 89 turtles per 1000 hooks. Based on these interaction and mortality rates, it is estimated that over 1000 loggerhead turtles were killed in 2005 and 2006, respectively, by eight boats in one community, of which there are at least 13 communities along the coast (Peckham, ProPennisula, pers. comm. December 2007).

Pelagic driftnets

Four species of marine turtles 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 and Liew 1996). It is believed that similar fisheries operating within the South China Sea also compounded the problem (Chan and 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 et al. (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 prohibition on pelagic driftnets based on the indiscriminate nature of the gear (Crouse 1999), yet illegal gillnetting is still believed to occur.

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 are neither comprehensive nor complete. The Hawaii-based longline fisheries may have the most comprehensive bycatch data of all longline fleets in the Pacific based on fishery effort and observer data. A study by Nishimura and Nakahigashi (1990) 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 (Polovina et al. 2000, Polovina et al. 2001). Lewison et al. (2004) estimate from Pacific longline fishing effort bycatch rate data, that approximately 30,000 loggerheads and 20,000 leatherbacks were caught in the year 2000, with between 2,600 and 6,000 loggerheads and between 1,000 and 3,200 leatherback turtles killed.

4.4.2.1.4 Impacts to Sea Turtles from the Alternatives Considered in Detail

Impacts to sea turtles from the effort alternatives (Alternatives 1A-1F) are described in number of predicted interactions. The other alternatives considered in detail for Topics 2 and 3 are not described as they would represent no or minimal changes to the impacts identified for Topic 1.

For Alternatives 1A-1F, estimated interactions range from 18-77 for loggerheads, 7-30 for leatherbacks, 1-4 for olive ridleys, and 1 or less for green turtles.

4.4.2.1.5 Overall Potential Cumulative Effects to Sea Turtles

Susceptibility to Quasi Extinction Analysis

Recent BiOps conducted by NMFS have used a quasi-extinction risk index called susceptibility to quasi-extinction (SQE) that can be used to classify populations based on relative risks (see Appendix II, Snover 2008). NMFS PIFSC conducted an SQE analysis that examined the effects of the existing hard caps (17 loggerheads and 16 leatherbacks) as well as those preliminarily preferred by the Council and contained in the DSEIS for this action (46 loggerheads and 19 leatherbacks) on loggerhead and leatherback sea turtle populations. Using population simulations, SQE analyses show that the method is robust in assessing actual risk (in terms of a binary assessment of at risk or not at risk), assuming that current conditions remain the same over the time period of the projection. The analysis uses long time frames of three generations (following IUCN criteria) which clarify that SQE values are primarily useful as an index for comparing populations and assessing the impacts of increased mortalities by comparing SQE values between perturbed and non-perturbed populations.

The SQE analysis is based on diffusion approximation methods, which is used to estimate population viability. The SQE analysis assumes that current conditions remain the same for the time horizon specified in the model, in this case, three generations. The current conditions include constant fishing pressure and other negative anthropogenic impacts, constant management practices for reducing mortality rates and increasing reproductive rates, and consistent climate/ocean conditions, prey availability/predation rates and the variations in these rates similar to that observed in the past. The probability that these conditions remain static over a three generation time period may be low; however, the SQE modeling approach applied does not incorporate uncertainties in future conditions. Hence, the method is not meant to be predictive but merely an assessment of the current status of the population based on the time series available. The same analysis, run again in five years, may give a different result that is representative of the status of the population at that point in time.

To account for exponential population growth in a randomly varying environment, the diffusion approximation method also uses two key parameters: 1) arithmetic mean of the log population growth rate, and 2) the variance of the log population growth rate which accounts for sources of variability, including environmental and demographic stochasticity and observation error. To achieve the resolution necessary to detect changes in the risk of quasi-extinction, PIFSC selected 50% as the level of quasi-extinction threshold (QET) to evaluate the impact of the proposed hard caps on the turtle populations. A QET of 50% is consistent with the International Union for Conservation of Nature (IUCN) listing criteria, that a species is considered vulnerable if it is likely to decline by 50% of its current size over 3 generations. The 2008 PIFSC analysis uses QET of 50% as recommended by the IUCN; however, SQE analyses conducted for other domestic fisheries, such as the Northeast Atlantic sea scallop dredge fishery, use significantly less QET levels than 50% (Merrick and Haas 2008). The SQE analysis for the Atlantic scallop fishery used a QET of 0.7% as opposed to the Snover (2008) analysis which used a QET 50%. This difference in QET is significant and the Snover (2008) analysis is considered conservative with regard to sea turtles in terms of characterizing the impacts of proposed hard caps on sea turtle populations (see Appendix II for more information).

The SQE analysis utilizes a diffusion approximation model that relies upon cyclic sea turtle nesting beach trends to determine the status of sea turtle populations. In order to determine the likely impact of interactions on the nesting trends and, derivatively, on the entire affected population, it is necessary to convert fishery interactions (which occur with both male and female turtles which may be juveniles or adults) to adult female equivalents.

Leatherback Sea Turtles

Recent information (Dutton et al. 2007) indicates that the number (2,700 -5,100) of nesting female leatherbacks in the south western Pacific region appears to be greater than previously stated in Spotila (1996) or NMFS (2004). Though greater numbers of nesting female leatherbacks have been discovered in the western Pacific region, trend information is not available for these newly described nesting sites, thus, no statements can be made describing the anticipated outlook (i.e., status) for these populations for which there is no trend data (Dutton et al. 2007).

Several exogenous factors identified in this document may be contributing to the decline of leatherbacks in the Pacific as both natural and anthropogenic threats to nesting and marine habitats continue to affect leatherback populations; however, it is not possible to quantitatively assess these impacts. Egg collection continues to occur in many countries as does the killing of nesting females. Incidental capture in pelagic longline fisheries is still a problem, and the potential effects of climate change are a concern. In addition, the geographic concentration of nests on the northwest coast of Papua, Indonesia (believed to represent 75% of known Western Pacific leatherback nesting sites) may increase their vulnerability to place-based impacts such as typhoons, disease and climate change. Despite the fact that there appear to be greater numbers of females nesting in certain regions of the western Pacific than once believed, nesting trend information is unavailable for these areas, hatchling production remains low, and nest depredation from feral pigs and dogs still occurs in some areas (Dutton et al. 2007; Hitipeuw et al. 2007; Tapilatu and Tiwari 2007).

While exogenous factors have directly or indirectly contributed to the decline of leatherback populations, two positive factors have been identified. First, there are the Council's leatherback conservation projects that have contributed to the conservation of thousands of hatchlings (e.g. 140,000 hatchlings in Papua, Indonesia) through activities such as reducing depredation of leatherback nests. These types of projects are identified as important recovery components in the leatherback recovery plan and are some of the only projects being conducted in the western Pacific to conserve this species. Second, is the reduction of adverse transferred effects due to the partial reopening of the Hawaii shallow-set fishery, which as previously described is believed to have reduced swordfish imports from international fisheries that do not utilize proven sea turtle mitigation measures. Transferred effects may have also had a direct positive impact as NMFS and the Council have contributed to programs in South America which distributed large circle hooks for use in fisheries that may impact sea turtles. In addition the Council has sponsored a series of international Fishers Forums with the objective of transferring bycatch reduction methods and technologies to other fishing nations.

The preferred alternative in the DSEIS would have implemented an annual leatherback hard cap of 19 interactions per year. Based on the assumptions regarding post-hooking mortality rates, sex ratios, adult equivalencies (see Section 3.3.1.7), approximately 2.40 adult female (AFM) leatherback mortalities are predicted if 19 interactions occur in the fishery.

(19 interactions)(0.229 mortalities/interactions)(0.65 females)(0.85 adult equivalent) = 2.40 adult females

The SQE analysis (Snover 2008; Appendix II) indicates that adult female leatherback mortalities of less than four would have a minimal impact on the Jamursba-Medi leatherback nesting population, which is part of the larger Western Pacific leatherback population. Of the 2.40 AFM expected to result from 19 leatherback interactions, 1.65 AFM (2.40 x 0.69) would be expected from the Jamursba-Medi nesting aggregation, 0.74 AFM (2.40 x 0.31) from the remaining

Western Pacific population.[27] Based on the SQE analysis, NMFS has found that the loss of 1.65 adult females from the Jamursba-Medi nesting aggregation (or component) resultant from 19 interactions with the fishery cannot be statistically distinguished from the effect of natural mortality (NMFS 2008c). In other words, 19 interactions are not expected to reduce the reproduction, numbers, or distribution of the Western Pacific leatherback population. However, because there is a lack of information regarding the status or trend of the remaining Western Pacific population, (the non-Jamursba-Medi component) which makes up 62% of the Western Pacific leatherback metapopulation, this component may be declining more rapidly than the Jamursba-Medi component. If this is true, then the Western Pacific metapopulation as a whole may be declining more rapidly than the Jamursba-Medi component alone. For this reason, NMFS, in its 2008 BiOp, did not authorize 19 leatherback annual interactions, but instead authorized only 16 (NMFS 2008c). Recognizing NMFS' findings in its 2008 BiOp, the Council subsequently recommended an annual leatherback hard cap of 16 as presented in the preferred alternative (Alternative 1F) in this document.

Although the Jamursba-Medi leatherback nesting trend has remained stable since 1999, the 1997 nest estimate and anecdotal evidence suggest a decline in that nesting aggregation since the 1980's. Coupled with the above consideration that the Western Pacific metapopulation as a whole may be declining more rapidly than the Jamursba-Medi population alone, it appears that exogenous factors, while largely unquantifiable, are resulting in cumulative negative effects on the Western Pacific leatherback population. For this reason, the Council's leatherback conservation projects, which have increased leatherback hatchling conservation and protection at key nesting locations, are critically important to help counteract these exogenous factors. In addition, the potential positive impacts of transferred effects resultant under the preferred alternatives may contribute positively to leatherback populations.

Loggerhead Sea Turtles

In Japan, increases in nesting populations occurred from 1998-2005, but declined in 2006 and 2007. Longer-term census data indicate a substantial decline (50-90%) in the size of the annual loggerhead nesting population in Japan in recent decades. Current work by Kamezaki and Chaloupka (in press) suggest an increasing population trend at Yakushima Island and further that there are synchronized,10-15 yr quasi-cyclic nesting beach abundance fluctuations across the archipelago likely due to environmental forcing such as foraging area productivity. In 2008,

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[27] Snover (2008; Appendix II) analyzed the impact of the proposed leatherback hard cap assuming that the fishery primarily interacts (94 percent) with leatherbacks of the western Pacific and rarely interacts (6 percent) with eastern Pacific leatherback populations. However, recent evaluations of the genetic samples taken from interactions in the fishery suggest that 100 percent of the leatherbacks that interact with the fishery derive from western Pacific nesting aggregations. Based on the size of the Jamursba-Medi nesting aggregation in Papua, Indonesia, 69 percent of the total western Pacific leatherback interactions are estimated to occur with turtles from with the Jamursba-Medi nesting aggregation. The remainder (31 percent) are believed to be from other nesting aggregations that comprise the western Pacific leatherback metapopulation.

loggerhead nesting appears to 2.5 times higher on Yakushima Island (approx. 30% of total nesting) than in 2007 (Matsuzawa, STAJ, pers. comm., June 2008). Hatchling mortalities are high on Japanese beaches due to erosion from typhoons and heavy beach traffic. The Council's loggerhead sea turtle conservation project in Japan has worked against nest erosion and beach traffic and since 2004 have conserved 1,729 nests producing around 108,300 loggerhead hatchlings, which equates to approximately 181 adult turtles.

Foraging juvenile and sub-adult turtles in the eastern Pacific at Baja, Mexico, face significant impacts from fisheries bycatch, up to 2,000 loggerhead mortalities each year. It has been estimated that juvenile loggerheads foraging in waters off of Baja have been exposed to harmful fishing gear remains for the last 15-20 years (H. Peckham, ProPennisula, pers. comm., in Snover, 2008.). The Council's loggerhead conservation project in Baja has resulted in a declaration being signed by a local fishing community agreeing to retire their especially harmful fishing gear, potentially saving approximately 700-900 juveniles per year.

The Council has proposed an annual loggerhead hard cap of 46 interactions per year. Based on the assumptions regarding post-hooking mortality rates, sex ratios, adult equivalencies as described in Section 3.3.1.7, 2.51 adult female loggerhead mortalities are predicted if 46 interactions occur in the fishery.

(46 interactions)(0.205 mortalities/interactions)(0.65 females)(0.41 adult equivalent) = 2.51 adult females

A SQE analysis of the impact of adult female mortality on the northern Pacific loggerhead population indicated that less than 7 adult female mortalities annually would have a minimal impact on this population's risk of extinction (Snover 2008; Appendix II). Less than half this number of adult female loggerheads are expected to be killed by the proposed action annually: The maximum number of adult females that could be killed by the proposed action (i.e., resulting from the maximum allowable 46 interactions in 1 year) is estimated at 2.51 adult females, thus no more than 3 adult female loggerheads would be killed per year (Snover 2008; Appendix II). NMFS concluded that the effect of 2.51 adult female mortalities cannot be statistically distinguished on from the effect of natural mortality, and hence does not adversely affect the population dynamics of North Pacific loggerheads (NMFS 2008c).

As seen in Figure 18, North Pacific loggerhead nests have been increasing since 1999, with the exception of years 2006 and 2007. However 2008 levels are likely to be the highest on record to date. Although impacts from adverse exogenous factors such as incidental capture in nearshore and pelagic fisheries and those associated with climate change including erosion, productivity of foraging areas, nesting beach temperatures, it appears that the North Pacific loggerhead population is on an increasing trend. The Council's loggerhead conservation project in association with the STAJ has conserved over 140,000 hatchlings and remains a critical piece in the conservation and protection of nests and hatchlings to counteract negative exogenous factors. In addition, the Council's successful outreach efforts in Baja, Mexico have influenced a group of fishermen to retire turtle-harmful gear, and have also contributed positively to cumulative effects. Given the above considerations, as well as potential positive impact from transferred effects, the preferred alternatives considered in this document are not expected to significantly adversely impact Pacific loggerhead sea turtle populations.

Other sea turtles
Based on the impact analysis that predicts low numbers of interactions to green, olive ridley, and hawksbill sea turtles, the proposed action is not expected to result in significant adverse impacts to these Pacific sea turtle populations. While some olive ridley populations and green sea turtle populations are increasing, cumulative effects from exogenous factors may be contributing to the global status of these species.

4.4.2.2 Cumulative Effects to Marine Mammals

4.4.2.2.1 Past Council/NMFS Actions Impacting Marine Mammals

The Marine Mammal Protection Act (MMPA) requires FMP-regulated fisheries be evaluated by NMFS for impacts on marine mammals and be designated as Category I, II, or III (with Category III having the lowest impact). The fishery classification criteria consist of a two-tiered, stock-specific approach that first addresses the total impact of all fisheries on each marine mammal stock, and then addresses the impact of individual fisheries on each stock. Under existing regulations, all fishers participating in Category I or II fisheries must register under the MMPA, obtain an Authorization Certificate, pay a fee of $25, and report any interactions with marine mammals. Additionally for Category I fisheries, fishers may be subject to a take reduction plan and requested to carry an observer (68 FR 20941).

The Hawaii-based longline fishery (deep-set and shallow-set) was previously listed as a Category I fishery, primarily due to interactions between the deep-set (tuna) fishery and false killer whales (*Pseudorca crassidens*) within EEZ waters around the Hawaiian Islands. Dolphins and false killer whales are also known to take bait and catches from longline and bottomfish fishing lines, most often without becoming hooked or entangled. However, rare instances of mortality of marine mammals have been documented in the deep-set longline fishery. The Hawaii longline fishery is in compliance with the MMPA in that it is subject to observer coverage and participants must obtain an Authorization Certificate and report any interactions.

A recent review of fishery interaction data has led NMFS to determine in its List of Fisheries for 2009 (73 FR 73032, December 1, 2008) that the Hawaii deep-set and shallow–set longline fisheries are considered as separate fisheries, with each to be categorized independently based on its characteristics and interactions with marine mammals. The deep-set fishery (which has a history of interacting with false killer whales) is a Category I fishery. The shallow-set fishery (which had one interaction with false killer whales in 1997, a second in 1998 and a third in 2008) is a Category II fishery. All other fisheries in the western Pacific region are classified as Category III fisheries (73 FR 73032 for further information).

Some marine mammals (e.g., Hawaiian monk seals, Humpback whale) occurring in the western Pacific region are also protected under the ESA, and NMFS must ensure that fisheries managed by the Council are not likely to jeopardize the continued existence and recovery of any threatened or endangered species or result in adverse impacts on the critical habitat of such species. BiOps prepared by NMFS have concluded that no fisheries managed by the Council are likely to jeopardize the continued existence and recovery of any ESA-listed marine mammal species or result in the destruction or adverse modification of designated critical habitat in the western Pacific region.

4.4.2.2.2 Reasonably Foreseeable Future Council/NMFS Actions Impacting Marine Mammals

Through data collected from observer programs and other sources, the Council and NMFS will continue to monitor interactions between managed fisheries and marine mammals. NMFS scientists in association with other researchers will continue to collect biological samples to refine stock definitions as well as conduct surveys to monitor populations. The Council and NMFS will continue to conduct workshops with participation from fishermen to develop mitigation methods as appropriate, and NMFS will continue to conduct mandatory annual protected species workshops for all longline permit holders that teach how to identify marine mammals and how to reduce and mitigate interactions.

4.4.2.2.3 Exogenous Factors Affecting Marine Mammals

A comprehensive description on the external factors affecting Hawaiian monk seals is provided in the 2005 EIS (June 17, 2005; 70 FR 35275) as well as the 2007 Monk Seal Recovery Plan (NMFS 2007). These factors include natural occurrences such as male aggression and mobbing, shark predation, disease, and ecosystem productivity regime shifts, as well as anthropogenic impacts such as sea wall entrapments, hookings, research activities, marine debris, and vessel groundings.

External factors affecting other marine mammals such as whales and dolphins include the following: (a) incidental take in fisheries; (b) collisions with ship traffic, ship disturbance, and ship noise, and (c) marine debris and waste disposal.

Interactions with Fisheries
Nearshore gillnet fisheries in Hawaii have been reported to interact with some dolphin species (e.g., bottlenose dolphins); however, the rate of interactions or severity of interactions is not well known (Forney 2004). Dolphins and false killer whales are also known to strip bait and catches from fishing lines without becoming hooked or entangled. Additionally, monk seal drowning in nearshore (reef) nets, and hooking by shore-based ulua fishermen have been documented in Hawaii.

Ship Traffic, Disturbance, and Anthropogenic Noise
Collisions with vessels and disturbance from low-frequency noise are potential threats to cetaceans and other marine mammals. Increasing levels of anthropogenic noise in the world's oceans may have an adverse effect on marine mammals. Ambient noise from shipping in the Pacific Ocean has doubled every decade for the last 40 years (McDonald et al. 2006). Commercially important fish stocks and marine mammals can be affected by noise pollution by making it more difficult to find food and mates, avoid predators, navigate and communicate (Popper 2003). The Marine Mammal Commission is currently assessing the acoustic impact of underwater sound on marine mammals.

Marine Debris and Waste Disposal
External activities that may have adverse effects on marine mammal habitat 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 bioaccumulate 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 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 diseases, thereby reducing their ability to survive, care for their young, and reproduce. These factors can have significance in local areas where there are high concentrations of marine debris, thus contributing to cumulative effects on marine mammals.

International agreements such as the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL), and domestic regulations under the U.S. Act to Prevent Pollution from Ships prohibit the intentional discard of plastic fishing gear such as the monofilament line used by Hawaii's longline fleet. These measures are enforced by the U.S. Coast Guard. In addition, current federal fishery regulations require all longline gear to be marked with the vessel's documentation number. To date, a voluntary derelict fishing net gear retrieval program has led to the removal of more than 50,000 pounds of derelict nets and other fishing gear (included spent monofilament longline held on board Hawaii longline vessels for appropriate disposal) since its inception in 2006 which represents a serious commitment to environmental stewardship by Hawaii's longline fishery participants. Whether further incentives are necessary or appropriate is currently being evaluated by NOAA, NMFS, the Council, and other regional partners. NOAA is also currently holding workshops and meetings to discuss research and assessments associated with the prevention and removal of marine debris.

4.4.2.2.4 Potential Cumulative Effects to Marine Mammals of the Alternatives Considered in Detail

As detailed in earlier sections of Chapter 4, none of the alternatives considered in this document would result in a significant number of mortalities of marine mammals, as most projected mortalities are in the single digits. The highest potential number of mortalities for all marine mammals would occur under Alternative 1E and to Risso's dolphins at approximately eight per year, and that would include interactions where Risso's dolphins were released alive.

4.4.2.2.5 Potential Cumulative Effects to Marine Mammals

Given the above considerations, such as the low levels of projected fishery interactions resultant from the alternative coupled with the effects of the exogenous factors described in this section, the cumulative impacts to marine mammals would not be expected to significantly adversely impact Pacific marine mammal populations.

4.4.2.3 Cumulative Effects to Seabirds

4.4.2.3.1 Past, Present, and Future Council/NMFS Actions

Prior to 1999, the shallow-set fishery was estimated to interact with around 2,000 albatross (black-footed and Laysan) per year. The short-tailed albatross, which is listed as endangered under the ESA, is thought to forage in areas where the shallow-set fishery operates; however, no interactions between the short-tailed albatross and the Hawaii-based longline fleet have ever been reported or observed. In 2002, the Council amended the Pelagics FMP to require Hawaii-based longline vessels to use known seabird mitigation measures that were expected to significantly reduce seabird interaction rates. These measures include blue-dyed bait, night-setting, line shooters, and weighted branch lines. In 2005, the Council amended the Pelagics FMP to allow longline vessels to side-set in lieu of most required alternative measures. Side-setting has been proven to nearly eliminate seabird interactions with longline vessels.

The introduction of the above regulations in the Hawaii longline fishery reduced the seabird interaction rate by 67 percent on deep-sets (Gilman et al. 2008). Due to the low levels of observer coverage on shallow-sets prior to the implementation of the seabird regulations, as well as the low numbers of annual interactions that have occurred since these measures were implemented, NMFS has not published a quantitative analysis of their efficacy in terms of shallow-set interaction rates. However, as presented in Table 27, during 2007 the shallow-set fishery made 1,497 sets with 47 interactions observed with black-footed or Laysan albatrosses combined (0.031 interactions per set). This can be compared to the 1994-1998 combined interaction rate of 0.758 interactions per shallow-set used by the USFWS in their 2004 BiOp (USFWS 2004), yielding a 96 percent reduction in the combined black-footed and Laysan albatross interaction rate.

The Council and NMFS will continue to monitor seabird interactions with managed fisheries, and if a management need arises, will recommend/implement appropriate measures.

Transfer of Seabird Interaction Avoidance Measures

Incidental seabird catch could be substantially reduced in North Pacific pelagic longline fisheries through adoption and enforcement of national regulations to control seabird bycatch and practical demonstrations of the effectiveness of seabird interaction avoidance measures (Gilman and Freifeld 2003). There are two levels at which practical information about seabird avoidance measures can be transferred. The first level is to disseminate written material and videotapes, translated into appropriate languages for the target longline fishing nations, at international trade shows and other meetings (particularly International Fishers' Fora), where there is exchange among fishermen, scientists and resource managers. The second level is industry-to-industry transfer of seabird interaction avoidance technology under arrangements between fishing organizations in longline fishing nations. Both levels of activities can occur with or without formal government-to-government agreements. There is precedent for such a program in the cooperative efforts of the Hawaii Longline Association, the Council, the National Marine Fisheries Service and Blue Ocean Institute to conduct research and commercial demonstration on a Hawaii longline vessel of three seabird interaction avoidance methods (Gilman et al. 2003). Broad multi-national longline industry compliance to reduce incidental seabird catch would have positive impacts on the seabird resource.

4.4.2.3.2 Exogenous Factors Affecting Seabirds

Albatross populations in the North Pacific Ocean live in an environment that has been substantially affected by anthropogenic factors. Major activities of the past that are part of the existing baseline include the intensive collection of short-tail albatross feathers in Japan during the early 20 century; the Battle of Midway during World War II and subsequent U.S. military use of Midway Island; and Asian high-seas drift net fisheries during the 1980s.

Degradation of Albatross Nesting Habitats

Overall, negative human impacts to albatross nesting habitats are abating in Japan and the NWHI. Currently active breeding colonies for the short-tailed albatross in Japan and the major nesting colonies of the black-footed and Laysan albatrosses in the NWHI are part of government refuges managed for the conservation of wildlife. Thus, human access and associated disturbance are limited. Due to management changes at Midway Atoll National Wildlife Refuge, air traffic and visitor use are considerably reduced, diminishing the threats to seabirds from air strikes and ecotourism. Cruise boats occasionally land visitors at Midway and the airfield is maintained as an emergency landing site, so there is still potential for visitor-related and aircraft-related impacts.

Exposure to lead and PCBs remain hazards to seabirds at the decommissioned military base in the Midway Island National Wildlife Refuge and the decommissioned LORAN station at Tern Island, French Frigate Shoals. Despite previous lead remediation (1994-1997) on Midway, Laysan albatross chicks continue to be exposed to substantially elevated levels of lead from the ingestion of lead-based paint from deteriorating buildings. This represents a serious health threat based on several reports of increased morbidity and mortality of Laysan albatross chicks nesting in the vicinity of buildings. The death of Laysan albatross chicks in a species of low productivity impedes efforts to conserve this species (Finkelstein et al. 2003). The U.S. Fish and Wildlife Service (USFWS) is currently attempting mitigate the lead paint problem. The future potential of Midway Atoll NWR to serve as a nesting colony for short-tailed albatross, through either natural colonization or propagation efforts remains unknown (USFWS 2000).

Continued Exposure to Environmental Contaminants, Especially PCBs

Black-footed and Laysan albatrosses from the North Pacific Ocean contain higher levels of organochlorine residues (polychlorinated dibenzo-p-dioxins, PCDDS; polycholorinated dibenzofurans, PCDFs; and polychlorinated biphenyls, coplanar PCBs) than albatrosses in the South Pacific Ocean. Black-footed albatross have 3-4 times more mercury and organochlorines than Laysan albatross (Finkelstein et al. 2006). Residue levels in albatrosses from the remote North Pacific Ocean far from point sources of pollution are comparable to or higher than those in terrestrial and coastal birds from contaminated areas in developed nations. The long lives of albatrosses and ingestion of plastic resin pellets that account for a high percentage of marine debris in some areas of the ocean are plausible explanations for accumulation of these persistent contaminants in albatrosses (Tanabe et al. 2004). Over the long term, high levels of PCBs may negatively affect the health of North Pacific Ocean albatross populations.

Continued Exposure to Concentrations of Small Plastic Debris in the North Pacific Ocean

Studies in the last 25 years have documented the prevalence of plastic in the diets of many seabird species in the North Pacific Ocean. Plastics may be consumed directly because particles resemble prey items or, indirectly, by eating prey attached to plastics or with plastics in their gut. In turn, adult seabirds may pass plastics on to chicks by regurgitation.

Studies of the distribution and abundance of small plastic particles in the North Pacific Ocean report that pelagic plastic is most abundant in the central subtropical and western North Pacific Ocean. User plastics, small, weathered remnants of larger manufactured items that are discarded or lost at sea by fishing vessels and shipping traffic, are the predominant type of plastic ingested by seabirds in the central North Pacific Ocean (Day and Shaw 1987). Currents and convergences of the region concentrate marine debris at levels that appear higher than for any other oceanic regions of the world and leading to some of the highest global incidence of plastic ingestion in central North Pacific Ocean seabirds (Robards et al. 1997).

Available evidence suggests that plastics are damaging to seabirds when they are consumed in sufficient quantities to obstruct the passage of food or cause stomach ulcers, through bioaccumulation of polychlorinated biphenyls (PCBs), toxic effects of hydrocarbons, diminished feeding stimulus, reduced fat deposition, lowered steroid hormone levels and delayed reproduction. However, acute effects of plastic ingestion are rarely observed and a search for correlations between plastic load and health indices for wild populations of seabirds has been generally unsuccessful in producing any more than indirect evidence of chronic health effects.

Spear et al. (1995) is the only investigation to show a statistically significant negative correlation between plastic loads and seabird body weight.

Incidental Seabird Mortality in Non-FMP Regulated Longline Fisheries
Black-footed and Laysan albatross, and occasionally short-tailed albatross, are incidentally captured in Alaskan demersal longline fisheries. NMFS published a final rule on January 13, 2004, to revise regulations requiring seabird avoidance measures in hook-and-line fisheries of the Bering Sea and Aleutian Islands management area and Gulf of Alaska, and in the Pacific Ocean halibut fishery in U.S. Convention waters off Alaska. This action is intended to improve the current requirements and further mitigate interactions with the short-tailed albatross and other species of seabirds in hook-and-line fisheries in and off Alaska (69 FR 1930, Jan. 13, 2004). Reducing incidental seabird catch in U.S. fisheries alone will not significantly reduce longline fisheries as a source of mortality to North Pacific albatross populations. The Hawaii longline fleet is a small component of total pelagic longline fishing effort in the North Pacific Ocean. Pelagic longline fishing effort by Asian fleets continues to expand in the North Pacific Ocean. Some of these fleets are known to set gear using “shallow” swordfish and “mixed” tuna/billfish methods (Bartram and Kaneko 2004) that have levels of interactions with seabirds 40-70 times higher than deep-set methods (Cousins et al. 2000). For example, since 1997, fishing by the Taiwan freezer longline fleet targeting albacore tuna has been increasing in waters north of the Hawaiian Islands. In 2000, effort by this fleet between 25° and 40° N and between 180° and 140° W exceeded 6 million hooks (Wang et al. 2002).

The National Research Institute of Far Seas Fisheries of Japan’s Fisheries Research Agency has initiated scientific activities to develop, evaluate and improve various kinds of seabird interaction avoidance methods. Of the many measures tested in Japan, blue-dyed bait has proven to be the most effective in reducing visibility of baits and in preventing bait-taking by seabirds. Japan’s National Plan of Action for Seabirds requires longline vessels operating north of 20° N in the North Pacific Ocean to adopt at least one interaction avoidance measure to avoid interactions with seabirds. Longline vessels that operate within 20 miles of Torishima Island, the major breeding island of the short-tailed albatross, are required to adopt two or more seabird interaction avoidance measures (Kiyota et al. 2003).

The U.S. is implementing a National Plan of Action to reduce the incidental catch of seabirds in U.S. fisheries. Other than New Zealand, Japan and the U.S., few national governments are engaged in policy-making, research, monitoring and enforcement to reduce incidental seabird catches by fishing fleets under their flags. Negative effects on seabird populations remain high because the majority of North Pacific longline fishing continues without the use of seabird interaction avoidance measures.

Global climate change and seabirds
The effects of climate change on the three species of albatrosses are uncertain at this time. However, climate change does have the potential to affect both breeding and non-breeding phases of albatross life history through direct and indirect effects.

The most obvious consequence of global warming is sea level rise. About 99% of Laysan albatrosses and 96% of black-footed albatrosses breed in the Northwestern Hawaii Islands (NWHI) (Naughton et al. 2008a, Naughton et al. 2008b). If sea levels rise, the amount of land area for nesting will be greatly reduced (Baker et al. 2006). Albatrosses are known for high breeding site fidelity. Given high site fidelity and the geographic isolation of these colonies, it is unlikely that these two species of albatrosses could easily relocate their breeding sites. The populations at these colonies have been monitored for at least 50 years (Naughton et al. 2008a, Naughton et al.2008b) and will continue to be. Changes in the number of breeding pairs would likely be detected. The third species, the ESA-listed short-tailed albatross, would likely be little affected by sea level rise. Its main breeding colony at Torishima (30° 28' 48" N Latitude and 140° 18' 22" E longitude) is relatively high in elevation (394 m, 1,293 feet) and has steep topography[28] These characteristics would logically minimize the potential for sea level rise to reduce the amount of area available for nesting. In addition to the potential for sea level rise, climate change may affect foraging success.

It is known that short-term (1-3 years) climate changes such as El Niño-Southern Oscillation can severely affect some seabird populations. These changes in weather can be closely correlated with reduced adult survival and breeding success in some seabird species due to reduced foraging success (WGSE 2008, Schreiber 2002). However, these changes may benefit other species (WGSE 2008). Seabird populations have evolved to survive these short-term changes. However, it is hypothesized that longer term changes in weather could have much more deleterious effects on some seabird populations (WGSE 2008, Schreiber 2002).

In addition to sea level rise, climate change could affect seabirds in the following three ways. First, it could cause changes to the prey base reducing or eliminating primary prey items from the environment. This would affect both adult survival and breeding success. Second, climate change has the possibility of causing seabirds to change their breeding periods and cause temporal mis-synchronization with usual prey items during critical chick rearing periods (WGSE 2008). Finally, climate change may cause oligotrophic tropical and sub-tropical water to expand reducing primary productivity that is the base of oceanic food webs (Polovina et al. 2008). Expansion of these poorly productive areas potentially higher energetic costs for seabirds as they would need to increase foraging effort in nutrient poor waters or fly further distances to more productive waters.

The trophic effects of climate change on North Pacific albatrosses are unclear at this point. The three species breed in tropical and subtropical areas, but they travel great distances to temperate and cold temperate waters to forage. Albatross distributions tend to be close to nesting colonies during the breeding seasons and closer to subtropical-temperate oceanic transition zones and continental shelves during non-breeding periods (Naughton et al. 2008a, Naughton et al. 2008b, Naughton et al. 2008c). It is possible that in the future, climate change could induce food web regime changes affecting albatrosses. However, the nature of these effects is unclear. Currently, there have been no wide spread population declines seen for any of the three North Pacific

[28] http://www.volcano.si.edu/world/volcano.cfm?vnum=0804-09, accessed on 7/26/08.

albatross species. One black-footed albatross colony at Laysan Island has seen slight declines, but there is no evidence that it is tied to climate change (Naughton et al. 2008a, Naughton et al. 2008b, Naughton et al.2008c). The ESA-listed short-tailed albatross has seen a steady increase in its numbers since 1947 (Naughton et al. 2008).

In summary, it is not possible to predict with specificity the impact of future climate change on seabirds. However, these effects would be considered in future management of the shallow-set longline fishery. Research will continue to track the status of seabird colonies, populations, nesting success, migration and foraging habits, and on the impacts of fisheries on seabirds. Information from the Hawaii-based shallow-set longline fishery will continue to be collected and analyzed through observer reports, and fishery participant's logbook accounts of interactions with seabirds. If there are changes to the status of seabirds or the fishery interactions with seabirds, the Council and NMFS would work to implement new fishery regulations that will help ensure the fishery is sustainable. In the case of the listed short-tailed albatross, if there were to be changes to the status of this species or to the fishery's interaction with it, NMFS would reinitiate consultation to ensure the fishery considers the impacts to this listed species. Therefore, the potential impacts of climate change on seabirds has been considered and will continue to be part of the environment affecting seabirds and the longline fishery that must be addressed through adaptive management regardless of which alternative is selected for implementation.

4.4.2.3.4 Potential Cumulative Impacts of the Alternatives Considered in Detail

The range of interactions associated with the alternatives considered in this document for black-footed albatross is from 7-26/yr (See Tables 40, 44, 48, 52, 56). The range of interactions associated with the alternatives considered in this document for Laysan albatross is from 30–107/yr (See Tables 40, 44, 48, 52, and 56). Serious interactions with adult albatrosses during the time when chicks are being fed and reared may also result in chick mortality. There have never been any observed or recorded interactions with short-tailed albatross in the shallow-set fishery.

4.4.2.3.5 Potential Cumulative Impacts on Seabirds

Given the above considerations, including increasing black-footed and Laysan albatross nesting trends (see Section 3.3.2 and Section 3.4), the levels of predicted fishery interactions coupled with the effects of exogenous factors are not expected to significantly adversely impact Pacific seabird populations.

4.4.2.4 Cumulative Impacts on Fishery Participants and Communities

4.4.2.4.1 Past, Present, and Reasonably Foreseeable Future Council/NMFS Actions Impacting Fishery Participants and Communities

As stated in Section 1.1.2, the Pelagics FMP was approved and implemented. FMPs do not "open" fisheries, but on the contrary, serve as mechanisms for the Council and NMFS to respond to management issues. Before the FMP, fishery participants were subject to little to no regulation, whereas through the FMPs and subsequent amendments, fishery participants have become subject to increasing regulation. Such regulations include but are not limited to, permit and reporting requirement, gear requirements, maximum vessel lengths, limited entry programs, observers, VMS, and protected species mitigation measures.

The 1996 reauthorization of the MSA required that the Council identify fishing communities under its jurisdiction. A fishing community, as defined by the MSA, means “a community which is substantially dependent or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes vessel owners, operators, and crew and Unites States fish processors that are based in such a community” (16 U.S.C. § 1802). The Council has identified American Samoa, Guam, CNMI, and each of the inhabited Hawaiian Islands, respectively, as fishing communities. The MSA requires that the Council or Secretary of Commerce describe the likely effects, if any, of conservation and management measures on fishing communities when developing FMPs or FMP amendments (16 U.S.C. §1853).The impacts of Council/NMFS actions on fishery participants are often transferred to fishing communities. Observable effects on fishing communities from the regulation of fishery participants depend on the number of fishery participants affected and to what degree they are affected.

Fishery management measures (discussed above) implemented under the FMPs have impacted fishing participants and fishing communities on various levels and have been analyzed in associated FMP/NEPA documents. The Council and NMFS will continue to assess the impact of management actions on fishery participants and fishing communities, and where possible, minimize negative effects while developing appropriate measures for the conservation and management of fishery resources.

4.4.2.4.2 Exogenous Factors Affecting Fishery Participants and Communities

There are wide-ranging factors (that change over time) that affect fishing participants as well as fishing communities. Current factors include high fuel costs, increased seafood imports, and restricted access to traditional fishing grounds. High fuel costs affect fishing participants in that it is simply increasingly expensive to go fishing. The effect is that fishery participants reduce fishing trips, switch to less fuel-intensive fisheries, or simply do not go fishing at all. The amount of imported seafood is also increasing, and where the U.S. now imports nearly 70 percent of consumed seafood.[29] Increased seafood imports are significant as it relates to market competition, where a glut of fish products can flood the market and lower ex-vessel prices. Once market channels are lost to imported seafood products it may also be hard for fishery participants to regain those channels.

[29] http://www.fas.usda.gov/ffpd/Fish-Circular/Market_News/IATR_Seafood_Imports.pdf

4.4.2.4.3 Potential Cumulative Effects of the Alternatives Considered in Detail

The estimated ex-vessel revenues from the preferred alternatives considered range from $9.7 million to $40 million (see Tables 42, 46, 50, 55, 59). In addition, the preferred alternatives would eliminate the set-certificate program which is expected to have overall benefits to fishery participants by reducing the application burden and eliminating the need to attach certificates to logbooks. Impacts to fishery participants to not implement time area closures under Topic 3 also appear positive as areas of the ocean would not be closed to fishing. Currently, there are approximately 30 vessels participating in the fishery, and under the preferred alternative, that number would be expected to incrementally increase by approximately 10-30 vessels. This increase in vessels, however, is dependent on several factors such as swordfish and bigeye markets, fuel costs, and other operational costs.

Based on the information presented in Sections 3.2.2.11 and 3.3.2.12, participants in fisheries other than the Hawaii shallow-set longline fishery are unlikely to face significant impacts from the preferred alternatives as swordfish catches by the MHI handline and troll fisheries are low and are not target species for these fisheries. In addition, the shallow-set fishery catches significantly less amounts of blue marlin and striped marlin than MHI troll fisheries, therefore no impacts to small vessel based fisheries, commercial or recreational, are expected from the implementation of the preferred alternatives.

The preferred alternatives are not expected to significantly impact California commercial or recreational swordfish fisheries. Section 3.2.1.2 describes these fisheries, with the California drift-gill net fishery being the largest and landing over 200 mt in recent years. Historically, this fishery caught over 2,000 mt of swordfish per year; however, in recent years significant fleet attrition has been observed. California recreational fisheries in recent years do not catch much swordfish, with fewer than 10 fish landed per year. The extent to which the swordfish the Hawaii-based fleet catches and the West Coast swordfish landed are of the same stock or if there if finer stock structure remains uncertain.

4.4.2.4.4 Cumulative Effects on Fishery Participants and Communities

Given the above considerations, it is anticipated that any increases in allowed fishing effort in the shallow-set fishery would positively impact fishery participants in the fishery, and to minimum extent fishing communities. The potential impact of the increased fishing effort in the shallow-set fishery on Hawaii’s regional economy is anticipated to positive, albeit minimal. In addition, fishery participants in other Hawaii fisheries such as small vessel commercial and recreational troll fisheries are not expected to be significant as these fisheries catch minimal amounts of swordfish nor they do these fisheries readily target swordfish. Billfish catches of blue marlin and striped marlin may increase under the preferred alternatives, but not to levels that would significantly impact existing small vessel commercial and recreational troll fisheries in Hawaii, as these currently fisheries catch at least an order of magnitude more billfish than the shallow-set fishery.

Existing recreational and commercial swordfish fisheries on the West Coast are also not expected to be significantly impacted by the preferred alternatives as the North Pacific swordfish stock is at this time considered healthy. However, further information is needed on the stock structure of swordfish in relation to catch locations and connectivity between North Pacific swordfish fisheries.

4.5 Environmental Justice

On February 11, 1994, President William Clinton issued Executive Order 12898 (E.O. 12898), "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." E.O. 12898 provides that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." E.O. 12898 also provides for agencies to collect, maintain, and analyze information on patterns of subsistence consumption of fish, vegetation, or wildlife. That agency action may also affect subsistence patterns of consumption and indicate the potential for disproportionately high and adverse human health or environmental effects on low-income populations, and minority populations. A memorandum by President Clinton, which accompanied E.O. 12898, made it clear that environmental justice should be considered when conducting NEPA analyses by stating the following: "Each Federal agency should analyze the environmental effects, including human health, economic, and social effects of Federal actions, including effects on minority populations, low-income populations, and Indian tribes, when such analysis is required by NEPA."[30]
In addition to Hawaii's indigenous and minority population, the shallow-set fishery has participants representing a variety of ethnicities that would fall under the minority provisions of the Executive Order. Previous social research on the Hawaii based shallow-set fishery by Allen and Gough (2006) determined that some of the fishery participants meet the definition of minority under the Environmental Justice E.O. For example, the fishery participants include sizable proportions of Korean-Americans and Vietnamese-Americans, as well as individuals from a variety of other ethnicities such as Micronesians and Filipinos. Because the purpose and need for this action is examining alternatives to increase fishery participation in the shallow-set fishery, none of the alternatives considered would have a significant adverse and disproportionate environmental or health impacts on members of low income or minority populations which participate in the fishery. Swordfish is not harvested in significant amounts by Hawaii small boat fisheries or subsistence fisheries, of which participation is composed of indigenous or minority populations. Increased longline fishing for swordfish by the Hawaii shallow-set fleet is not anticipated to result in significant harvests of non-target species that are targeted by Hawaii small boat fisheries or subsistence fisheries. Overall, no negative environmental justice impacts are expected from the proposed action; however, positive affects

[30] Memorandum from the president to the Heads of Departments and Agencies. Comprehensive Presidential Documents No. 279 (February 11, 1994).

are anticipated for low income or minority populations that participate in the Hawaii shallow-set fishery.

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Chapter 5: Consistency with the National Standards and Other Provisions of the MSA

5.1 National Standards

This section discusses the consistency of the proposed action with the National Standards of the MSA (50 C.F.R. § Subpart D – National Standards).

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 Pelagics FMP regards optimum yield as the amount of fish harvested in the EEZ without causing any type of overfishing (e.g. economic, growth, recruitment). As indicated in Section 3.2.1.3, the North Pacific swordfish stock is not subject to overfishing, not overfished, and not approaching either condition. There is a considerable portion of the North Pacific swordfish stock that is underutilized. Under the proposed action, the anticipated increase in swordfish harvests from the expanded effort[31] in the fishery is not expected to exceed MSY.[32] Allowing potential increases in fishing effort under the proposed action will likely lead to increases in catches of target species which will have positive impacts on Hawaii's fishing communities, economy, and benefits to the Nation.

Currently one stock in the WCPO, the Pacific bigeye tuna[33], landed by the shallow-set fishery is experiencing overfishing (Section 3.2.2.1). The action being taken to address this overfishing condition is Council's participation in international efforts, particularly in the context of the WCPFC and IATTC, to decrease fishing mortality as needed to end overfishing. The WCPFC has adopted measures to be implemented in 2009-2011 that have the objective of reducing the fishing mortality rate on bigeye tuna in the WCPO. The measures are not necessarily sufficient to end overfishing. The IATTC has adopted measures in the past to reduce fishing mortality on bigeye tuna in the EPO but currently has no measures in place. As discussed in Section 4.1.6.1 the proposed action is expected to result in a decrease in bigeye tuna catches by Hawaii deep-set fishery in the WCPO, albeit a minor decrease.

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[31] See Section 4.1.6: the proposed action is expected to result in an increase in the fishing mortality rate on North Pacific swordfish of 4,000-5,000 sets per year (3.4 - 4.2 million hooks/year).

[32] Current (domestic and foreign) swordfish landings in the North Pacific amount to about 14,500 mt, which, according to a recent stock assessment, amounts to about 65% of an estimated MSY of 22,284 mt (Kleiber and Yokawa 2004, Bigelow, PIFSC, pers. comm. January 2008). The current swordfish catch by the Hawaii-based fishery is between 850-1,637 mt.

[33] The current estimate of MSY for bigeye in WCPO is 64,600 mt (Langley et al. 2008) and 102,263 mt for the EPO (Maunder and Hoyle 2006).

As indicated in Section 3.2.2.5, the most recent assessment for striped marlin in the North Pacific indicated a substantial decline in stock size relative to historical levels. Because striped marlin comprise less than one percent of the shallow-set fishery's landings, and a smaller percent of Pacific-wide catches, multilateral international efforts are necessary to manage the stock. The U.S. (State Department, NOAA, regional fishery management councils) will assist in the development of such measures through its participation in the WCPFC and IATTC. As discussed in Section 4.1.6.2, the preferred alternative is expected to result in an increase in the fishing mortality rate of non-target species, including North Pacific striped marlin, although contributing to a small fraction of Pacific-wide catches of these species.

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

The proposed action is consistent with National Standard 2 because the best scientific information available (see Chapter 8) on both national and international levels was utilized to: determine appropriate management measures for target species, determine sea turtle population impacts from the proposed action, consider the pelagic ecosystem including catches of non-target species and interactions with protected species and seabirds, and assess the effects of the alternatives on fishery participants and regional economy.

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 proposed action is consistent with National Standard 3 because the natural ranges of target and non-target stocks are identified and considered to the maximum extent possible To maximize management benefits across the range(s) of these species this FMP amendment acknowledges international coordination and participation in several regional fisheries management organizations, such as the WCPFC and IATTC (see Section 4.4.1), and continues adherence to international quotas.

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 proposed action is consistent with National Standard 4 because it does not discriminate between residents of different States or allocate fishing privileges among fishery participants. Under the Pelagics FMP (see Section 1.2.2), the Hawaii-based longline fishery is managed under a limited entry program that was initially implemented based on prior participation and catch history. Fishery participation through permit ownership in the Hawaii longline limited entry program is currently open to U.S. citizens, regardless of prior participation. Several participants in the Hawaii-based shallow-set fishery have historically operated (seasonally) out of West Coast ports (see Section 3.2.1.2). Increased effort under the proposed action will likely facilitate greater exchange between Hawaii and West Coast fishery participants providing socio-economic benefits to both areas and to the Nation.

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 proposed action is consistent with National Standard 5 because it does not require or promote inefficient fishing practices. Rather, they promote sustainable harvest through the continued use of gear and technology which maximizes efficiency and ecosystem sustainability while minimizing protected species interactions and bycatch (see Sections 2.1 and 4.4.2).

National Standard 6 states that conservation and management action shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

The proposed action is consistent with National Standard 6 because it identifies and integrates a management structure that considers local factors affecting fisheries, fishery resources, and catches. Also, the adaptive management approach of Amendment 18 enables the Council and NMFS to adjust the regulatory regime governing the shallow-set longline fishery to ensure its sustainability and continued conservation of protected species (see Section 4.4.1.3).

National Standard 7 states that conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

The proposed action is consistent with National Standard 7 because it would implement management measures that are simple, yet effective and do not unnecessarily duplicate existing regulations or data collection programs. For example, elimination of the shallow-set certificates program under the proposed action would provide NMFS with some savings through reduction in administrative costs (see Section 4.2.2).

National Standard 8 states that conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities.

The propose action is consistent with National Standard 8 because it maintains continued opportunities for participants in the Hawaii longline fleet to harvest swordfish in a profitable and sustainable manner (see Section 4.2.2.4).

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 proposed action is consistent with National Standard 9 because it would maintain the requirements to use circle hooks and mackerel bait shown to significantly reduce and mitigate sea turtle bycatch, as well as seabird mitigation measures such as night-setting (Section 1.4). The majority of fish bycatch in the shallow-set fishery is blue sharks of which approximately 94 percent are released alive.

National Standard 10 states that conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

The proposed action is consistent with National Standard 10 because it does not require or promote any changes to current fishing practices and they continue to promote the safety of human life at sea. Furthermore, it will result in a less restrictive fishery management regime that may reduce fishing effort in the first quarter when weather on the fishing grounds is worst and potentially the most hazardous. Measures already in place which promote safety at sea include the use of limited access programs; workshops to educate fishery participants on sea turtle release methods and safety issues; and changes in longline gear requirements in response to fishermen's concerns about the use of 60 g weighted swivels in association with side-setting.

5.2 Essential Fish Habitat

None of the alternatives considered in this FMP amendment are expected to result in adverse impacts to Essential Fish Habitat (EFH) or Habitat Areas of Particular Concern (HAPC) for species managed under the FMPs of the Western Pacific Region (Table 65). The alternatives are not likely to lead to substantial physical, chemical, or biological alterations to the oceanic and coastal habitat, or result in any alteration to waters and substrate necessary for spawning, breeding, feeding, and growth of harvested species or their prey.

Longline is a form of hook-and-line that causes few fishing-related impacts to the benthic habitat of bottomfish, crustaceans, coral reefs, and precious corals. The current management regime protects habitat through prohibitions on the use of bottom-set nets, bottom trawls, explosives, and poisons. None of the alternatives will result in a change in fishing gear or operation, therefore, EFH and HAPC maintain the same level of protection.

Table 65: EFH and HAPC for Management Unit Species of the Western Pacific Region

MUS	EFH (Juveniles and Adults)	EFH (Eggs and Larvae)	HAPC
Pelagic	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	Water column and bottom from 80 to 600 m, bounded by 29° –35° N and 171° E – 179° W (adults only)	Epipelagic zone (0–200 nm) bounded by 29° –35° N and 171° E -179° W (includes juveniles)	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 ecosystem	Water column and benthic substrate to a depth of 100 m	Water column and benthic substrate to a depth of 100 m	All MPAs identified in the FMP, all PRIA, many specific areas of coral reef habitat (see Chapter 6)

Note: All areas are bounded by the shoreline, and the seaward boundary of the EEZ, unless otherwise indicated.

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Chapter 6: Consistency with other Applicable Laws

6.1 National Environmental Policy Act

To comply with NEPA, a draft Supplemental Environmental Impact Statement (SEIS) was prepared to analyze alternatives considered herein. A Notice of Intent to prepare the draft SEIS was published in the *Federal Registe*r in August 2007 (72 FR 46608). See section 1.5 for further information on NEPA.

A 45-day comment period was provided to allow public review of the draft SEIS. In addition to publishing a Notice of Availability in the Federal Register (73 FR 49667, August 22, 2008), NMFS held a public informational meeting in Honolulu on September 24, 2008 to inform the public of the proposed changes to the shallow-set fishery and to review the NEPA analyses. All public comments received (in summarized form) during the public comment period, and responses to them are included in Appendix VII.

NEPA also requires the following environmental management issues be considered when evaluating a proposed action:

Energy Requirements and Conservation Potential of the Alternatives and Mitigation Measures
The alternatives for effort limit levels are distinguished by the amount of fishing effort to be allowed under the FMP regulations. The vessels used to target swordfish consume energy in the form of petroleum-based fuels and electricity. If the shallow-set fishery was not authorized, it is expected that all fishery participants would switch to deep-set longline fishing for tuna. Although the trip length duration is longer for shallow-set fishing, the alternatives considered in this document are not expected to result in the consumption of significant amounts of energy.

Natural or Depletable Resource Requirements and Conservation Potential of the Alternatives and Mitigation Measures
All of the effort alternatives affect natural and depletable resources (fish). However, existing regulations and management reference points associated with overfishing and overfished resources exist to prevent significant depletion of target and non-target species, as applicable. All of the alternatives considered would manage the affected stocks sustainably and ensure appropriate conservation of the resources.

Urban Quality, Historic and Cultural Resources, and Design of the Built Environment Including the Reuse and Conservation Potential of the Alternatives and Mitigation Measures
None of the alternatives would have an appreciable effect on urban quality or design of the built environment because of the relatively small size of the shallow-set fishing fleet and its shore-side supporting infrastructure.

Possible Conflicts between the Proposed Action and Other Land Use Plans
The alternatives considered in this SEIS do not conflict with the objectives or provisions of any other proposed action or other land use plans as the management objective of the shallow-set fishery is to provide for a sustainable fishery while minimizing bycatch of protected species. The proposed action does not preclude the development of a West Coast shallow-set limited entry program as this action is considered conservative in terms of available harvests of swordfish as well as impacts on protected species.

Adverse Impacts That Cannot Be Avoided
None of the alternatives propose measures that would produce unavoidable adverse impacts.

The Relationship Between Local Short-Term Uses of the Human Environment and the Maintenance and Enhancement of Long-Term Productivity
The alternatives considered are not expected to have negative impacts on the long-term productivity of any ecosystem.

Irreversible and Irretrievable Commitments of Resources Involved in the Proposed Action
Nonrenewable resources consumed in the industry include the energy used in fishing operations and ancillary businesses, as well as the materials used to construct the physical assets used in the industry, although some of these assets would be available for reuse if taken out of use in shallow-set fishing. None of the alternatives considered would result in irreversible or irretrievable commitments of resources. The proposed actions would continue to result in sustainable fishing on target and non-target stocks and would not jeopardize the continued existence of any protected species.

Permits, Licenses, and Approvals Necessary to Implement the Proposed Action
No permits or approvals outside the purview of NMFS are required for this action.

6.2 Regulatory Flexibility Act

In order to meet the requirements of the Regulatory Flexibility Act (RFA), 5 U.S.C. 601 et seq. requires government agencies to assess the impact of their regulatory actions on small businesses and other small entities via the preparation of regulatory flexibility analyses. The RFA requires government agencies to assess the impact of significant regulatory actions on small businesses and other small organizations. The purpose and need for the management action considered in this FMP amendment is described in Chapter 1, and the alternatives considered are discussed in Chapters 2 and the potential impacts of the alternatives are discussed in Chapter 4. Because some of the alternatives may have a significant impact on a substantial number of small entities for the purposes of the RFA, an Initial Regulatory Flexibility Analysis has been prepared (See Appendix V).

6.3 Executive Order 12866

In order to meet the requirements of Executive Order 12866 (E.O. 12866), NMFS requires that a Regulatory Impact Review 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 proposed 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. In accordance with E.O. 12866, it is the Council's position that: (1) The proposed action is not likely to have an annual effect on the economy of more than $100 million or to adversely affect in a material way the economy, a sector of the economy, productivity, jobs, the environment, public health or safety, or state, local, or tribal governments or communities; (2) This proposed action is not likely to create any serious inconsistencies or otherwise interfere with any action taken or planned by another agency; (3) The proposed action is not likely to materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights or obligations of recipients thereof; and (4) The proposed action is not likely to raise novel or policy issues arising out of legal mandates, or the principles set forth in the Executive Order.

The alternatives considered in this FMP amendment are anticipated to yield net economic benefits to the nation by improving our ability to maintain healthy and productive marine ecosystems, and foster the long-term sustainable use of marine resources in an ecologically and culturally sensitive manner that relies on the use of a science-based ecosystem approach to resource conservation and management. Please see Appendix V for more discussion of this topic.

6.4 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 the enforceable polices of an affected state's approved coastal zone management program. A copy of the draft SEIS was submitted on August 7, 2008 to the appropriate state government agencies in Hawaii for review and concurrence with a determination that the recommended measures are consistent, to the maximum extent practicable, with the State coastal zone management program. On October 6, 2008 NMFS received a response from the State of Hawaii concurring with the NMFS' determination that the proposed amendment is consistent with the Hawaii Coastal Zone Management Program based on the following condition: that no taking of any endangered or threatened species within State of Hawaii waters, i.e., within 3 nautical miles of shore shall occur.

6.5 Endangered Species Act

The ESA requires that any action authorized, funded, or carried out by a federal agency ensure its implementation would not jeopardize the continued existence and recovery of listed species or adversely modify their critical habitat. Species listed as endangered or threatened under the ESA that have been observed, or may occur, in the action area are listed below (and are described in more detail in Chapter 3):

- All Pacific sea turtles including the following: olive ridley sea turtles (*Lepidochelys olivacea*), leatherback sea turtles (*Dermochelys coriacea*), hawksbill sea turtles (*Eretmochelys imbricata*), loggerhead sea turtles (*Caretta caretta*), and green sea turtles (*Chelonia mydas*).

- The humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), North Pacific right whale (*Eubalaena japonica*), and sei whale (*B. borealis*). In addition, one endangered pinniped, the Hawaiian monk seal (*Monachus schauinslandi*).

- The short-tailed albatross (*Phoebastria albatrus*).

An informal consultation under the ESA was initiated on August 27, 2008, with the U.S. Fish and Wildlife Service (USFWS) on the effects of Amendment 18 on the endangered short-tailed albatross. On September 24, 2008, the U.S. Fish and Wildlife Service concurred with NMFS determination that the proposed modifications to Hawaii shallow-set longline fishery under Pelagics FMP Amendment 18 may affect, but are not likely to adversely affect the short-tailed albatross during a one-year period beginning January 1, 2009 through December 31, 2009.

On October 15, 2008, NMFS issued a Biological Opinion on Management Modifications for the Hawaii-based Shallow-set Longline Swordfish Fishery – Implementation of Pelagic FMP Amendment 18. The biological opinion concluded that the proposed action is not likely to jeopardize the continued existence of ESA-listed humpback whales, loggerhead sea turtles, leatherback sea turtles, olive ridley sea turtles, green sea turtles, and hawksbill sea turtles. Critical habitat has not been designated in the proposed action area, so no critical habitat would be affected by the proposed action.

Existing Biological Opinions

NMFS issued a BiOp on February 23, 2004, following a consultation under section 7 of the ESA on the ongoing operation of the western Pacific region's pelagic fisheries as managed under the Pelagic FMP. The opinion concluded that the fisheries were not likely to jeopardize the continued existence and recovery of any threatened or endangered species under NMFS' jurisdiction or destroy or adversely modify critical habitat that has been designated for them. Although not considered in NMFS' BiOp, the Council has undertaken five off-site sea turtle conservation projects. These projects are aimed at protecting and enhancing affected sea turtle populations on their nesting beaches and in their nearshore foraging grounds at sites in Southeast Asia, Mexico, and Japan.

On October 4, 2005 NMFS issued a BiOp on the ongoing operations of the deep-set sector of the Hawaii-based longline fishery. The opinion concluded that the deep-set sector was not likely to jeopardize the continued existence and recovery of any humpback whales, or green, leatherback, loggerhead, or olive ridley sea turtles.

On November 18, 2002, the U.S. Fish and Wildlife Service issued a BiOp on the potential impacts of the entire Hawaii-based domestic longline fishery on the short-tailed albatross. The opinion concluded that the fishery is not likely to jeopardize the continued existence and recovery of the short-tailed albatross.

On October 8, 2004, the U.S. Fish and Wildlife Service issued a BiOp on the potential impacts of the shallow-set sector of the Hawaii-based pelagic longline fishery on the short-tailed albatross. The opinion concluded that the shallow-set sector is not likely to jeopardize the continued existence and recovery of the short-tailed albatross.

6.6 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) establishes a comprehensive federal program for the protection and management of marine mammals occurring within U.S. jurisdiction. With respect to commercial fishing, section 118(b) of the MMPA establishes a goal of reducing incidental mortality and serious injury of marine mammals to insignificant levels approaching zero. Under section 118 of the MMPA, NMFS must publish, at least annually, a List of Fisheries (LOF) that classifies U.S. commercial fisheries into one of three categories. These categories are based on the level of serious injury and mortality of marine mammals that occurs incidental to each fishery. Specifically, the MMPA mandates that each fishery be classified according to whether it has frequent, occasional, remote, or no likelihood of incidental mortality or serious injury of marine mammals.

NMFS uses fishery classification criteria, which consist of a two-tiered, stock-specific approach. This two-tiered approach first addresses the total impact of all fisheries on each marine mammal stock and then addresses the impact of individual fisheries on each stock. This approach is based on the rate, in numbers of animals per year, of incidental mortalities and serious injuries of marine mammals due to commercial fishing operations relative to a stock's Potential Biological Removal (PBR) level. The PBR level is defined in 50 CFR 229.2 as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population.

Tier 1:
If the total annual mortality and serious injury across all fisheries that interact with a stock is less than or equal to 10 percent of the PBR level of this stock, all fisheries interacting with this stock would be placed in Category III. Otherwise, these fisheries are subject to the next tier of analysis to determine their classification.

Tier 2:
Category I: Annual mortality and serious injury of a stock in a given fishery is greater than or equal to 50 percent of the PBR level.
Category II: Annual mortality and serious injury of a stock in a given fishery is greater than 1 percent and less than 50 percent of the PBR level.
Category III: Annual mortality and serious injury of a stock in a given fishery is less than or equal to 1 percent of the PBR level.

In the MMPA List of Fisheries, NMFS has classified the Hawaii longline fishery as a single fishery for many years. In 2004, the single longline fishery was placed in Category I due to takes of false killer whales in excess of the PBR for the stock or portion of the stock designated as the Hawaii EEZ stock of false killer whales. A recent review of fishery interaction data has led NMFS to propose revisions in the proposed List of Fisheries for 2008 (73 FR 33760, June 13, 2008). Under the proposed rule, the deep-set and shallow-set fisheries would be considered as separate fisheries, with each to be categorized independently based on its characteristics and interactions with marine mammals. The deep-set fishery (which has a history of interacting with false killer whales) would be placed in Category I; the shallow-set fishery (which has no history of interacting with false killer whales) would be placed in Category II. In the proposed rule, NMFS identifies the species of marine mammals with which there are interactions and the basis for the category proposed for each longline fishery.

Under existing regulations, all fishers participating in Category I or II fisheries must register under the MMPA, obtain an Authorization Certificate, and pay a fee of $25. Additionally, fishers may be subject to a take reduction plan and requested to carry an observer. The Authorization Certificate authorizes the taking of marine mammals incidental to commercial fishing operations. The regulations governing Category III fisheries (found at 50.CFR 229.5) are listed below:

§ 229.5 Requirements for Category III fisheries.

- (a) *General.* Vessel owners and crew members of such vessels engaged only in Category III fisheries may incidentally take marine mammals without registering for or receiving an Authorization Certificate.
- (b) *Reporting.* Vessel owners engaged in a Category III fishery must comply with the reporting requirements specified in §229.6.
- (c) *Disposition of marine mammals.* Any marine mammal incidentally taken must be immediately returned to the sea with a minimum of further injury unless directed otherwise by NMFS personnel, a designated contractor, or an official observer, or authorized otherwise by a scientific research permit in the possession of the operator.
- (d) *Monitoring.* Vessel owners engaged in a Category III fishery must comply with the observer requirements specified under §229.7(d).
- (e) *Deterrence.* When necessary to deter a marine mammal from damaging fishing gear, catch, or other private property, or from endangering personal safety, vessel owners and crew members engaged in commercial fishing operations must comply with all

deterrence provisions set forth in the MMPA and any other applicable guidelines and prohibitions.

- (f) *Self-defense.* When imminently necessary in self-defense or to save the life of a person in immediate danger, a marine mammal may be lethally taken if such taking is reported to NMFS in accordance with the requirements of §229.6.
- (g) *Emergency regulations.* Vessel owners engaged in a Category III fishery must comply with any applicable emergency regulations.

6.7 Migratory Bird Treaty Act

The MBTA, 16 U.S.C. §§ 703-12, is a criminal statute that prohibits the "taking" or "killing" of listed migratory birds, except as authorized under permits issued by the U.S. Fish and Wildlife Service (USFWS). The MBTA generally applies to activities within the United States and adjacent waters within 3 nautical miles, where commercial longline activities are prohibited. The MBTA contains no provision for the incidental (i.e., unintentional or inadvertent) take of migratory birds during commercial fishing activities conducted outside of nearshore waters. Accordingly, NMFS does not interpret MBTA to proscribe otherwise lawful short-set fishery activities merely because they have the potential to interact with migratory birds. (70 FR. 75075, 75076, Dec. 19, 2005).

In addition, after completing the public review and comment processes afforded by the MSA and NEPA, and after consulting with USFWS regarding the potential for incidental take of short-tailed albatross, the Council and NMFS have implemented specific seabird conservation measures. These measures are in effect under all of the action alternatives, apply to fishery participants, require monitoring and reporting of seabird incidental take, and require the use of reasonable and effective methods to minimize seabird incidental rates in the shallow-set fishery. As implemented, these measures have dramatically reduced incidental take of seabirds in the shallow-set fishery to levels that are not expected to have significant adverse short term, long-term, or cumulative effects on affected seabird populations, even when considering the impacts of increased mortalities under Alternatives 1B-1E.

6.8 Paperwork Reduction Act

The purpose of the Paperwork Reduction Act (PRA) is to minimize the burden on the public by ensuring that any information requirements are needed and are carried out in an efficient manner (44 U.S.C. 350191(1)). This amendment contains no new reporting requirements and all existing requirements were lawfully approved and have been issued the appropriate OMB control numbers.

6.9 Information Quality Act

The information in this document complies with the Information Quality Act and NOAA standards (NOAA Information Quality Guidelines, September 30, 2002) that recognize information quality is composed of three elements: utility, integrity, and objectivity. Central to the preparation of this regulatory amendment is objectivity that consists of two distinct elements: presentation and substance. The presentation element includes whether disseminated information is presented in an accurate, clear, complete, and unbiased manner and in a proper context. The substance element involves a focus on ensuring accurate, reliable, and unbiased information. In a scientific, financial, or statistical context, the original and supporting data shall be generated, and the analytic results shall be developed, using sound statistical and research methods.

At the same time the federal government has recognized that “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, marine ecosystems), this does not suggest that perfect information is required for management and conservation measures to proceed. In brief, it does suggest that caution be taken but that it not lead to paralysis until perfect information is available. This document has been prepared using the best available information and made a broad presentation of it. The process of public review of this document provided an opportunity for comment and challenge to this information, as well as for the provision of additional information.

6.10 Executive Order 13112 (Invasive Species)

Executive Order 13112 requires agencies to use authorities to prevent introduction of invasive species, respond to, and control invasions in a cost effective and environmentally sound manner, and to provide for restoration of native species and habitat conditions in ecosystems that have been invaded. Executive Order 13112 also provides that agencies shall not authorize, fund, or carry out actions that are likely to cause or promote the introduction or spread of invasive species in the U.S. or elsewhere unless a determination is made that the benefits of such actions clearly outweigh the potential harm, and that all feasible and prudent measures to minimize the risk of harm will be taken in conjunction with the actions. The Council has adopted several recommendations to increase the knowledge base of issues surrounding potential introductions of invasive species into waters included under its jurisdiction. The first recommendation is to conduct invasive species risk assessments by characterizing the shipping industry, including fishing, cargo, military, and cruise ships in the Western Pacific Region. This assessment will include a comparative analysis of the risk posed by U.S. fishing vessels in the western Pacific with other vectors of marine invasive species.

The second recommendation is to develop a component in the Council’s existing education program to educate fishermen on invasive species issues and inform the fishing industry of methods to minimize and mitigate the potential for inadvertent introduction of alien species to island ecosystems.

6.11 Executive Order 13089 (Coral Reef Protection)

In June 1998 the President signed an Executive Order for Coral Reef Protection (E.O. 13089), which established the Coral Reef Task Force (CRTF) and directed all Federal agencies with coral reef-related responsibilities to develop a strategy for coral reef protection. Federal agencies were directed to work cooperatively with state, territorial, commonwealth, and local agencies; non-governmental organizations; the scientific community; and commercial interests to develop the plan. The Task Force was directed to develop and implement a comprehensive program of research and mapping to inventory, monitor, and address the major causes and consequences of degradation of coral reef ecosystems. The Order directs federal agencies to use their authorities to protect coral reef ecosystems and, to the extent permitted by law, prohibits them from authorizing, funding, or carrying out any actions that will degrade these ecosystems.

Of particular interest to the Council is the implementation of measures to address: (1) fishing activities that may degrade coral reef ecosystems, such as overfishing, which could affect ecosystem processes (e.g., the removal of herbivorous fishes leading to the overgrowth of corals by algae) and destroy the availability of coral reef resources (e.g., extraction of spawning aggregations of groupers); (2) destructive fishing techniques, which can degrade EFH and are thereby counter to the Magnuson-Stevens Act; (3) removal of reef substrata; and (4) discarded and/or derelict fishing gear, which can degrade EFH and cause “ghost fishing.”

To meet the requirements of Executive Order 13089, the Coral Reef Task Force issued the National Action Plan to Conserve Coral Reefs in March 2000. In response to the recommendations outlined in the Action Plan, the President announced Executive Order 13158 (Marine Protected Areas), which is designed to strengthen and expand Marine Protected Areas. The shallow-set fishery does not harvest coral reef species nor does its operation occur in the coral reef ecosystems. Materials associated with fishing operations could be incidentally lost while at sea and end up in coral reef ecosystems contributing to some impacts; however, the rate of this occurrence is estimated to be rare. Disposing of gear or waste at sea is illegal, and enforced by the USCG.

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Chapter 7: Proposed Regulations

The proposed regulations associated with the preferred alternatives in this document are presented in their entirety for clarity, with deletions indicated using strikethrough and additions indicated by double underlines.

§ 665.22 Prohibitions.

In addition to the prohibitions specified in Part 600 § 600.725 of this chapter, it is unlawful for any person to do any of the following:

(a) Falsify or fail to make and/or file all reports of Pacific pelagic management unit species landings, containing all data and in the exact manner, as required by applicable state law or regulation, as specified in § 665.3, provided that the person is required to do so by applicable state law or regulation.

(b) Use a vessel without a valid permit issued under the High Seas Fishing Compliance Act to fish for Pacific pelagic management unit species using longline gear, on the high seas, in violation of §§ 300.15 and 665.21(a) of this title.

(c) Use a vessel in the EEZ around the Hawaiian Archipelago without a valid Hawaii longline limited access permit registered for use with that vessel, to fish for Pacific pelagic management unit species using longline gear, in violation of § 665.21(b)(1).

(d) Use a vessel shoreward of the outer boundary of the EEZ around the Hawaiian Archipelago without a valid Hawaii longline limited access permit registered for use with that vessel, to land or transship Pacific pelagic management unit species that were harvested with longline gear, in violation of § 665.2l(b)(2).

(e) Use a vessel in the EEZ around American Samoa without a valid American Samoa longline limited access permit registered for use with that vessel, to fish for Pacific pelagic management unit species using longline gear, in violation of § 665.21(c)(1)

(f) Use a vessel shoreward of the outer boundary of the EEZ around American Samoa without a valid American Samoa longline limited access permit registered for use with that vessel, to land Pacific pelagic management unit species that were caught with longline gear within the EEZ around American Samoa, in violation of § 665.21(c)(2).

(g) Use a vessel within the EEZ around American Samoa without a valid American Samoa longline limited access permit registered for use with that vessel, to transship Pacific pelagic management unit species that were caught with longline gear, in violation of § 665.21(c)(3).

(h) Use a vessel in the EEZ around Guam, the Northern Mariana Islands, or the Pacific remote island areas (with the exception of Midway Atoll) without either a valid Western Pacific general longline permit, American Samoa longline limited access permit or a Hawaii longline limited access permit registered for use with that vessel, to fish for Pacific pelagic management unit species using longline gear, in violation of § 665.21(d)(l).

(i) Use a vessel shoreward of the outer boundary of the EEZ around Guam, the Northern Mariana Islands, or the Pacific remote island areas (with the exception of Midway Atoll) without either a valid Western Pacific general longline permit, American Samoa longline limited access permit or a Hawaii longline limited access permit registered for use with that vessel, to land or transship Pacific pelagic management unit species that were harvested using longline gear, in violation of § 665.21(d)(2).

(j) Use a vessel in the Western Pacific Fishery Management Area to land or transship Pacific pelagic management unit species caught by other vessels using longline gear, without a valid receiving vessel permit registered for use with that vessel, in violation of § 665.21(e).

(k) Use a vessel in the EEZ around the PRIA employing handline or trolling methods to fish for Pacific pelagic management unit species without a valid PRIA pelagic troll and handline fishing permit registered for use for that vessel, in violation of § 665.21(f).

(l) Fish in the fishery after failing to comply with the notification requirements in § 665.23.

(m) Fail to comply with notification requirements set forth in § 665.23 or in any EFP issued under § 665.17.

(n) Fail to comply with a term or condition governing the vessel monitoring system when using a vessel registered for use with a Hawaii longline limited access permit, or a vessel registered for use with a size Class C or D American Samoa longline limited access permit, in violation of § 665.25.

(o) Fish for, catch, or harvest Pacific pelagic management unit species with longline gear without a VMS unit on board the vessel after installation of the VMS unit by NMFS, in violation of § 665.25(d)(2).

(p) Possess on board a vessel without a VMS unit Pacific pelagic management unit species harvested with longline gear after NMFS has installed the VMS unit on the vessel, in violation of § 665.25(d)(2).

(q) Interfere with, tamper with, alter, damage, disable, or impede the operation of a VMS unit or to attempt any of the same; or to move or remove a VMS unit without the prior permission of the SAC in violation of § 665.25(d)(3).

(r) Make a false statement, oral or written, to an authorized officer, regarding the use, operation, or maintenance of a VMS unit, in violation of § 665.25(d)(l).

(s) Interfere with, impede, delay, or prevent the installation, maintenance, repair, inspection, or removal of a VMS unit, in violation of § 665.25(d)(l).

(t) Interfere with, impede, delay, or prevent access to a VMS unit by a NMFS observer, in violation of § 665.28(f)(4).

(u) Connect or leave connected additional equipment to a VMS unit without the prior approval of the SAC, in violation of § 665.25(e).

(v) Fish with longline gear within a longline fishing prohibited area, except as allowed pursuant to an exemption issued under § 665.17 or § 665.27, in violation of § 665.26.

(w) Fish for Pacific pelagic management unit species with longline gear within the protected species zone, in violation of § 665.26(b).

(x) Fail to comply with a term or condition governing the observer program established in § 665.28 if using a vessel registered for use with a Hawaii longline limited access permit, or a vessel registered for use with a size Class B, C or D American Samoa longline limited access permit, to fish for Pacific pelagic management unit species using longline gear.

(y) Fail to comply with other terms and conditions that the Regional Administrator imposes by written notice to either the permit holder or the designated agent of the permit holder to facilitate the details of observer placement.

(z) Fail to fish in accordance with the seabird take mitigation techniques set forth at § 665.35(a)(1) or § 665.35(a)(2) when operating a vessel registered for use under a Hawaii longline limited access permit in violation of § 665.35(a).

(aa) When operating a vessel registered for use under a American Samoa longline limited access permit or a Hawaii longline limited access permit, fail to comply with the sea turtle handling, resuscitation, and release requirements, in violation of § 665.32(b).

(bb) ~~Engage in shallow-setting without a valid shallow-set certificate for each shallow set made, in violation of § 665.33(c).~~ Engage in shallow-setting from a vessel registered for use under a Hawaii longline limited access permit without a NMFS observer on board the vessel in violation of § 665.33(h).

(cc) Own or operate a vessel registered for use under any longline permit issued under § 665.21 while engaged in longline fishing for Pelagic Management Unit Species and fail to be certified for completion of a NMFS protected species workshop, in violation of § 665.34(a).

(dd) Own or operate a vessel registered for use under any longline permit issued under § 665.21 while engaged in longline fishing for Pelagic Management Unit Species without having on board a valid protected species workshop certificate issued by NMFS or a legible copy thereof, in violation of § 665.34(d).

(ee) Possess light sticks on board a vessel registered for use under a Hawaii longline limited access permit at any time during a trip for which notification to NMFS under § 665.23(a) indicated that deep-setting would be done, in violation of § 665.33(b~~d~~).

(ff) Fail to carry, or fail to use, a line clipper, dip net, or dehooker on a vessel registered for use under any longline permit issued under § 665.21, in violation of § 665.32.

(gg) Engage in shallow-setting from a vessel registered for use under a Hawaii longline limited access permit north of the equator (0° lat.) with hooks other than offset circle hooks sized 18/0 or larger, with a 10° offset, in violation of § 665.33(c~~f~~).

(hh) Engage in shallow-setting from a vessel registered for use under a Hawaii longline limited access permit north of the equator (0° lat.) with bait other than mackerel-type bait, in violation of § 665.33(d~~g~~).

(ii) When operating a vessel registered for use under any longline permit issued under § 665.21 or operating a vessel using hooks to target Pelagic Management Unit Species while fishing under the Pelagics FMP, fail to comply with the sea turtle handling requirements, in violation of § 665.32(b).

(jj) Engage in shallow-setting from a vessel registered for use under any longline permit issued under § 665.21 north of the Equator (0° lat.) with hooks other than offset circle hooks sized 18/0 or larger, with a 10° offset, in violation of § 665.33(c~~f~~).

(kk) Engage in shallow-setting from a vessel registered for use under any longline permit issued under § 665.21 north of the Equator (0° lat.) with bait other than mackerel-type bait, in violation of § 665.33(d~~g~~).

(ll) Operate a vessel registered for use under a Hawaii longline limited access permit while engaged in longline fishing without having on board a valid protected species workshop certificate issued by NMFS or a legible copy thereof, in violation of § 665.34(d).

(mm) Fail to use a line setting machine or line shooter, with weighted branch lines, to set the main longline when operating a vessel that is registered for use under a Hawaii longline limited access permit and equipped with monofilament main longline, when making deep sets north of 23° N. lat., in violation of § 665.35(a)(l) or (a)(2).

(nn) Fail to employ basket-style longline gear such that the mainline is deployed slack when operating a vessel registered for use under a Hawaii longline limited access north of 23° N. lat., in violation of § 665.35(a)(3).

(oo) Fail to maintain and use blue dye to prepare thawed bait when operating a vessel registered for use under a Hawaii longline limited access permit that is fishing north of 23° N. lat., in violation of § 665.35(a)(4), (a)(5), or (a)(6).

(pp) Fail to retain, handle, and discharge fish, fish parts, and spent bait, strategically when operating a vessel registered for use under a Hawaii longline limited access permit that is fishing north of 23° N. lat., in violation of § 665.35(a)(7), through (a)(9).

(qq) Fail to be begin the deployment of longline gear at least 1 hour after local sunset or fail to complete the setting process before local sunrise from a vessel registered for use under a Hawaii longline limited access permit while shallow-setting north of 23° N. lat., in violation of § 665.35(a)(l).

(rr) Fail to handle short-tailed albatrosses that are caught by pelagic longline gear in a manner that maximizes the probability of their long-term survival, in violation of § 665.35(b).

(ss) Engage in shallow-setting from a vessel registered for use under a Hawaii longline limited access permit after the shallow-set component of the longline fishery has been closed pursuant to § 665.33(ab), in violation of § 665.33(fi).

(tt) Fail to immediately retrieve longline fishing gear upon receipt of actual notice that the shallow-set component of the longline fishery has been closed pursuant to § 665.33(ab), in violation of
§ 665.33(fi).

(uu)-(vv) [Reserved]

(ww) Fail to handle seabirds other than short-tailed albatrosses that are caught by pelagic longline gear in a manner that maximizes the probability of their long-term survival, in violation of § 665.35(c).

(xx) Use a large vessel to fish for Pelagic management unit species within an American Samoa large vessel prohibited area except as allowed pursuant to an exemption issued under § 665.38.

(yy) Fish for Pacific pelagic management unit species using gear prohibited under § 665.30 or not permitted by an EFP issued under § 665.17.

§ 665.33 Western Pacific longline fishing restrictions.

~~(a) *Annual Effort Limit on shallow-setting by Hawaii longline vessels.* (1) A maximum annual limit of 2,120 is established on the number of shallow-set certificates that will be made available each calendar year to vessels registered for use under Hawaii longline limited access permits.~~

~~(2) The Regional Administrator will divide the 2,120-set annual effort limit each calendar year into equal shares such that each holder of a Hawaii longline limited access permit who provides notice of interest to the Regional Administrator no later than November 1 prior to the start of the calendar year, pursuant to paragraph (a)(3) of this section, receives one share for each permit held. If such division would result in shares containing a fraction of a set, the annual effort limit will be adjusted downward such that each share consists of a whole number of sets.~~

~~(3) Any permit holder who provides notice according to this paragraph is eligible to receive shallow-set certificates. In order to be eligible to receive shallow-set certificates. for a given calendar year, holders of Hawaii longline limited access permits must provide written notice to the Regional Administrator of their interest in receiving such certificates no later than November 1 prior to the start of the calendar year, except for 2004, the notification deadline for which is May 1, 2004.~~

~~(4) No later than December 1 of each year, the Regional Administrator will send shallow-set certificates valid for the upcoming calendar year to all holders of Hawaii longline limited access permits, as of the just previous November 1, that provided notice of interest to the Regional Administrator pursuant to paragraph (a)(3) of this section. The Regional Administrator will send shallow-set certificates valid for 2004 no later than June 1, 2004, based on permit holders as of May 1, 2004.~~

(a~~b~~) *Annual Limits on sea turtle interactions.* (1) Maximum annual limits are established on the numbers of physical interactions that occur each calendar year between leatherback and loggerhead sea turtles and vessels registered for use under Hawaii longline limited access permits while shallow-setting. ~~The limits are based on the annual numbers of the two turtle species expected to be captured in the shallow-set component of the Hawaii-based fishery, as indicated in the incidental take statement of the biological opinion issued by the National Marine Fisheries Service pursuant to section 7 of the Endangered Species Act. If the numbers in the incidental take statement are modified or if a new biological opinion is issued, new rule-making will be undertaken to change the interaction limits accordingly.~~ The annual leatherback sea turtle *(Dermochelys coriacea)* interaction limit is sixteen (16) and the annual loggerhead sea turtle *(Caretta caretta)* interaction limit is forty-six (46).

(i) In the event that either one or both of the annual sea turtle interaction limits is exceeded during any calendar year, the annual sea turtle interaction limit or limits, as appropriate, will be adjusted downward by the amount exceeded during the following calendar year.

(ii) As applicable, in January of each year, or as soon as practicable thereafter, the Regional Administrator shall file for publication at the Office of the Federal Register a notification of the applicable annual sea turtle interaction limits established pursuant to paragraph (a)(i) of this section.

(~~2~~3) Upon determination by the Regional Administrator that, based on data from NMFS observers, either of the two sea turtle interaction limits has been reached during a given calendar year:

(i) As soon as practicable, the Regional Administrator shall file with the Office of the Federal Register for publication, notification of closure when a sea turtle interaction limit has been reached. The notification of closure shall include an advisement that the shallow-set component of the longline fishery shall be closed and that shallow-setting north of the equator by vessels registered for use under Hawaii longline limited access permits shall be prohibited as of the date specified in the closure notification until the end of the calendar year in which the sea turtle interaction limit was reached. The closure date specified by the Regional Administrator shall not be earlier than seven (7) days after the date of filing of the notification of closure for public inspection at the Office of the Federal Register. Coincidental with the filing of the notification of closure with the Office of the Federal Register, the Regional Administrator shall provide appropriate notice via telephone, radio, electronic mail, facsimile, or U.S. mail, to all vessel operators and holders of Hawaii longline limited access permits, that the shallow-set component of the longline fishery shall be closed and that shallow-setting north of the equator by vessels registered for use under Hawaii longline limited access permits will be prohibited beginning at a specified date.

(ii) Beginning on the date specified in the notification of closure published in the Federal Register under paragraph (a~~b~~)(3)(i) of this section until the end of the calendar year in which the sea turtle interaction limit was reached, shallow-setting north of the equator by vessels registered for use under the Hawaii longline limited access permit shall be prohibited.

~~(c) Owners and operators of vessels registered for use under a Hawaii longline limited access permit may engage in shallow-setting north of the equator (0° lat.) providing that there is on board one valid shallow-set certificate for every shallow-set that is made north of the equator (0° lat.) during the trip. For each shallow-set made north of the equator (0° lat.) vessel operators must submit one valid shallow-set certificate to the Regional Administrator. The certificate must be attached to the original logbook form that corresponds to the shallow-set and that is submitted to the Regional Administrator within 72 hours of each landing of management unit species as required under § 665.14.~~

(b~~d~~) Vessels registered for use under a Hawaii longline limited access permit may not have on board at any time during a trip for which notification to NMFS under § 665.23(a) indicated that deep-setting would be done any float lines less than 20 meters in length or light sticks. As used in this paragraph "float line" means a line used to suspend the main longline beneath a float and "light stick" means any type of light emitting device, including any fluorescent "glow bead", chemical, or electrically powered light that is affixed underwater to the longline gear.

~~(e) Shallow-set certificates may be transferred only to holders of Hawaii longline limited access permits.~~

(c~~f~~) Owners and operators of vessels registered for use under a Hawaii longline limited access permit must use only offset circle hooks sized 18/0 or larger, with 10° offset, when shallow-setting north of the equator (0° lat.). As used in this paragraph, an offset circle hook sized 18/0 or larger is one whose outer diameter at its widest point is no smaller than 1.97 inches (50 mm) when measured with the eye of the hook on the vertical axis (y-axis) and perpendicular to the horizontal axis (x-axis). As used in this paragraph, a 10° offset is measured from the barbed end of the hook and is relative to the parallel plane of the eyed-end, or shank, of the hook when laid on its side.

(d~~g~~) Owners and operators of vessels registered for use under a Hawaii longline limited access permit must use only mackerel-type bait when shallow-setting north of the equator (0° lat.). As used in this paragraph, mackerel-type bait means a whole fusiform fish with a predominantly blue, green, or grey back and predominantly grey, silver, or white lower sides and belly.

(e~~h~~) Owners and operators of vessels registered for use under a Hawaii longline limited access permit may make sets only of the type (shallow-setting or deep-setting) indicated in the notification to NMFS pursuant to § 665.23(a).

(f~~i~~) Vessels registered for use under Hawaii longline limited access permits may not be used to engage in shallow-setting north of the equator (0° lat.) any time during which the shallow-set component of the longline fishery is closed pursuant to paragraph (a~~b~~)(3)(ii) of this section.

(g~~j~~)Owners and operators of vessels registered for use under a Hawaii longline limited access permit may land or possess no more than 10 swordfish from a fishing trip for which the permit holder notified NMFS under § 665.23(a) that the vessel would engage in a deep-setting trip.

(h) A vessel registered for use under a Hawaii longline limited access permit must have a NMFS observer on board the vessel whenever engaged in shallow-setting.

Chapter 8: References

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Chapter 10: Public Reivew of the DSEIS

The following agencies, organizations, and individuals were provided copies of the DSEIS for Pelagics FMP Amendment 18.

Federal Agencies/Councils

General Counsel	Enforcement and Litigation, Pacific Islands Region
Regional Administrator	Environmental Protection Agency
Chief	NMFS Office for Law Enforcement Pacific Islands Division
Administrator	NMFS Pacific Islands Regional Office
Director	NMFS Pacific Islands Fishery Science Center
Administrator	NMFS Southwest Regional Office
Executive Director	Pacific Fishery Management Council
General Counsel	Pacific Islands Region NOAA
District Commander	U.S. Coast Guard (14th District)
Director	U.S. Department of State, OES/OMC
Director	U.S. DOI, Office of Environmental Policy and Compliance
Regional Director	U.S. Fish and Wildlife Service
Executive Director	Western Pacific Fishery Management Council
Members	Western Pacific Fishery Management Council

U.S. Congressional Delegation

Senators	State of Hawaii
Representatives	State of Hawaii

State/Territory/Commonwealth Agencies/Organizations

Director	American Samoa Department of Marine and Wildlife Resources
Secretary	CNMI Department of Land and Natural Resources
Director	CNMI Division of Environmental Quality
Director	CNMI Division of Fish and Wildlife
Director	Department of Land and Natural Resources
Administrator	Division of Aquatic Resources, DLNR
Administrator	Division of Conservation and Resources Enforcement, DLNR
Administrator	Division of Forestry and Wildlife, DLNR
Director	Guam Bureau of Statistics and Plans
Director	Guam Community College
Director	Guam Department of Agriculture
Director	Guam Division of Aquatic and Wildlife Resources
Assistant	Guam Office of the Governor, Environmental Policy
Director	Hawaii Coastal Zone Management Program
Director	Hawaii Department of Land and Natural Resources

Director	Hawaii Office of Environmental Quality Control
Mayor	Honolulu City and County
Administrator	Office of Hawaiian Affairs
Director	Public Libraries, Hawaii
Director	Secretariat of the Pacific Communities
Governor	State of Hawaii
Speaker of the House	State of Hawaii, House of Representatives
Senate President	State of Hawaii, State Senate

Other Organizations

Director	BioDax Consulting, Tahiti
Director	Center for Biological Diversity
Director	Center for Marine Conservation
Managing Attorney	Earth Justice Legal Defense Fund
Director	Environmental Defense Fund
President	Guam Fishermen's Cooperative Association
President	Hawaii Audubon Society
General Manager	Hawaii Longline Association
Director	`Ilio`ulaokalani Coalition
Director	Inter-American Tropical Tuna Commision
President	KAHEA
Director	Living Oceans Program, National Audubon Society
Commodore	Maui Trailer Boat Club
President	Marine Conservation Biology Institute
Director	Marine Mammal Commission
President	Natural Resources Defense Council
Director	The Nature Conservancy, Hawaii
President	The Ocean Conservancy, Pacific Regional Office
President	Pacific Ocean Producers
Director	Sierra Club of Hawaii
Director	United Fishing Agency, Hawaii
Director	University of Hawaii Cooperative Fisheries Research Unit
Director	University of Hawaii Institute of Marine Biology
Director	University of Hawaii Law School, Environmental
Director	University of Hawaii Marine Option Program
Director	University of Hawaii Pelagic Fisheries Research Program
Director	University of Hawaii School of Law, Environmental Law
Director	Western Pacific Fisheries Coalition
President	Windward Sport Fishing Club

Media

Bureau Chief	Associated Press, Hawaii
Editor	Environment Hawaii
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News Editor	Hawaii Tribune-Herald
City Editor	Honolulu Advertiser (Oahu bureau)
Editor	Honolulu Star Bulletin (Oahu office)
Editor	Honolulu Weekly
Editor	Marianas Variety
Editor	Maui News
Editor	Molokai Advertiser-News
Editor	Pacific Business News
Editor	Pacific Daily News
Editor	Samoa News
Editor	West Hawaii Today