Endangered Species Act – Section 7 Consultation

Biological Opinion and Incidental Take Statement

Action Agency:	National Marine Fisheries Service, Pacific Islands Region, Sustainable Fisheries Division
Activity:	Continued authorization of the Hawaii-based Pelagic, Deep-Set, Tuna Longline Fishery based on the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region
Consulting Agency:	National Marine Fisheries Service, Pacific Islands Region, Protected Resources Division
Approved By:	William L. Robinson Regional Administrator, Pacific Islands Region
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1.0 Introduction

Section 7(a)(2) of the Endangered Species Act (ESA; 16 U.S.C. § 1531 et seq.) requires that each Federal agency shall ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When the action of a Federal agency may affect a protected species or critical habitat, that agency is required to consult with either the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service, depending upon the protected species or critical habitat that may be affected. For the actions described in this document, the action agency is the Sustainable Fisheries Division of NMFS, Pacific Islands Region (PIR). The consulting agency is the Protected Resources Division, also of NMFS PIR. Section 7 of the ESA contains provisions to include entities requiring formal approval or authorization from a Federal Agency as a prerequisite to conducting an action in the consultation process. Qualifying entities are referred to as 'applicants' in the formal consultation process. For purposes of this consultation, the Hawaii Longline Association (HLA) is an applicant.

NMFS issued a final biological opinion on proposed regulatory amendments to the Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region (Pelagics FMP) on February 23, 2004 (2004 BiOp) (NMFS 2004). That biological opinion considered effects of authorizing the Pelagics FMP as modified by proposed sea turtle protection measures, on threatened and endangered species under NMFS' jurisdiction. That biological opinion determined that authorization of the Pelagics FMP as modified by proposed sea turtle protection measures, was not likely to jeopardize the continued existence of threatened and endangered green turtles (*Chelonia mydas*), endangered leatherback turtles (*Demochelys coriacea*), threatened loggerhead turtles (*Caretta caretta*), or threatened and endangered olive ridley turtles (*Lepidochelys olivacea*).

The 2004 BiOp contained an Incidental Take Statement (ITS) specifying take levels of threatened and endangered sea turtles anticipated to occur incidental to the proposed action. The ITS differentiated anticipated interactions in the various components of the fishery and specified separate take levels for the Hawaii-based shallow-set longline fishery which targets swordfish; the Hawaii-based deep-set longline fishery which targets tuna; and the handline, troll, and pole and line fisheries managed under the Pelagics FMP as well as the longline fisheries based out of America Samoa. The ITS stipulated that formal consultation be reinitiated upon exceeding specified take levels. NMFS promulgated a final rule on April 2, 2004 which implemented sea turtle protection measures analyzed in the 2004 BiOp and the March 2004 Final Supplemental Environmental Impact Statement (FSEIS) (NMFS 2004a).

Incidental take limits were set for various fishery components in the 2004 BiOp, such that exceedence of take in one fishery would not require reinitiation of formal consultation in components of the fishery in which take levels were not exceeded. In 2004, the deep-set component of the Hawaii-based pelagic longline fishery was estimated to have exceeded the take of olive ridley turtles authorized in the 2004 ITS. Formal consultation on the deep-set component of the Hawaii-based pelagic longline fishery was reinitiated on February 17, 2005. The 2004 BiOp remains in effect for all other fisheries authorized under the Pelagics FMP. This Opinion supersedes the 2004 BiOp with respect to the deep-set component of the Hawaii-based pelagic longline fishery and its effects on threatened and endangered species under NMFS' jurisdiction.

Limited new information has become available since completion of the 2004 BiOp. Therefore, this Opinion will incorporate specific sections of the 2004 BiOp by reference and will be supplemented by relevant information about the deep-set fishery and affected species that has become available since completion of the 2004 BiOp. This new information is summarized in section 3.0.

2.0 Consultation History

Consultation histories for earlier consultations on the Pelagics FMP are summarized in section 1.0 of the 2004 BiOp (NMFS 2004). The sequence of events related to this formal consultation and leading up to the development of this Opinion are provided below.

On December 29, 2004, the Sustainable Fisheries Division (SFD) of NMFS PIR sent a memorandum to the Protected Resources Division (PRD) of NMFS PIR, requesting reinitiation of formal consultation on effects of the Hawaii-based pelagics, deep-set longline fishery on listed sea turtles and indicating that the Hawaii Longline Association (HLA) would be an applicant during the consultation process.

On February 7, 2005, NMFS PIR SFD and PRD staff met with NMFS Pacific Islands Fisheries Science Center staff (PIFSC), representatives from HLA, and staff of the Western Pacific Regional Fishery Management Council (Council) to discuss reinitiation and provide an overview summary of the consultation process, scope, and preliminary schedule.

On February 9, 2005, PRD responded to SFD in a memorandum requesting information on the 2004 deep-set longline fishery and observed sea turtle interactions to complete the reinitiation package for section 7 consultation.

On February 17, 2005, SFD sent a memorandum to PRD attaching the requested information necessary to complete the reinitiation package.

On March 1, 2005, PRD sent a memorandum to SFD acknowledging receipt of the additional information; confirming that formal consultation was reinitiated effective February 17, 2005; and establishing a consultation schedule.

On March 16, 2005, PRD staff presented the trigger, scope, and proposed timeline for reinitiation of formal consultation to the Council at their 126th meeting.

On March 31, 2005, PRD staff met with scientists at the PIFSC to discuss details of the analytical approach to be used in this Opinion.

On April 8, 2005, in a record to the file, the Regional Administrator (RA) of NMFS PIR issued findings and a decision pursuant to section 7(d) of the ESA, 16 U.S.C. § 1536(d). The RA concluded that the continuing operation of the deep-set pelagic tuna fishery during the consultation period would not violate the prohibition in ESA section 7(d) against making irreversible or irretrievable commitment of resources that preclude the formulation or implementation of reasonable and prudent alternatives to avoid the likelihood of jeopardy to listed species or adverse modification of critical habitat.

On May 5, 2005, PRD and PIFSC staff met with SFD and Council staff and representatives of the HLA to discuss the analytical approach developed by PRD and PIFSC, a 30 day extension to the consultation schedule, and available information and data regarding effects of the deep-set fishery on sea turtles.

On May 11, 2005, PRD and SFD called HLA to discuss an additional five day extension to the consultation period. PRD and SFD are not required to obtain consent from the applicant to extend the consultation by a period not exceeding 60 days, however PRD and SFD wanted to inform the applicant of the reasons necessary to extend the schedule and assure HLA representatives would be available to review a draft biological opinion within the revised timeline.

On May 12, 2005, PRD and SFD sent a letter to HLA informing them of the 35 day extension to the formal consultation period and notifying them that a final biological opinion would be delivered no later than August 5, 2005.

On May 13, 2005, PRD and SFD held a call with representatives from Earth Justice, The Center for Biological Diversity, Turtle Island Restoration Network, Oceana, The Ocean Conservancy, and the World Wildlife Fund to inform them of the reinitiation, timeline, scope, and analytical approach for the 2005 consultation on the deep-set component of the Hawaii-based pelagic longline fishery.

On May 13, 2005, PIR staff met with PIFSC staff to review the exposure analysis for the 2005 biological opinion.

On May 18, 2005, PRD staff presented the analytical approach for the 2005 consultation to members of the Science and Statistical Committee (SSC) of the Council at the 87th meeting of the Council's SSC.

On May 25, 2005, PRD and SFD met with PIFSC and Council staff, and representatives from HLA to discuss the proposed approach and considerations of the exposure analysis. The discussion was based on preliminary results from the exposure analysis. Because the data were preliminary, no actual numbers or conclusions were discussed.

On June 1, 2005, PRD staff presented the analytical approach and consultation update to the Council at their 127th meeting.

On June 12, 2005, a preliminary draft biological opinion was circulated to NMFS F/PR and NOAA Southwest/Pacific Islands regional counsel.

On June 16, 2005, PRD provided the action agency (SFD) and applicant (HLA) with a preliminary draft biological opinion for review and comment.

From June 14 through July 12, 2005, PRD received comments on the preliminary draft biological opinion.

On July 12, 2005, at the request of HLA, PIR staff met with representatives from HLA to receive comments on the preliminary draft biological opinion. Due to the extent of substantive comments provided to NMFS by HLA, an extension to the timeline was discussed.

On July 14, 2005, PIR staff met to discuss the extent of anticipated revisions to the draft biological opinion and an appropriate revised timeline.

On July 28, 2005, PRD and SFD sent a letter to HLA describing the revised timeline and requesting HLA's written concurrence. The letter stated that under the revised timeline, a final biological opinion would be issued no later than October 4, 2005.

On August 19, 2005, PRD provided the action agency (SFD) and applicant (HLA) with a draft biological opinion for review and comment.

On September 13, 2005, HLA provided PRD with comments on the draft biological opinion.

On October 4, 2005, the RA signed and released the Final Biological Opinion on the effects of the deep-set component of the Hawaii-based longline fishery.

3.0 Summary of New Information

This section provides a summary of the information on the deep-set component of the Hawaii-based longline fishery and affected threatened and endangered species that has become available since the completion of the 2004 BiOp on February 23, 2004.

<u>2004 Fishery Data</u>
The 2004 BiOp did not have empirical data from the deep-set fishery as executed under the proposed rule analyzed in that opinion. For this consultation, we have the benefit of having one year of fishery catch and effort data from the current regulatory regime (the proposed rule analyzed in the 2004 BiOp). Deep-set fishing effort and catch data for 2004 are presented in section 5.1. The Hawaii-based shallow-set, swordfish fishery had been closed since April 2001 and was reopened at reduced levels of effort with the issuance of the April 2004 final rule (NMFS 2004c). Because the final rule did not take effect until April of 2004, there was very limited participation in the shallow-set fishery. The 2004 fishery data would not be considered a significant source of new information for the shallow-set fishery since effort is expected to increase to the maximum allowed number of sets (2,120 sets) in 2005 and beyond. However, effort in the deep-set fishery was consistent with recent fishing effort trends and extends the time series of data available for the analysis.

2004 Observer Data

We also have the benefit of an additional year of observer data from the 2004 deep-set fishery which yielded additional estimates of protected species interactions on which to base the analysis.

Genetics data from 2004 fishery interactions

Genetic analyses were conducted on skin biopsies taken from sea turtles observed in the 2004 deep-set fishery. Samples were collected from 13 olive ridley turtles and 1 leatherback turtle. Genetic analyses were also completed on 2 leatherback samples from interactions in the 2005 Hawaii-based, shallow-set longline fishery. The results from these analyses supplemented genetic information presented and analyzed in the 2004 BiOp regarding estimated proportions of animals originating from eastern or western Pacific stocks.

Prediction Model for Estimating Sea Turtle Bycatch in Hawaii-based Longline Fisheries

A NOAA Technical Memorandum published in 2004 provided prediction models for estimating bycatch of olive ridley, leatherback, and loggerhead sea turtles in the 1994-1999 Hawaii-based longline fisheries (McCracken 2004). This memorandum discusses challenges associated with modeling a rare event (such as observed sea turtle interactions) when the data are hierarchical. From 1994-1999 only about 5% of the annual trips by Hawaii-based longliners were observed. The sampling scheme employed during this time period did not allow for the calculation of probability based bycatch estimates, thus it was necessary to develop predictive models for estimating sea turtle bycatch during this era.

There were few observed interactions of olive ridley and leatherback turtles; yet bycatch rates were affected by a few of the predictor variables. The majority of olive ridley bycatch from 1994-1999 occurred in warmer water. While the density and seasonal distribution of leatherbacks throughout the fishing ground is unknown, bycatch rates appeared to vary by latitude with fewer catches occurring in the northern portion of the fishing grounds. Loggerhead catches appeared to be higher in northern latitudes. Olive ridley and loggerhead bycatch was inversely related to the number of hooks set. This seemingly counter-intuitive result is likely attributable to fishing style. In general, more hooks are used when targeting tuna than swordfish. From 1994-1999 'trip-type' (shallow-set or deep-set) was not an easily discernable variable, though it is believed to have a stronger influence on bycatch rates than number of hooks.

Bycatch estimates from 1994-1999 for deep and shallow-set fisheries combined, are presented for leatherbacks, olive ridleys, and loggerheads (section 9.2.2). Methods presented in the 2004 Technical Memorandum are not required to estimate bycatch in the current Hawaii-based longline fisheries. The shallow-set component of the Hawaii-based pelagic longline fishery is now 100% observed. Observer coverage in the rest of the fleet is now around 20% and a quasi-probability sample protocol is now being followed. The bycatch of turtles in the deep-set fishery has diminished to the point where the use of predictive models is no longer reasonable to model bycatch levels. Instead, the Horvitz-Thompson estimator (Thompson 1992) is being used to estimate total bycatch (McCracken 2004).

Revised Exposure Analysis for Sea Turtles

For this consultation, PIFSC scientists generated a report which contains information on the anticipated level of sea turtle take and mortality in the deep-set component of the Hawaii-based pelagic longline fishery in 2005 and beyond (Kobayashi 2005). Several scenarios were evaluated to determine a reasonable approach for projecting anticipated levels of sea turtle interactions in the deep-set longline fishery. In the 2004 BiOP, deep-set interactions were projected based on data from the 1994-1999 fishery baseline. The revised approach is explained in section 9.2. Figure 10 illustrates why the revised approach likely results in more reliable estimates of the anticipated level of sea turtle interactions with the fishery.

Updated Sea Turtle Mortality Rates

Sea turtle interactions with the longline fishery are not always fatal. As in the 2004 BiOp, the fraction of turtles likely to die as a result of incidental hooking and entanglement in the Hawaii-based deep-set longline fishery was estimated (Boggs 2005). NMFS Office of Protected Resources (OPR) finalized the most recent post-interaction criteria developed to estimate survival and mortality rates for various categories of sea turtle interactions with commercial fisheries in April 2005. The April 2005 post-interaction criteria and 2004 deep-set fishery observer data with notes on the condition, handling, and release of sea turtles were used to update average mortality fractions (Boggs 2005). Interactions occurring in the 2004 fishery were added to the total interaction database to estimate average mortality rates. The database of observed interactions by the deep-set fishery, from the inception of the observer program through the end of December 2004, contains 63 sea turtles, including 17 additional deep-set longline-caught turtles than were analyzed for the purposes of the 2004 BiOp (Boggs 2005). Most of these additional turtles (13 olive ridley and 1 green) were dead upon capture. The remaining three sea turtles added in this analysis, were leatherbacks, all of which were released alive.

Revised Population Growth Rate Calculations

In the 2004 BiOp, a population viability analysis typically referred to as the Dennis Model (Dennis et al. 1991, Morris and Doak 2002) was applied to trend data for several sea turtle nesting aggregations to determine population growth and extinction parameters for these populations. These parameters were calculated to determine the effect of additional mortality attributed to interactions with the Hawaii-based deep-set longline fishery. In these analyses, the yearly count data of nesting females were either analyzed raw or each yearly count was multiplied by a term representing a mean remigration interval. The Dennis Model is based on the assumption that each census is a measure of the total population size, or some portion of the population that is representative of the total. Adult female sea turtles do not nest every year (Hays 2000). Remigration intervals for nesting sea turtles range from 1.4 to 4 years (Van Buskirk and Crowder 1994) and are likely dependent on environmental conditions (Hays 2000, Chaloupka 2001). Hence, the number of females nesting in any given year is neither a reliable estimate of either the total numbers of adult females in the population or an index of the population as a whole. The variability observed in these census data (or the census data multiplied by a constant) would suggest (with the assumptions of the Dennis Model) that sea turtle populations are capable of wildly varying annual population levels (with sharp increases as well as decreases), which for a long-lived, late maturing species is not possible.

A modification of the Dennis Model (Dennis et al. 1991), called the Dennis-Holmes Model, was presented by Holmes (2001; see also Holmes and Fagan 2002; Holmes 2004). In this model, Holmes suggests the use of a running sum methodology which reduces sampling error and provides a more accurate approximation of total population size. For this consultation, the Dennis-Holmes Model was applied to nest trend data from the 2004 BiOp (with new counts included when available) to update estimated population growth rate parameters for each nesting beach. These parameters were used to estimate probabilities of quasi-extinction and ultimate extinction under different take scenarios (Snover 2005).

2004 Western Pacific Sea Turtle Cooperative Research and Management Workshop

The Western Pacific Fishery Management Council convened the 2nd Western Pacific Sea Turtle Cooperative Research and Management Workshop from May 17-21, 2004. One of the primary missions of the workshop was to convene leatherback researchers from the western Pacific region to gather and exchange information, promote collaboration, and build consensus for continued leatherback turtle research. Genetic data indicate that the Hawaii-based longline fisheries primarily encounter leatherbacks of western Pacific origin (17 of 18 leatherback genetic samples collected in the fishery are of western Pacific origin). Prior to this workshop, there was great uncertainty about the status of leatherback populations in the western Pacific.

Researchers, managers, and tribal community leaders with extensive local knowledge from Papua Indonesia, Papua New Guinea, Solomon Islands and Vanuatu were assembled to update information on the status and threats of leatherback nesting populations in the western Pacific (Dutton et al. in press). Dutton et al. (in press) provide an update on leatherbacks nesting in the western Pacific; identify all known leatherback nesting beaches in the region; and estimate rookery size. The group identified 19 previously unknown or poorly described nesting sites in the region and estimated a minimum of 2,000 females nesting annually among all 25 sites identified. These estimates are higher than previously reported estimates of nesting females for the region (Dutton et al. in press).

Recent Literature Quantifying Effects of Fishery and Other Mortality Sources on Loggerhead and Leatherback Sea Turtles

Two recent papers describe relative threats of longline fisheries and other anthropogenic sources of mortality on leatherback and loggerhead populations (Lewison et al. 2004 and Kaplan 2005). Lewison et al. (2004) integrate fishery catch data from over 40 nations and bycatch data from 13 international observer programs to assess incidental catch of loggerhead and leatherback sea turtles by global pelagic longlines. Available fishery and bycatch data were extrapolated over broad spatial scales using a variety of techniques. Lewison et al. (2004) emphasize the need to accurately characterize bycatch in global fisheries despite large data gaps on both fishing effort and bycatch. Cited among the limitations to large scale assessments are low total observer effort and single nation or regional perspectives which constrain the applicability of findings for globally distributed bycatch species. The objective of the Lewison et al. paper was to synthesize data at a scale relevant to imperiled sea turtle populations and the global pelagic longline fishery.

Lewison et al. estimated that more than 200,000 loggerheads and 50,000 leatherbacks were likely taken as bycatch in the Atlantic, Pacific, and Indian Ocean Basins in 2000. They note that all interactions do not result in mortality, yet estimated that thousands of turtles die annually in Pacific longlines alone. The authors note that their calculations are subject to error from data limitations which also limit the precision of their estimates. However they are confident their calculations of longline effort and turtle bycatch are reasonable assessments of the magnitude of the actual effects. Lewison et al. argue that we have enough information to know that intervention is needed in the Pacific.

The third part of their assessment estimated the probability of a bycatch event and mortality for individual loggerheads and leatherbacks in the Pacific (Lewison et al. 2004). Results from this analysis indicate a high probability of capture for individuals in the Pacific. Population abundance estimates used in this component of the analysis depart from some commonly accepted estimates for the same populations and may even have been used in error[1]. Therefore, while we lack confidence about the probability of individual sea turtle rate of capture given the population estimates used, it does highlight the need for evaluating bycatch at a global level. Lewison et al. (2004) illustrate the small, relative impact of Hawaii-based pelagic longline fisheries in context of larger scale, unmonitored fisheries. The basin-wide distributions of both pelagic longline effort and sea turtles, coupled with the relatively small U.S. contribution to total pelagic longline effort (*c*. 2% of worldwide landings), suggest that effective protection for loggerheads and leatherbacks will require coordinated international action (Lewison et al. 2004).

The magnitude of Pacific leatherback mortality in longline fisheries and coastal sources (harvest of females and eggs) is evaluated by Kaplan (2005). Kaplan compares mortality resulting from longline fisheries in the eastern and western Pacific with coastal sources of mortality in these regions. Four scenarios were evaluated to assess the risk of each on Pacific leatherback populations: continuing longline bycatch and coastal mortality; halting bycatch and coastal mortality; halting longline bycatch only; and halting coastal mortality only. Bycatch rates observed in the Hawaii longline fleet were extrapolated to effort data for the international Pacific longline fleet. Kaplan (2005) estimates intrinsic growth rates of eastern and western Pacific leatherback populations and the magnitude of coastal mortality on each. In the western and central Pacific, coastal mortality sources lead to a 13% annual mortality rate and longlining lead to an annual mortality rate of 12%. In the eastern Pacific, coastal sources account for 28% of the mortality compared to 5% for longlining (Kaplan 2005).

Kaplan (2005) concludes that if the populations are to avoid extinction both coastal sources of mortality and mortality from longlining must be reduced. Kaplan goes a step further from the Lewison et al. (2004) paper and states that international efforts need to go beyond bycatch in the longline fisheries and attempt to reduce coastal harvest of females and eggs and bycatch by inshore gears such as gillnets. Kaplan's results indicate that eastern Pacific populations can only recover in cases where coastal harvest is stopped.

<u>Pacific Green Sea Turtle (*Chelonia mydas*) Status</u>

Since the 2004 BiOp, several papers have been published regarding the current status of green turtle populations in the Pacific. Balazs and Chaloupka (2004) report on a 30-year study of the

[1] For example, Lewison et al. (2004) cite Spotila et al. (2000) as the source for the number of nesting female leatherback turtles in the Pacific Ocean. Lewison et al. use *c.* 1,500 adult females for the total number of adult females in the Pacific Ocean and Spotila et al. (2000) estimate eastern and western Pacific populations to be 1,690 and 1,800 nesting females respectively in 2000. Dutton et al. (in press) produced a revised estimate of *c*. 5,000 nesting females in the western Pacific region based on the identification of 19 previously unknown leatherback rookeries in the western Pacific. Thus, the number of nesting female leatherbacks in the Pacific may be roughly 4 times larger than the estimate used by Lewison et al. (2004).

nesting abundance of the green turtle stock endemic to the Hawaiian Archipelago. Seminoff (2004) compiled information on 32 index sites of nesting female green sea turtles from the Atlantic, Pacific, and Indian Oceans for the 2003 International Union for the Conservation of Nature and Natural Resources (IUCN) Red List Assessment of green turtles. Chaloupka et al. (in press) compile available nesting female abundance data for to assess the status of sea turtle stocks in the Pacific.

Balazs and Chaloupka (2004) demonstrate a substantial long-term increase in abundance of the once seriously depleted Hawaiian stock of green turtles following cessation of harvesting since the 1970s. This population increase has occurred in a far shorter period of time than previously thought possible. The data-set analyzed in their paper is one of the few reliable long-term population abundance time series for a large long-lived marine species.

Seminoff (2004) discussed that while some green turtle stocks are stable or increasing, the overall global trend of green turtles is in decline and many threats to their continued existence remain. Seminoff (2004) concluded that continued listing status as 'endangered' on the IUCN Red List was warranted.

Status of Sea Turtle Stocks in the Pacific

Chaloupka et al. (in press) review abundance trends for six Pacific species of sea turtles using available quantitative information on nesting female abundance at key rookeries in the Pacific. This paper primarily compiles previously published information on trends at key rookeries and main threats and sources of mortality. Chaloupka et al. discuss the paucity of data available for a thorough assessment of the entire demographic structure of sea turtle populations in their foraging grounds where they are likely to be exposed to fishery impacts. They warn of assumptions and risks of using only nesting female abundance information to assess population status and trends and the magnitude of impacts likely inflicted by fisheries.

Preliminary Results from Council Funded Conservation Projects

The Western Pacific Fishery Management Council (Council) is highly active in sea turtle conservation in the Pacific. The Council sponsors a sea turtle coordinator, a sea turtle advisory committee (TAC), and numerous projects aimed at (1) diminishing the effects to sea turtle populations impacted by federally managed fisheries in the western Pacific and (2) aiding in recovery of these sea turtle populations. Of the sea turtle species of concern in the Pacific Ocean, leatherback and loggerhead turtles are the species most often captured by the Hawaii-based shallow-set longline fishery and are also populations in general decline. For this reason, these two species are the primary focus of the Council's five turtle conservation projects. Leatherback and loggerhead projects were first implemented in November 2003 and April 2004 respectively. These projects were described in the 2004 BiOp. The TAC, comprised of eight world renowned sea turtle biologists and scientists, convened from March 1-3, 2005 to review progress on projects they recommended to the Council in late July, 2003 and comment on the direction of continued efforts into 2005 and beyond. The status of these projects is discussed in section 7.4.

2005 International Sea Turtle Symposium

The 25th Annual Symposium on Sea Turtle Biology and Conservation was held in Savannah, Georgia from January 18-22, 2005. The proceedings from this symposium are not yet available;

however, recent data on the status and threats were presented for various populations that may be affected by the Hawaii-based longline fishery. These data are cited where published information is lacking or inconsistent with information presented at the symposium.

2005 Draft Final Alaska Marine Mammal Stock Assessment Stock Assessment Report
Marine mammal stock assessment reports (SARs) are prepared under the Marine Mammal Protection Act (MMPA) to evaluate impacts of commercial fisheries on marine mammal stocks. The SARs contain information on the stock definition and geographic range; population structure; population abundance, including a minimum estimate of population abundance; current and maximum net productivity rates; the stock's potential biological removal (as defined under the MMPA); and a summary of annual human-cause mortality and serious injury which includes fishing related impacts. Stock assessment reports for strategic stocks (which includes stocks listed as threatened or endangered under the ESA) must be reviewed at least annually. Information in the draft Final Alaska Marine Mammal Stock Assessment Report, 2005, (Angliss and Outlaw 2005) was used to evaluate the impacts of the deep-set longline fishery on the central north Pacific stock of humpback whales as it contains the most recent information on estimated population abundance and trend and analysis of impacts resulting from commercial fisheries, including the Hawaii longline fishery and other human-related impacts.

4.0 Approach to the Assessment

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. §1536), requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat that has been designated for those species. Regulations that implement section 7(b)(2) of the ESA define "jeopardize the continued existence of" as engaging in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02). With respect to threatened and endangered species, then, federal actions are required to ensure that their actions would not be reasonably expected to appreciably reduce the species' likelihood of both surviving and recovering in the wild, by reducing the species' reproduction, numbers, or distribution.

By law, NMFS issues biological opinions to help federal agencies comply with the requirements of section 7 of the Endangered Species Act. This Opinion is designed to help the Sustainable Fisheries Division of NMFS' Pacific Islands Region ensure that the proposed management regime of the Hawaii-based pelagic, deep-set longline fishery in the Pacific Ocean is not likely to jeopardize the continued existence of threatened or endangered species. As described in the 2004 BiOp, the proposed fishery has been determined to be not likely to adversely affect critical habitat that has been designated in the action area (see Section 5, Status of the Species and Environmental Baseline, of that BiOp). Therefore, this Opinion will focus only on jeopardy analyses.

4.1 Method

In developing the approach to the jeopardy analysis for this Opinion, NMFS relied on the following documents: the 2004 BiOp; an overview document describing the analytical framework applied in the 2004 BiOp (NMFS 2004b); and a background paper describing the assessment framework for conducting jeopardy analyses under section 7 of the ESA (Appendix A). In our effects assessment of the deep-set component of the Hawaii-based pelagic longline fishery we follow the framework described in the background paper (Appendix A). The framework is broken into nine steps beginning with identifying the proposed action and ending with making the jeopardy determination. For this Opinion, we traced each of the steps presented in the analytical framework (Appendix A), reviewed how each step was presented and/or analyzed in the 2004 BiOp, and identified which steps warranted changes or additions.

A thorough description of the analytical approach is provided in section 3 of the 2004 BiOp. Here we provide a description of how these steps were adopted and/or adapted for this Opinion. Changes to the approach in the 2004 BiOp are as follows:

4.1.1 Step 1. Description of the Action

The scope of the action for this consultation is the deep-set component of the Hawaii-based pelagic longline fishery. Thus, the description will focus on aspects of the deep-set longline fishery as conducted under current regulations.

4.1.2 Step 2. Deconstruct the fisheries to their constituent parts

Rather than distinguishing impacts between the deep-set and shallow-set fisheries, this section will focus on prior experience of the deep-set longline fishery and continued prosecution of the fishery under the current regulatory regime into the future.

4.1.3 Step 3. Identify the Action Area

See section 6.0

4.1.4 Step 4. Conduct exposure analyses to identify the listed species and designated critical habitat that are likely to be exposed to the direct or indirect effects of the fishery

The exposure analysis will be limited to interactions likely to occur in the deep-set fishery and will be supported by: (a) revised estimates of anticipated sea turtle and marine mammal interactions which incorporate previously unavailable 2004 fishery and observer data; (b) results from genetic analyses defining the origin (eastern or western Pacific) of individual sea turtles taken incidental to the 2004 fishery and (c) the draft Final Stock Assessment Report for Central North Pacific Humpback Whales (Angliss and Outlaw 2005).

The sea turtle exposure analysis has been refined from the 2004 BiOp to improve precision in the number of individuals likely to be exposed to the deep-set fishery. The 2004 BiOp considered deep and shallow-set longline fisheries and used a 1994-1999 fishery baseline to project the number of individuals by species likely to be exposed to the various components of the fishery. In section 9.2 of this Opinion, we describe how we isolate interactions likely to occur in the deep-set fishery and project future interactions based only on deep-set longline fishery and observer data.

4.1.5 Step 5. Conduct response analysis to determine how listed resources are likely to respond once exposed to the Action's stressors

These analyses distinguish between animals that are captured and released, unharmed; captured and released with injuries that prove fatal later, and immediate mortalities. Revised criteria to estimate sea turtle post-interaction injury and mortality were issued by NMFS' Office of Protected Resources in April 2005. These criteria were applied to the entire database of sea turtle interactions observed in the deep-set fishery, including interactions occurring in 2004, to estimate mortality rates from anticipated take levels. Information from recent literature on behavioral responses of sea turtles to incidental capture in fisheries is also discussed.

To determine the response of humpback whales to exposure and interactions with the deep-set longline fishery we relied on the analyses in the 2005 SAR (Angliss and Outlaw 2005). The SAR provides estimates of the mean annual mortality of humpback whales attributed to each commercial fishery with reported interactions.

4.1.6 Steps 6 - 8. Conduct risk analyses to estimate the risk of the fishery on listed sea turtles and marine mammals[2]

The risk analyses conducted in steps 6-8 built on the previous two steps which identified the number of individuals of each species likely to be exposed to the fishery (along with their estimated age or life history stage) and the likely fate of those individuals given exposure. In the final steps of the assessment we asked (step 6) what is likely to happen to different stocks (marine mammals) or nesting aggregations (sea turtles) given the exposure and responses of individual members of those stocks or aggregations and what is likely to happen to the populations (step 7) and species (step 8) those stocks or nesting aggregations comprise.

The environmental baseline and status of the species section framed the point of reference for the jeopardy determination. The risk to the individuals, populations and species resulting from effects of the proposed action, were added to the environmental baseline and evaluated using the status and trend of the species as the reference point to determine if the action, as proposed, would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.

Environmental Baseline
The analysis was conducted according to the description provided in Tables 1 and 2 of the January 9th, 2004, memorandum (NMFS 2004b). The environmental baseline for an action includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. Impacts that have occurred incidental to the Hawaii-based shallow-set swordfish fishery are described and considered in the environmental baseline.

Species Status

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[2] These steps are ordered according to the conceptual analytical framework as presented in Appendix A. However, to facilitate the flow of the document, species status information is presented prior to the environmental baseline.

At a broader scale than the action's environmental baseline, a species status encompasses the base condition of the entire species (as they are listed) given their exposure to human activities. To assess species status NMFS compiled new information on the status and trends of various populations. Where available, additional years of nesting female sea turtle census data were added to the time series analyzed in the 2004 BiOp to estimate mean population growth rates and variance. Where possible, population growth rate parameters calculated in the 2004 BiOp were recalculated using the "run sum" method which circumvents problems related to life-stage-specific counts and accounts for sampling error (Holmes 2001). The application of this method reduced a potential bias in population growth parameter estimates presented in the 2004 BiOp. Scenarios presented in the 2004 BiOp were updated with new estimates of take anticipated to occur in the deep-set fishery to calculate estimated time to quasi-extinction[3], and the probability of quasi and ultimate extinction over 25, 50, and 100-year horizons with and without the additive mortalities expected to occur incidental to the fishery under the current management structure[4].

In applying the jeopardy standard, quantitative analyses were supplemented by qualitative discussions and presentations of species status and trend information where data are lacking to conduct quantitative analyses. This approach is described in Table 1 of the January 9, 2004, memorandum (NMFS 2004b).

4.1.7 Step 9. Conclusion

As in the 2004 BiOp, the jeopardy determination is based on an assessment of the cumulative effects and supported by analyses conducted during this process. The conclusion is NMFS' opinion regarding whether the aggregate effects of the factors analyzed under the 'environmental baseline', 'effects of the action', and 'cumulative effects' in the action area, when viewed against the status of the species or critical habitat as listed or designated – are likely to jeopardize the continued existence of the species or result in the destruction or adverse modification of critical habitat.

5.0 Description of the Proposed Action

NMFS' Sustainable Fisheries Division, Pacific Islands Region (SFD), requested ESA Section 7 consultation on the deep-set component of the Hawaii-based pelagic longline fishery to be managed under the Pelagics FMP as amended by the sea turtle mitigation measures promulgated in the April 2, 2004, Final Rule. Therefore, the management regime, for the Hawaii-based pelagic, deep-set longline fishery as described in the Pelagics FMP and adopted by the Secretary of Commerce, constitutes the main action being considered in this Opinion.

The purpose of fishery management plans, including the Pelagics FMP, has been established by the Magnuson-Stevens Fishery Conservation and Management Act (MSA; 16 U.S.C. 1801 *et seq*.). The stated purpose of the Pelagics FMP is to maximize the net benefits of the fisheries to the nation and to the Western Pacific region. Background information on Federal fisheries policy and management under the MSA, fishery management plan development process, and Pelagics FMP is described in the July 1987 Pelagics FMP as amended.

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[3] As defined in the 2004 BiOp quasi-extinction is defined 50 adult females.

[4] Duration of fishery effects were assumed to continue into the future at least as long as it has persisted in the past (14 years).

Subsection 0 below provides a description of the deep-set longline fishery. Subsection 5.2 below summarizes the existing management measures, which would continue under the proposed action.

5.1 Description of the Hawaii-based Pelagic Deep-set Longline Fishery

The SFD proposes to maintain the existing regulatory regime for the pelagic deep-set fishery component (the "deep-set fishery") of the Hawaii-based longline fishery managed under Pelagics FMP, and to manage the deep-set fishery pursuant to those regulations. The effects of these regulations were previously analyzed in the 2004 BiOp (NMFS 2004) and no regulatory changes have been proposed by the Council. Subsection 0 below provides a description of the deep-set fishery. Subsection 5.2 below summarizes the existing regulatory requirements and management measures, which would continue under the proposed action.

5.1.1 Hawaii-based longline fisheries

Today the Hawaii-based longline fishery consists of two separately managed components – the deep-set (tuna-target) gear configuration fishery and the shallow-set (swordfish-target) gear configuration fishery. The management and operation of these fisheries as a consolidated longline fishery until March 2001 is described in detail in the March 2001 FEIS (Section 3.10.3.1, pages 195 to 256) (NMFS 2001). Since 2000, the fisheries have been operating in a highly dynamic regulatory environment. Accordingly, the operational characteristics of the fisheries have been quite dynamic as well, with vessels moving back and forth between the two fishery components. The fisheries' regulatory history is described in the March 2001 FEIS, the new technologies regulatory amendment (WPFMC 2004), the 2004 Supplemental Environmental Impact Statement regarding the Pelagics FMP (Pelagics FSEIS) (NMFS 2004a) and the 2004 BiOp (NMFS 2004).

The Hawaii-based longline fishery is a limited access fishery, with 164 permits that are transferable. Vessels active in this fishery are limited to 101 feet in length. The area fished ranges from 25 miles offshore from the main Hawaiian Islands to thousands of miles from port. These Hawaii-based longline vessels compete with foreign distant water fishing fleets operating on the high seas. Figure 1 displays the location of tuna sets made by the deep-set component of the Hawaii-based pelagic longline fishery in 2002.

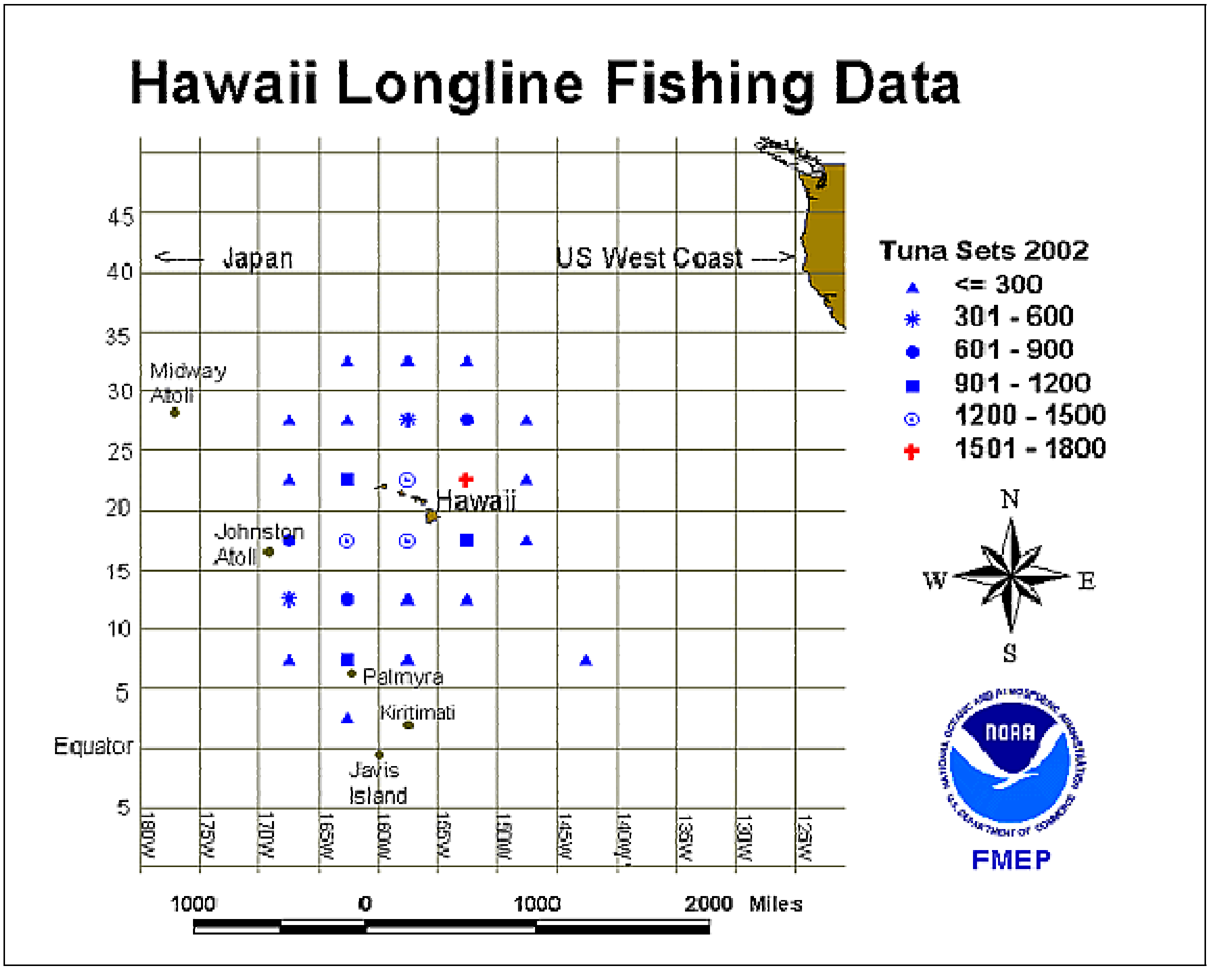

Figure 1. Distribution of tuna sets by the Hawaii-based pelagic, deep-set longline fishery in 2002. (Source: http://www.pifsc.noaa.gov/fmep/charts/tset2002.gif Accessed 10/2/2005).

5.1.2 Hawaii-based Longline Deep-Set (tuna-target) Gear Configuration

Longline fishing allows a vessel to distribute effort over a large area to harvest fish that are not concentrated in great numbers. Overall catch rates in relation to the number of hooks are generally low. Tuna-target longline fishing is also known as deep-set longline fishing. In general, longline gear consists of a continuous main line set on the surface and supported in the water column horizontally by floats with branch lines connected at intervals to the main line. Plastic floats are commonly used; in addition radio buoys are also used to keep track of the mainline. A line shooter is used on deep-sets to deploy the mainline faster than the speed of the vessel, thus allowing the longline gear to sink to its target depth (average target depth is 167 m, target depth for bigeye tuna is approximately 400 m). The main line is typically 30 to 100 km (18 to 60 nm) long. A minimum of 15, but typically 20 to 30, weighted branch lines (gangions) are clipped to the mainline at regular intervals between the floats. Each gangion terminates with a single baited hook. The branch lines are typically 11 to 15 meters (35 to 50 feet) long. Sanma (saury) or sardines are used for bait. Lightsticks are not typically attached to the gangions on this type of longline set. A typical deep-set (one day of fishing) consists of 1,800 to 2200 hooks.[5] In

[5] Swordfish-target (shallow-set) fishing differs from tuna target fishing as it is set at a shallower depth, usually between (-~30-90m). Shallow-set longline gear is generally set at night, with luminescent light sticks, thought to

2004 the deep-set fishery averaged about 2,007 hooks per set. Deep-set longline gear is set in the morning and hauled in the afternoon (Ito and Machado 2001).

5.1.3 Vessel Activity

The Hawaii-based deep-set longline fishery is the largest domestic commercial fishery in the western Pacific region. The number of active vessels in the combined Hawaii-based deep-set and shallow-set longline fishery increased dramatically in the late 1980s and peaked at 141 vessels in 1991. The number of vessels in the combined longline fisheries has since ranged from 101 to 125. In 2004, 125 Hawaii-based longline vessels were active in the deep-set fishery. The deep-set fishery operates year-round although vessel activity increases during the fall and is greatest during the winter and spring months.

5.1.4 Number of Trips

The annual number of trips for the combined Hawaii-based longline fishery has remained relatively stable, but there has been a shift from mixed-target and swordfish-target trips to tuna-target trips from the early 1990s up to 2002. In the years 2000-2003, this shift reflected the regulatory closure of the shallow-set and mixed-target fisheries, while in 2004 the shallow-set fishery was reopened but experienced limited participation. In 2004, there were 1,380 deep-set (tuna-target) trips, which resulted in 15,880 deep sets (Figure 2).

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attract swordfish, attached to the gangions. 4-6 gangions are typically clipped to the mainline between floats. A typical set for swordfish uses about 700-1,000 hooks. The historical swordfish fishery used squid as bait, but the current fishery is required to use circle hooks with mackerel bait for shallow-sets. The Hawaii-based longline fleet is currently limited to 2,120 shallow sets each year.

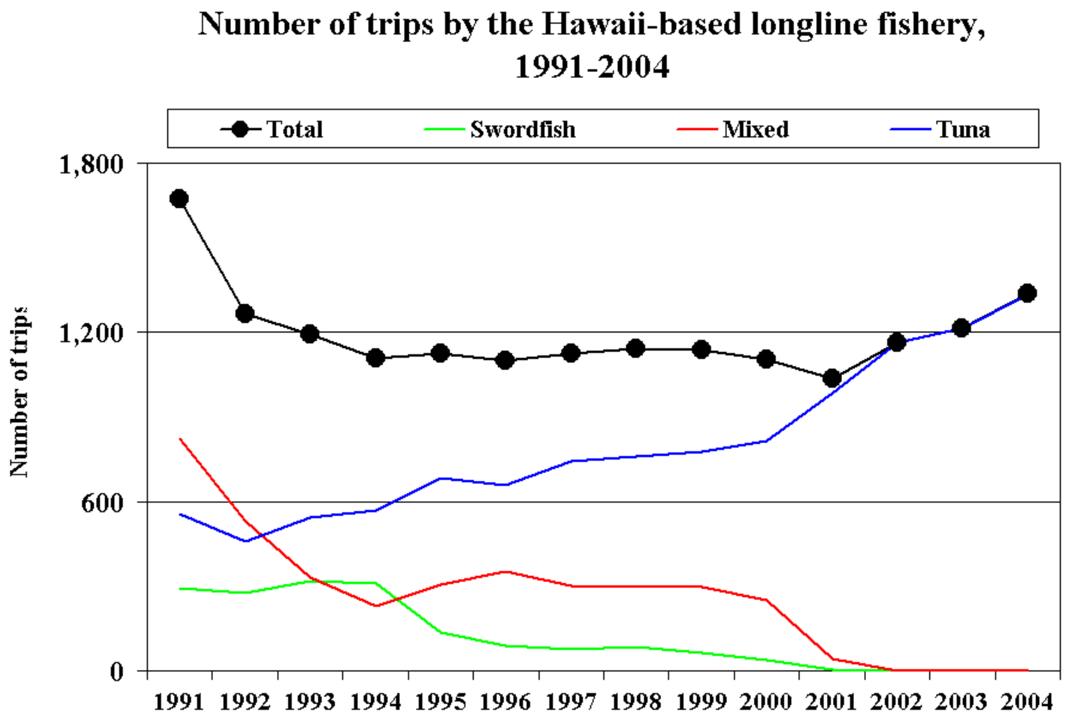

Figure 2. Number of trips by the Hawaii-based longline fishery, 1991-2004. Total trips are indicated by a black dotted line, swordfish trips are indicated by a green line, mixed trips are indicated by a red line, and tuna trips are indicated with a blue line.

5.1.5 Number of Hooks Set (Fishing Effort)

Effort in the deep-set fishery, measured by the number of hooks set, has increased in each of the past five years: 2000 (20,282,826); 2001 (22,327,897); 2002 (27,018,673); 2003 (29,297,813); and 2004 (31,868,290) (Figure 3). The average annual increase in effort during this period was approximately 10 percent. (This trend is also reflected in the total number of sets per year increasing at about the same rate). Consistent with this trend, and information from fishery participants provided by HLA, the total number of hooks set in the deep-set tuna fishery is expected to increase in 2005 by approximately 10 percent, to 35,055,119 hooks set because some vessels are expected to return to Hawaii from California to participate in the 2005 deep-set fishery (Jim Cook, HLA, personal communication, 2005). At some point the total number of hooks set will eventually stop increasing either because of physical limitations (total number of trips and sets [Figure 2], number of hooks per set), and/or diminishing returns.

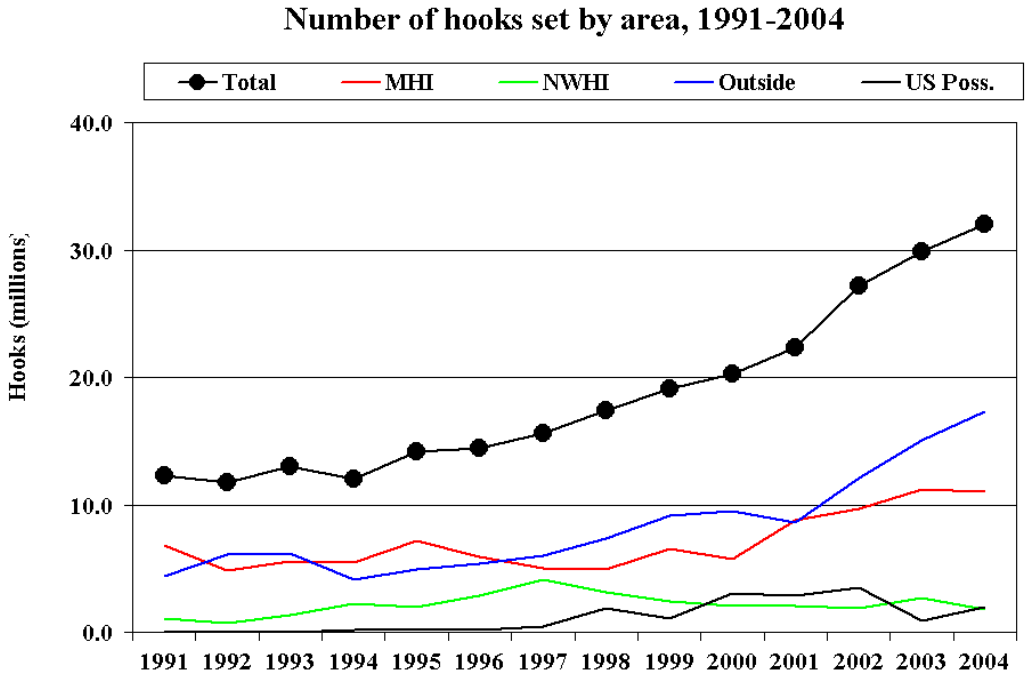

Figure 3. Number of hooks set by area the Hawaii-based longline fishery, 1991-2004. Total number of hooks is indicated by a black dotted line, hooks set in the northwest Hawaiian Islands are indicated by a green line, main Hawaiian Island hooks set are indicated by a red line, and hooks set inside and outside the U.S. EEZ are indicated with a black and blue line, respectively.

5.1.6 Catches

Because of the high degree of variability in the regulatory management of the Hawaii-based longline fisheries in recent years, catch data are highly variable by year. In 2004, the deep-set fishery reported catches of tuna, billfish, sharks and other PMUS (Mahimahi, Moonfish, Oilfish, Pomfret and Wahoo. For the deep-set tuna fishery in 2004, catch numbers by species were: Bigeye (140,956); Yellowfin (25,477); Skipjack (18,862); Albacore (17,021); and Bluefin (6) (Table 1). A complete historical description of catch reports and landings are available in the 2004 Pelagics FSEIS (NMFS 2004a), the 2004 BiOp, the 2005 Seabird/Squid FEIS (NMFS 2005), and from the Pacific Islands Fisheries Science Center website (http://www.nmfs.hawaii.edu/).

Species class	Pelagic Management Unit Species (PMUS)	# kept	# caught	# caught per 1000 hooks
Billfish	Blue Marlin	4,755	4,854	0.15
	Spearfish	13,707	14,069	0.44
	Striped Marlin	15,565	15,943	0.50
	Swordfish	2,892	3,785	0.12
	Other	539	559	0.02
	Total	**37,458**	**39,210**	**1.23**
Sharks	Blue	1,337	63,559	1.99
	Mako	853	1,623	0.05
	Thresher	720	5,313	0.17
	Other	210	3,035	0.10
	Total	**3,120**	**73,530**	**2.31**
Tuna	Albacore	16,920	17,021	0.53
	Bigeye	138,396	140,956	4.42
	Bluefin	6	6	0.00
	Skipjack	17,687	18,862	0.59
	Yellowfin	24,768	25,477	0.80
	Total	**197,826**	**202,371**	**6.35**
Other PMUS	Mahimahi	65,158	66,178	2.08
	Moonfish	8,485	8,532	0.27
	Oilfish	19,421	19,626	0.62
	Pomfret	64,327	65,002	2.04
	Wahoo	15,566	15,667	0.49
	Total	**173,555**	**175,614**	**5.49**
Miscellaneous	Non-PMUS	1,675	1,867	0.06

Table 1. Species catch information from the Western Pacific longline logbook summary for 1/2004 through 12/2004. (Vessels landing or based in Hawaii; all areas; tuna trips) (Source: Pacific Islands Fisheries Science Center).

5.2 Description of Current Management Measures

The U.S. pelagic fisheries in the central and western Pacific region are authorized and managed under the Pelagics FMP, as amended. The Pelagics FMP and its amendments are developed by the Council under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C. § 1801 *et seq*. The SFD of NMFS PIR implements regulations enacted by NMFS under the MSA to administer enforceable elements of the Pelagics FMP. The stated purpose of the Pelagics FMP is to maximize the net benefits of the fisheries to the western Pacific region and the Nation. The current management regime under the Pelagics FMP primarily regulates the domestic pelagic longline fisheries, although certain permit, reporting, and sea turtle mitigation measures apply to non-longline pelagic fisheries in the region, such as the domestic troll, handline, and pole-and-line fisheries. Background information on federal fisheries policy and management under the MSA, the fishery management plan development process, and the Pelagics FMP is described in the March 2001 FEIS (Section 1.3, pages 11 - 34) (NMFS 2001) and the March 2004, Pelagics New Technology SEIS (Section 4, pages 1-6) (NMFS 2004a).

As proposed, the deep-set longline fishery will continue to be managed under a combination of all applicable fishery management measures adopted in the Pelagics FMP and in MSA regulations in existence on February 17, 2005, which is the date of initiation of this consultation. In summary, the existing management measures that constitute the action under consultation, along with their sources, are:

1. Fishing vessels that use longline gear to catch PMUS in the EEZ around American Samoa, Guam, Commonwealth of the Northern Mariana Islands, or the U.S. Pacific remote islands areas (PRIA), such as Palmyra and Johnston Atolls, Kingman Reef, Jarvis, Howland, Baker and Wake Islands, and vessels used to transport or land U.S. longline-harvested PMUS shoreward of the outer boundary of these same EEZs, must be registered for use with longline general permits or Hawaii longline limited access permits, and must keep daily logbooks detailing species harvested, area of harvest, time of sets, and other information, including interactions with protected species. Also, longline gear must be marked with the official number of the permitted vessel that deploys the gear *(56 FR 24731, May 26, 1991).*

2. Fishing vessels that use longline gear to catch PMUS in the EEZ around Hawaii, or are used to transport or land longline-harvested PMUS shoreward of the outer boundary of the EEZ around Hawaii, must keep daily logbooks detailing species harvested, area of harvest, time of sets, and other information, including interactions with protected species *(56 FR 24731, May 26, 1991).*

3. Longline fishing for PMUS is prohibited in closed areas 50 nm around the center points of each of the Northwestern Hawaiian Islands, plus a 100 mile wide corridor connecting those circular closed areas that are non-contiguous (protected species zone) *(56 FR 52214, October 14, 1991).* In the main Hawaiian Islands longline fishing, except as exempted, is prohibited in areas approximately 75 nm around the islands of Kauai, Niihau, Kaula, and Oahu, and approximately 50 nm off the islands of Hawaii, Maui, Kahoolawe, Lanai, and Molokai. This prohibition is lessened from October 1 through January 30, when the longline closed areas decrease on the windward sides to approximately 25 nm off Hawaii, Maui, Kahoolawe, Lanai, Molokai, Kauai, Niihau, and Kaula, and approximately 50 nm off Oahu *(56 FR 28116, June 14, 1991).*

4. Longline fishing is also prohibited in an area approximately 50 nm off Guam *(57FR 7661, March 2, 1992).*

5. Vessels registered for use under Hawaii longline limited access permits ("Hawaii-based longline vessels") must carry a NMFS observer when directed to do so by NMFS *(58 FR 67699, December 22, 1993).*

6. Fishing vessels that use longline gear to catch PMUS in the EEZ around Hawaii, or are used to transport or land longline-harvested PMUS shoreward of the outer boundary of the EEZ around Hawaii, must be less than 101 feet in length and be registered for use with one of 164 Hawaii longline limited access permits *(59 FR 26979, June 24, 1994).*

7. As directed by NMFS, all vessels registered for use with Hawaii longline limited access permits (Hawaii longliner) must carry NMFS-owned "vessel monitoring system" transmitters *(59 FR 58789, November 15, 1994).*

8. All Hawaii-based longline vessels and fishing vessels registered for use with longline general permits are required to employ sea turtle handling measures specified by NMFS, including mitigation gear, sea turtle resuscitation, and sea turtle release procedures, to maximize the survival of sea turtles that are accidentally taken by fishing gear *(65 FR 16346, March 28, 2000).*

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

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

11. Any domestic fishing vessel that employs troll or handline gear to catch PMUS in the EEZ around the U.S. Pacific remote islands areas (e.g., Palmyra and Johnston Atolls, Kingman Reef, Jarvis, Howland, Baker and Wake Islands) and Midway Atoll, must be registered for use with a permit issued by NMFS and must also maintain daily logbooks detailing species harvested, area of harvest, fishing effort, and other information, including interactions with protected species *(67 FR 30346, May 6, 2002).*

12. Hawaii-based longline vessels operating north of 23° N. must: when using traditional basket-style longline gear, ensure that the main longline is deployed slack to maximize its sink rate; when making deep sets using monofilament main longline, use a line-setting machine or line shooter and attach a weight of at least 45 gm to each branch line within 1 m of each hook; use thawed blue-dyed bait; and discharge offal strategically *(67 FR 34408, May 14, 2002).*

13. The operator and crew of all Hawaii-based longline vessels that accidentally hook or

entangle an endangered short-tailed albatross must employ specific handling procedures *(67 FR 34408, May 14, 2002).*

14. Operators and owners of Hawaii-based longline vessels and operators of vessels chartered for use under longline general permits are required to attend annual protected species workshops conducted by NMFS that cover sea turtle and seabird conservation and mitigation techniques *(67 FR 34408, May 14, 2002).*

15. Operators of Hawaii-based longline vessels are required to notify the Regional Administrator in advance of every trip whether the trip will involve shallow-setting or deep-setting, and such vessels are required to make sets only of the type declared *(69 Fed. Reg. 17329; April 2, 2004).*

16. Operators of Hawaii-based longline vessels are required to carry and use NMFS approved de-hooking devices *(69 Fed. Reg. 17329; April 2, 2004).*

17. The governments of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands do not specifically regulate pelagic fishing activities, although fishing vessel registration is required. The State of Hawaii (State) prohibits the sale of yellowfin and bigeye tuna (both known in Hawaii as *ahi)* smaller than three pounds landed by all domestic fisheries. State statutes establishing longline area closures around the main Hawaiian Islands and prohibiting shark finning activities[6] complement Federal fisheries regulations. The State also requires fishermen who sell any portion of their catch to hold a commercial marine license and file catch reports.

5.2.1 Observer program for the Hawaii-based longline fishery

NMFS' fishery observer program for the Hawaii-based longline fisheries began in 1990, with the voluntary sampling of fishing operations to collect fishery data and because of unconfirmed reports of interactions between swordfish vessel operations and protected species such as Hawaiian monk seals, listed sea turtles, and seabirds (Dollar 1991). A mandatory observer program was implemented in April 1994, to better characterize and understand the effects of the incidental take of sea turtles, seabirds, and marine mammals by the Hawaii-based longline fishery. A more complete description of the observer program is provided in section 2.1.1.7 of the 2004 BiOp.

In late 2000, observer services were contracted out on a permanent basis through a private contractor, Saltwater, Inc. Since January 2001, over 100 observers have been trained. An experienced corps of observers has emerged from this group enabling NMFS' observer program, to maintain an observer staff ranging from 25 to 40 persons. Since 2000, NMFS has maintained observer coverage levels about 20%. In 2004, NMFS PIR restructured the observer program by separating the shallow-set and deep-set components. The observer coverage level for the deep-set fishery in 2004 was approximately 25%.

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[6] Hawaii Revised Statutes Chapter 188, enacted in June 2001, prohibit shark finning in State waters. All sharks caught by fishermen must be landed whole; that is, fins must be attached to the shark.

6.0 Description of the Action Area

The action area, for purposes of this Opinion, is the U.S. Exclusive Economic Zones (EEZs) around the U.S. Pacific islands and the high seas waters where Hawaii-based fishing vessels using deep-set longline (tuna-target) gear configurations are managed under the Pelagics FMP. These areas include the EEZs around the Hawaiian Islands, and the remote U.S. Pacific islands of Johnston Atoll, Kingman Reef, Palmyra, Jarvis, Howland, Baker, Midway, and Wake Islands.

The Hawaii-based pelagic, deep-set longline fishery operates inside and outside the EEZ primarily around the main Hawaiian Islands and Northwestern Hawaiian Islands (NWHI) with some trips to the EEZs around the remote U.S. Pacific islands. Longline fishing is prohibited inside the protected species zone surrounding the NWHI (50 nautical miles from the center geographical positions of Nihoa Island, Necker Island, French Frigate Shoals, Gardner Pinnacles, Maro Reef, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Island, and Kure Island) to protect monk seals. The area closed around the main Hawaiian Islands varies from 25 to 75 nautical miles seaward of the shore depending on the season, island, and direction of the facing shore. These closures are in place to alleviate potential gear conflicts among small boat handline/troll fishers, charter boat operators, recreational fishers, and longline fishers. From February 1 through September 30 each year, longline fishing is prohibited up to 75 nautical miles around the main Hawaiian Islands in the portion of the EEZ seaward of Hawaii bounded by straight lines. From October 1 through the following January 31 each year, longline fishing is prohibited further inshore around the main Hawaiian Islands in the portion of the EEZ seaward of Hawaii.

Hawaii-based longline vessels vary their fishing grounds depending on their target species. Most effort is to the north and south of the Hawaiian Islands between the equator and 40 ° N and longitudes 140 ° and 180 ° W, however, the vast majority of deep-set fishing occurs south of 20 º N.

7.0 Species Status and Trends

The following species occur in the action area, as defined above, and may be affected by the proposed action:

Marine Mammals	**Status**
Blue whale (*Balaenoptera musculus*)	Endangered
Fin whale (*Balaenoptera physalus*)	Endangered
Hawaiian Monk seal (*Monachus chauinslandi*)	Endangered
Humpback whale (*Megaptera novaeangliae*)	Endangered
Pacific right whale (*Eubalaena japonica)*	Endangered
Sperm whale (*Physeter macrocephalus*)	Endangered
Sei whale (*Balaenoptera borealis*)	Endangered

Sea Turtles	
Green turtle (*Chelonia mydas*)	Endangered/Threatened
Hawksbill turtle (*Eretmochelys imbricata*)	Endangered
Leatherback turtle (*Dermochelys coriacea*)	Endangered
Loggerhead turtle (*Caretta caretta*)	Threatened
Olive ridley turtle (*Lepidochelys olivacea*)	Endangered/Threatened

7.1 Critical Habitat

Except for the Hawaiian monk seal, no critical habitat has been designated for any of these threatened or endangered species in the Pacific Ocean. In May 1988, NMFS designated critical habitat for the Hawaiian monk seal out from shore to 20 fathoms in 10 areas of the Northwestern Hawaiian Islands. Critical habitat for these species includes "all beach areas, sand spits and islets, including all beach crest vegetation to its deepest extent inland, lagoon waters, inner reef waters, and ocean waters out to a depth of 20 fathoms around the following: Kure Atoll, Midway Islands, except Sand Island and its harbor, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island" (50 CFR § 226.201). The action area for the Hawaii-based pelagic, deep-set longline fishery does not overlap critical habitat for the endangered Hawaiian monk seals and is not likely to adversely affect critical habitat that has been designated for the Hawaiian monk seal. Therefore, impacts to critical habitat are not expected as a result of the proposed fishery and are not discussed further in this Opinion.

7.2 Marine Mammals

7.2.1 Hawaiian Monk Seals

The endangered Hawaiian monk seal is currently found throughout the northwest Hawaiian Islands, specifically: Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianki Island, Laysan Island, French Frigate Shoals, Gardner Pinnacles, Necker Island and Nihoa Island. These islands form a chain approximately 1,840 km long. Hawaiian monk seals also occur in the main Hawaiian Islands. The longline area closure around the northwest Hawaiian Islands, instituted in 1991 (longline fishing prohibited within 50 nm of the northwest Hawaiian Islands and in 100 nm closed corridors connecting the non-contiguous closed circles), appears to have eliminated monk seal interactions with the Hawaii-based longline fleet, as there have been no observed or reported interactions with this fishery since then. Therefore, although the action area for the Hawaii-based pelagic, deep-set longline fishery includes the distribution of the endangered Hawaiian monk seals, NMFS has determined that the proposed action is not likely to adversely affect the Hawaiian monk seal. The FSEIS contains more information on Hawaiian monk seal population status and trends on page 126 of that document (NMFS 2004a).

7.2.2 Humpback Whales

The International Whaling Commission (IWC) 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). See pages 124 – 125 in the FSEIS for more information on humpback whale feeding habits and seasonal distributions (NMFS 2004a).

Distribution

The humpback whale is distributed worldwide in all ocean basins, though it is less common in Arctic waters. In winter, most humpback whales occur in the temperate and tropical waters of the North and South Hemispheres (from 100-230 latitude). Humpback whales in the high latitudes of the North Pacific are seasonal migrants that feed on zooplankton and small schooling fishes (NMFS 1991). The humpback whale population in much of this range was considerably reduced as a result of intensive commercial exploitation during the 20th century.

Aerial, vessel, and photo-identification surveys and genetic analyses indicate that within the US Exclusive Economic Zone (EEZ) there are at least three relatively separate populations that migrate between their respective summer/fall feeding areas to winter/spring calving and mating areas (Calambokidis et al. 1997, Baker et al. 1998). Members of the winter/spring populations of the Hawaiian Islands migrate to northern British Columbia/Southeast Alaska and Prince William Sound west to Unimak Pass (Baker et al. 1990, Perry et al. 1990, Calambokidis et al. 1997)

Until further information becomes available, 3 stocks of humpback whales are recognized within the US EEZ of the north Pacific: one in the eastern north Pacific (the California/Oregon/Washington - Mexico stock), one in the central north Pacific, and one in the western north Pacific. Humpback whales occurring in the action area are members of the central north Pacific stock.

The central north Pacific stock of humpback whales consists of feeding aggregations along the northern Pacific Rim, and some humpbacks are present offshore in the Gulf of Alaska (Brueggeman et al. 1989). Humpback whales are also present in the Bering Sea (Moore et al. 2002); it is not conclusively known whether those animals belong to the western or central north Pacific stocks.

In Hawaii, humpback whales have been sighted as early in the season as October and as late as June, but the general breeding and mating season is considered to be from December to April (A. Ligon, Humpback Whale Sanctuary, personal communication, September 23, 2005).

Humpback whales occur off all eight of the main Hawaiian Islands, and are commonly found in shallow waters of the “four-island” region (Kaho’olawe, Molokai’i, Lanai’i, and Maui), the northwestern coast off the island of Hawaii, and the waters around Niihau, Kauai, and Oahu

(Wolman and Jurasz 1977, Herman et al. 1980, Baker and Herman 1981). Humpback whales are generally found in shallow water shoreward of the 182 m contour (Herman and Antinoja 1977). Cow and calf pairs appear to prefer very shallow water less than 18 m (Glockner and Venus 1983). Humpback whales are known to dive to a maximum depth of approximately 150 m, though most dives do not exceed 60 m (Hamilton et al.1997).

Recent abundance estimates indicate that the central north Pacific stock consists of approximately 4,000 individuals and has been increasing in abundance since the early 1980s (Mobley et al. 1999, NMFS 2005, Baker and Herman 1997). Mizroch et al. (2004) estimate the central north Pacific stock to be increasing at a rate of 10% per year. Mobley et al. (2001) estimate an annual population increase of 7% based on aerial surveys conducted from 1993 – 2000 across the main Hawaiian Islands. According to the draft 2005 SAR, the best estimate of the current rate of increase for the central north Pacific stock of humpback whales is 7% per year (Angliss and Outlaw 2005).

7.2.2.1 Humpback Interactions in Other Fisheries

Until 2004, four federally-regulated commercial fisheries in Alaska were monitored for incidental mortality of central north Pacific humpback whales. Fishery definitions changes in the List of Fisheries resulted in the separation of these four fisheries into 17 fisheries (69 FR 70094, 2 December 2004). This change provides managers with more detailed information on the component of each fishery to which incidental serious injury or mortality of marine mammal stocks in Alaska should be attributed. From 1999-2003, incidental serious injuries and mortalities of central north Pacific humpback whales were observed in the Bering Sea/Aleutian Islands pollock trawl fishery and estimated to occur in the Bering Sea/Aleutian Islands sablefish pot fishery with an estimated mean annual mortality rate of 0.29 whales/year and 0.20 whales/year, respectively (Angliss and Outlaw 2005).

Under the Marine Mammal Protection Act, marine mammal stock assessments must evaluate human-caused mortality and serious injury of marine mammals. Determinations of the seriousness of injuries reported in the 2005 SAR were made based on guidelines established by a 1997 workshop on differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations (Angliss and Demaster 1998). Injuries were considered serious if the animal ingested the hook, was hooked in the head or mouth, or was released with substantial gear attached. Injuries were considered non-serious if the animal was hooked in a region other than the head and released with no or minimal gear attached. Serious injuries are further defined by NMFS as “any injury that is likely to result in mortality” (50 CFR part 229.2). Thus, it can be inferred that a non-serious injury is not likely to result in mortality.

Under the MMPA, vessel operators are required to ‘self-report’ fishery information on the number of humpback whales killed or injured incidental to commercial fishery operations. There were no fisher self-reports of humpback whale injuries or mortalities from interactions with commercial fishing gear in any Alaska fishery within the range of the central north Pacific humpback whale stock from 1990 and 1993 (Angliss and Outlaw 2005). Logbook data are partially available from 1989-94. In 1994 incidental mortality reporting requirements were modified, logbook requirements were retracted and replaced with self-reporting requirements. Data for the 1994-95 phase-in period are fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality are assumed to minimum estimates. The incidental take of one humpback whale was reported in the Southeast Alaska salmon purse seine fishery in 1994. In 1996, a humpback whale was reported entangled and trailing gear as a result of interacting with the Southeast Alaska drift gillnet fishery and is presumed to have died as a result of the entanglement. These two mortalities result in an annual mortality rate of 0.4 (0.2 + 0.2) humpback whales based on self-reported fisheries information which is considered to be a minimum estimate (Credle et al. 1994).

Reports of entangled humpback whales found swimming, floating, or stranded with fishing gear attached occur in both Alaskan and Hawaiian waters. Overall, there were 30 reports of human-related mortalities or injuries during this 4-year period; 21 incidents involved commercial fishing gear, and 13 involved serious injuries or mortalities. Seriousness of injuries was assessed using guidelines developed for marine mammal stock assessments under the MMPA (Angliss and Demaster 1998). This estimate is considered a minimum because not all entangled animals strand and not all stranded animals are found, reported, or cause of death determined. Stranding and entanglement data from 1998 – 2001 were analyzed in the draft 2005 SAR. Information on more recent events in Hawaii are available that, as of yet, has not been incorporated into the SAR analysis.

The overall fishery-related minimum mortality and serious injury rate for the entire stock is 3.39 humpback whales per year, based on observer data from Alaska (0.49), self reports from Alaska (0.4), stranding records from Alaska (2.25), and stranding records from Hawaii (0.25). The estimated fishery-related minimum mortality and serious injury rate incidental to commercial fisheries for the northern portion of the stock is 1.74 humpback whales per year, based on observer data from Alaska (0.49), stranding records from Alaska (1.0), and stranding data from Hawaii (0.25) (Angliss and Outlaw 2005). The estimated minimum mortality and serious injury rate incidental to the commercial fisheries in Southeast Alaska is 1.9 humpback whales per year, based on self reports from Alaska (0.4), stranding records from Alaska (1.25), and stranding data from Hawaii (0.25) (Angliss and Outlaw 2005). Because it is unknown whether the stranding reports for Hawaii involve animals from the central or northern portion of the central north Pacific stock, the level of serious injury/mortality is analyzed as though the animal came from either stock. However, the 0.25 animals per year reported via stranding reports for Hawaii is included once for the entire stock (Angliss and Outlaw 2005).

As mentioned previously, these estimates of serious injury/mortality levels should be considered a minimum. Several fisheries known to interact with this stock have not received observer coverage, resulting in an unreliable estimated mortality rate. Further, due to limited Canadian observer program data, mortality incidental to Canadian commercial fisheries (i.e., those similar to U.S. fisheries known to interact with humpback whales) is uncertain. Though interactions are thought to be minimal, data regarding the level of humpback whale mortality related to commercial fisheries in northern British Columbia are not available, again indicating that the estimated mortality incidental to commercial fisheries is underestimated for this stock (Angliss and Outlaw 2005).

7.2.2.2 Humpback Whale Ship Strikes

Humpback whales are vulnerable to ship strikes and other interactions with non-fishing vessels. Two documented ship strikes occurred in Southeast Alaska and one occurred in the northern portion of this stock's range. It is not known whether the difference in ship strike rates between Southeast Alaska and the northern portion of this stock is due to differences in reporting, amount of vessel traffic, densities of animals, or other factors. These 3 ship strike mortalities increased the average annual mortality of humpback whales for the entire stock by 0.75 from 1998 - 2001 (0.25 ship strikes/year for the northern portion of the stock, and 0.50 strikes/year for the southeast portion) (Angliss and Outlaw 2005).

7.2.2.3 Humpback Whale Habitat Concerns

The central north Pacific stock is the focus of a large whalewatching industry in its wintering grounds (Hawaii) and a growing whalewatching industry in its summering grounds (Alaska). Regulations concerning minimum distance to keep from whales and how to operate vessels when in the vicinity of whales have been developed for Hawaii waters in an attempt to minimize the impact of whalewatching. In 2001, NMFS issued regulations to prohibit most approaches to humpback whales in Alaska within 100 yards (91.4m; 66 FR 29502; May 31, 2001). The growth of the whalewatching industry, however, is a concern as preferred habitats may be abandoned if disturbance levels are too high.

Noise from the Acoustic Thermometry of Ocean Climate (ATOC) program, the U.S. Navy's Low Frequency Active (LFA) sonar program, and other anthropogenic sources (i.e., shipping and whale watching) in Hawaii waters is another concern for this stock. Results from experiments in 1996 off Hawaii indicated only subtle responses of humpback whales to ATOC-like transmissions (Frankel and Clark 1998). Frankel and Clark (2002) indicated that there were also slight shifts in humpback whale distribution in response to ATOC. Efforts are underway to evaluate the relative contribution of noise (e.g., experiments with LFA sound sources) to Hawaii's marine environment, although reports summarizing the results of recent research are not available.

7.2.2.4 Humpback Whale Serious Injury and Mortality Estimates

Serious injury and mortality levels for the central north Pacific stock of humpback whales are shown in Table 2. The total estimated annual mortality and serious injury rate for the entire stock is 4.14, of which 3.4 is fishery related. Under the MMPA, potential biological removal (PRB) refers to 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 (16USC sec. 1362). The PBR for the entire stock of central north Pacific humpback whales is 12.9 animals per year (Angliss and Outlaw 2005). While the total estimated annual mortality and serious injury rate of 4.14 is below the PBR of 12.9 this should be considered as a minimum estimate of annual mortality and serious injury.

Data types for fishery-related information								
Area	Observer data	Self reports	AK Strand.	HI Strand.	Total fish.	Ship strikes	Total	“PBR”
Northern	0.49		1.0	0.25	1.74	0.25	2.0	9.9
Southeast		0.4	1.25	0.25	1.9	0.5	2.4	3.0
TOTAL	0.49	0.4	2.25	0.25*	3.39**	0.75	4.14***	12.9

Table 2. Summary of serious injury and mortality levels (SI/M) for the central north Pacific stock of humpback whales. * The average annual SI/M in HI is 0.25, not 0.5; in the area-specific analysis, 0.25 is added to both the northern and southern portions of the CNP stock because animals from both portions of the stock feed in HI, so it is not known to what portion of the stock this level of SI/M should be assigned. ** This is the sum of the observed SI/M (0.49), the self reports (0.4), the AK strandings (2.25), and the average HI stranding rate (0.25). * This is the sum of 3.39 + 0.75. Source: Angliss and Outlaw 2005.**

7.2.3 Other Whales

Although blue whales, fin whales, northern right whales, sperm whales, and sei whales are found within the action area and could potentially interact with the Hawaii-based pelagic, deep-set longline fishery, there have been no reported or observed incidental takes of these species in this fishery. Therefore, although the action area for the proposed fisheries includes the distribution of endangered blue whales, fin whales, Pacific right whales, sperm whales and sei whales, the proposed action is not likely to adversely affect these species, which will not be considered further in this Opinion.

7.3 Sea Turtles

For the purposes of this consultation, this Opinion focuses first on the effects of the Hawaii-based pelagic, deep-set longline fishery on sea turtle populations in the Pacific Ocean as distinct from their listed distributions. Sea turtle populations in the Pacific Ocean are biologically significant, loss of populations from the Pacific would result in a significant gap in the distribution of each turtle species. Finally, the loss of these sea turtle populations in the Pacific Ocean would dramatically reduce the distributions and population abundances of these species and would, by itself, appreciably reduce the entire species’ likelihood of surviving and recovering in the wild. Conversely, if effects from the proposed action are deemed not likely to reduce appreciably, the survival and recovery of Pacific sea turtle populations’ in the wild, there would be no logical connection to state that the continued existence of the entire species would be jeopardized by the proposed action. Once we have completed the analysis of the effects on these sea turtle populations, we will then evaluate the effects of the Hawaii-based, pelagic, deep-set longline fishery on each species’ population as listed. The following subsections summarize information contained on pages 40 -114 in the 2004 BiOp and focus on sea turtle populations likely to be affected by the proposed action in the Pacific.

7.3.1 Hawksbill Sea Turtle

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. 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. 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 longline fishery (there have been no reported or observed interactions between these pelagic longliners and hawksbill turtles). Based on the available data and the distribution of hawksbill turtles relative to the distribution of the deep-set longline fishery, NMFS does not anticipate future interactions between hawksbill turtles and longline gear. Thus, hawksbill sea turtles will not be considered further in this Opinion.

7.3.2 Green Sea Turtles

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 face a measurable risk of extinction (Seminoff 2004).

Green turtles range in the western Atlantic from as far north as Long Island Sound to Argentina, including the Gulf of Mexico and Caribbean (Wynne and Schwartz 1999). Green turtles face many of the same natural and anthropogenic threats as for loggerhead sea turtles described below. In the continental United States, green turtle nesting occurs on the Atlantic coast of Florida (Ehrhart 1979). Recent population estimates for the western Atlantic area are not available. However, the pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the ten years of regular monitoring since establishment of index beaches in 1989. However, given the species' late sexual maturity, caution is warranted about over interpreting nesting trend data collected for less than 15 years.

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.

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. in press). 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.

Region	Index Site	Status	Trend	Abundance Estimate				
				Past	Years	Present	Years	Percent change[b]
eastern Pacific	Mexico (Colola, Michoacan)	Endangered	Declining[a]	15,000	1970	851[a]	1997-2001	- 96%
	Ecuador (Galapagos Is.)	Threatened	Stable	~1,400	1976-1982	~1,400	1999-2001	0%
central Pacific	U.S. Hawaii (French Frigate Shoals)	Threatened	Increasing	387	1974-1978	574	1999-2000	53%
western Pacific	Australia (southern Great Barrier Reef, Heron Is.)	Threatened	Increasing	~400	1964-1969	562	1993-1999	44%
	Austraila (northern Great Barrier Reef, Raine Is.)	Threatened	Increasing	2,361 females/ night	1974-1979	~18,000 females/ season	2001	56%

Table 3. Description of green turtle population status and trend by region in the Pacific Ocean from Seminoff (2004). Past and present (current until 2001) abundance estimates are based on nesting female census data from the years listed to the right of the estimate.

[a] There are different values and trends reported in the literature for nesting females at Colola, Michoacan, Mexico in recent years. While Seminoff (2004) describes the stock as declining based on data from Alvarado et al. 2001 and a personal communication reference; Chaloupka et al. (in press) describes this stock as a stable or increasing based on a draft of Seminoff (2002). Seminoff (2004) reports 2001 nesting female abundance to be 851 animals and the 2004 BiOp (NMFS 2004) reports an updated estimate of 2,100 nesting females in 2001.

[b] Percent change in nesting female abundance since the earliest count listed for each index site (Seminoff 2004).

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
Green turtles that interact with the Hawaii-based longline fisheries will be members 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). Therefore, this section will focus on the status and trends of eastern and central Pacific green turtle populations.

Central Pacific - Hawaii
Green turtles in Hawaii are considered genetically distinct and geographically isolated although a nesting population at Islas Revillagigedos in Mexico appears to share the mtDNA haplotype that commonly occurs in Hawaii. In Hawaii, green turtles nest on six small sand islands at French Frigate Shoals, a crescent-shaped atoll situated in the middle of the Hawaiian Archipelago (Northwestern Hawaiian Islands) (Balazs 1995). Ninety to 95% percent of the nesting and breeding activity occurs at the French Frigate Shoals, and at least 50% of that nesting takes place on East Island, a 12-acre island. Long-term monitoring of the population shows that there is strong island fidelity within the regional rookery.

Researchers monitoring East Island since 1973 have collected information on numbers of females nesting annually and have conducted tagging studies (Balazs 2002). Since the enactment of the ESA in 1973, and following years of exploitation, the nesting population of Hawaiian green turtles has shown a steady increase (Balazs 1996; Balazs and Chaloupka 2004). The number of nesting females at East Island increased from 67 nesting females in 1973 to 467 nesting females in 2002. Nesting abundance increased rapidly at this rookery during the early 1980s, leveled off during the early 1990s before again increasing rapidly during the late 1990s and up to the present. This trend is very similar to the underlying trend in the recovery of the much larger green turtle population that nests at Tortuguero, Costa Rica (Bjorndal et al. 1999). The stepwise increase of the long-term nester trend since the mid-1980s is suggestive, but not conclusive, of a density-dependent adjustment process affecting sea turtle abundance at the foraging grounds (Bjorndal et al. 2000; Balazs and Chaloupka 2004). Balazs and Chaloupka (2004) conclude that the Hawaiian green sea turtle stock is well on the way to recovery following 25 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). Low level nesting also occurs at Laysan Island, Lisianki Island and on Pearl and Hermes Reef (NMFS and USFWS 1998a).

Important resident areas of green turtles have been identified and are being monitored along the coastlines of Oahu, Molokai, Maui, Lanai, Hawaii, and at nesting areas in the reefs surrounding the French Frigate Shoals, Lisianski Island, and Pearl and Hermes Reef (Balazs 1982; Balazs et al. 1987).

The green turtle population in the Hawaiian Islands area is afflicted with a tumor disease, fibropapillomatosis, which is of an unknown etiology and often fatal, as well as spirochidiasis, both of which are the major causes of stranding of this species. Green turtles captured off Molokai from 1982-96 showed a massive increase in fibropapillomatosis over this period. Prevalence of fibropapillomatosis peaked at 61% occurrence in 1995 (Balazs et al.1998). Preliminary evidence suggests that there is an association between the distribution of fibropapillomatosis in the Hawaiian Islands and the distribution of toxic benthic dinoflagellates

(*Prorocentrum* spp.) known to produce a tumor promoter, okadaic acid (Landsberg et al. 1999). Stranding reports from the Hawaiian Islands from 1982-1999 indicate that the green turtle is the most commonly stranded sea turtle (96.5 percent, compared to other species), averaging around 150 per year (2,689 total/18 years). While the disease is often fatal, a recent study found no apparent effect of fibropapillomatosis on Hawaiian green turtle population-specific somatic growth rates (Balazs and Chaloupka 2004b). Moreover, despite the occurrence of fibropapillomatosis in the Hawaiian Archipelago green turtle stock, nester abundance continues to increase (Aguirre et al. 1998 in Balazs and Chaloupka 2004) and the stock is well on the way to recovery (Balazs and Chaloupka 2004b).

Eastern Pacific - Distribution and Abundance of Nesting Females
Analysis using mitochondrial DNA (mtDNA) sequences from three key nesting green turtle populations in the eastern Pacific indicate that they may be considered distinct management units: Michoacán, Mexico; Galapagos Islands, Ecuador, and Islas Revillagigedos, Mexico (Dutton 2003).

The primary green turtle nesting grounds in the eastern Pacific are located in Michoacán, Mexico, and the Galapagos Islands, Ecuador (NMFS and USFWS 1998a). Here, green turtles were widespread and abundant prior to commercial exploitation and uncontrolled subsistence harvest of nesters and eggs. Sporadic nesting occurs on the Pacific coast of Costa Rica.

Mexico
In the Mexican Pacific, the two main nesting beaches for female green turtles occur in Michoacán and include Colola, which is responsible for 70% of total green turtle nesting in Michoacán (Delgado and Alverado 1999), and Maruata. Green turtle populations at these nesting beaches have shown a dramatic decline, with the greatest decline in the early 1980s. From 1982 to 1984 the number of nesting females decreased from 5,585 to 940; which represents a decline of approximately 90% in two years. Since their decline in the 1980s from about 5,500 nesting females per year, the number of nesting females arriving at Colola Beach in Mexico has fluctuated widely from a low of 171 to a high of 880, until recently when about 2,100 female turtles returned to nest in 2001 (Figure 4).

Population growth rate parameters were calculated for green turtles using nesting female trend data from Colola Beach, Mexico (Snover 2005). These parameters apply only to the portion of the population represented by females in the adult stage. Population growth rate parameters were updated from the 2004 BiOp using the Dennis-Holmes running sum method which corrects for observation error when the entire population in not surveyed (Holmes 2001; Morris and Doak 2002). The running-sum of the nesting female counts results in a more accurate approximation of total population size. These values should be interpreted in a qualitative sense and the uncertainty about long term projections of extinction probabilities should be emphasized. Extinction probabilities extending over 50 and 100 year time periods based on only 25 years of variable trend information should be interpreted with caution. These values provide an indication of the general trend observed for the monitored component of the population and provide an indication of population viability given current population status and observed trends. It should also be noted that while the general trends observed in adult females on the nesting beach may be representative of population trends, in terms of increasing, decreasing, or stable; specific values for λ and r calculated from nesting beach censuses are not likely to represent the population as a whole (Snover 2005). Thus, λ and r are subscripted with an A to indicate that these numbers represent trends in the adult female portion of the population only (Snover 2005).

The mean log growth rate (= -0.01) and the finite rate of population growth (λ_A = 1.02) for this population indicate that this population is close to stable for now (Snover 2005). The mean estimated extinction probabilities indicate very low risks of quasi-extinction over the next 100 years (Table 4). However, given the uncertainties in our estimates of μ and σ^2 as indicated by the wide confidence intervals (Table 4), the possibility of quasi-extinction occurring over a 50 year time frame cannot be eliminated as a probability of almost 1 falls within the upper 95% CI (Snover 2005). Based on the 2-yr running sum, a low estimate of the number of adult females in this nesting aggregation as of 2002 was 3,260. Within the eastern Pacific there is additional nesting in the Galapagos Islands and Ecuador (Delgado and Alvarado 1999, NMFS and USFWS 1998). If we consider only Michoacan nesting, a conservative estimate of the total number of adult females is 4,238 (Snover 2005).

Demographic Parameter		Estimate
Log growth rate (μ)		-0.01 [-0.16, 0.14]
Variance in mean log growth rate (σ^2)		0.06 [0.02, 0.32]
Finite rate of change in population size (λ_A)		1.02 [0.87, 1.35]
Instantaneous rate of change in population size (r_A)		0.02 [-0.14, 0.30]
Risk of quasi-extinction		
Probability of quasi-extinction ever occurring		1 [0.03, 1]
Median time to quasi-extinction (yr)		>100
Probability of quasi-extinction in:	25 yr	0 [0, 0.46]
	50 yr	0.02 [0, 1]
	100 yr	0.14 [0, 1]
Risk of ultimate extinction		
Probability of extinction ever occurring		1 [0, 1]
Median time to extinction (yr)		>100
Probability of extinction in:	25 yr	0 [0, 0]
	50 yr	0 [0, 0.46]
	100 yr	0 [0, 1]

Table 4. Results of the Dennis-Holmes Model for green turtles from Colola Beach, Michoacan, Mexico. Unless otherwise noted, values are reported as means with the lower and upper 95% confidence intervals in brackets. Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female. (Source: Snover, 2005).

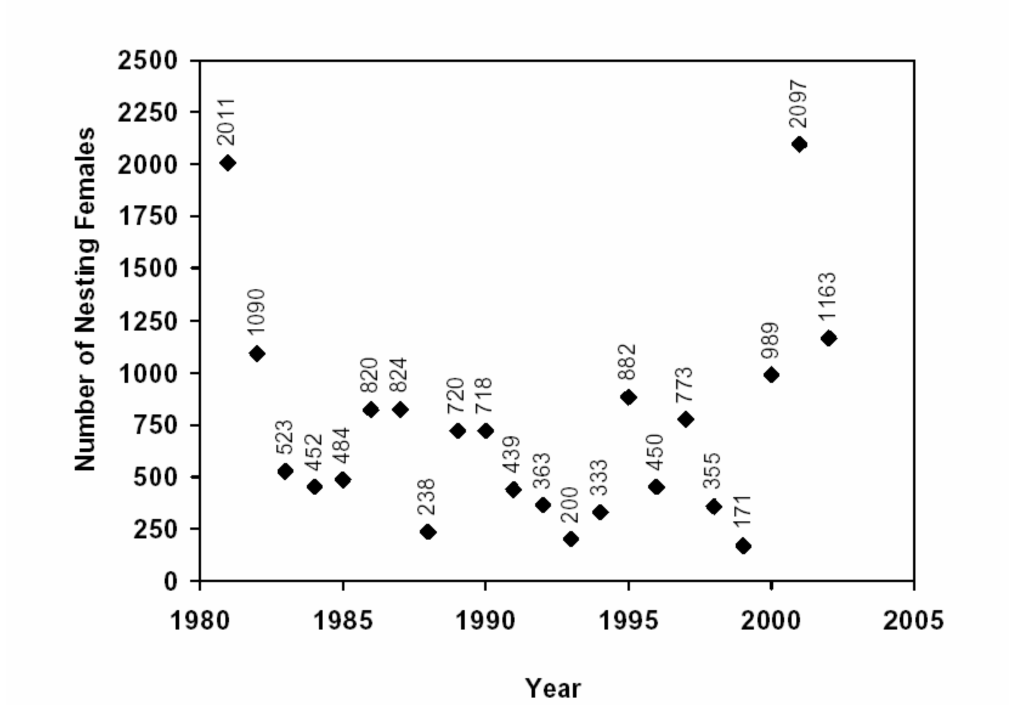

Figure 4. Estimated numbers of nesting green turtles at Colala Beach, Michoacan, Mexico. (Data source: 2004 BiOp, pg. 57; figure source: Snover 2005).

Ecuador

There are few historical records of abundance of green turtles from the Galapagos. Investigators documented nesting females during the period 1976-1982 and recorded an annual average of 1,400 nesting females. During that period, only residents were allowed to harvest turtles for subsistence and egg poaching occured only occasionally (NMFS and USFWS 1998a). The main documented threats registered in the past were: presence of introduced feral pigs (*Sus scrofa*), and a native beetle (*Omorgus suberosus*). Both of these combined to reduce turtle hatchling success during earlier monitoring years (Zárate et al. 2003). After nearly twenty years of limited data, a field study commenced in 2002 to assess the status of green turtles nesting in the main nesting sites of the Galapagos Archipelago. The most important nesting beaches are Quinta Playa and Bahía Barahona, both on Isabela Island, Las Bachas, Santa Cruz Island, Las Salinas, Seymour Island, and Espumilla, Santiago Island. All are protected as national parks or tourist sites, or are under military jurisdiction, etc. Monitoring sites included all of the above-listed nesting beaches except Espumilla. Nesting activity was monitored for nearly 4 months in Las Bachas and approximately 3 months on the remaining sites. During the 2002 season, a total of 2,756 females were tagged, with the highest numbers in Las Bachas (925 females). This total outnumbers the highest values recorded in previous studies (1,961 females tagged in 1982). Researchers observed few feral pigs and they were only observed in Qunita Playa. There were few documented beetle observations, although feral cats were observed predating on hatchlings as they emerged from the nest (Zárate et al. 2003).

7.3.3 Leatherback Turtles

Global Status

The leatherback sea turtle was listed as endangered throughout its global range on June 2, 1970. Leatherbacks are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, and Indian oceans; the Caribbean Sea; and the Gulf of Mexico (Ernst and Barbour 1972). Leatherback sea turtles are the largest living turtles and range farther than any other sea turtle species. Their large size and tolerance of relatively low temperatures allow them to occur in northern waters such as off Labrador and in the Barents Sea (NMFS and USFWS 1995). Adult leatherbacks forage in temperate and subpolar regions from 71° N to 47° S latitude in all oceans and undergo extensive migrations to and from their tropical nesting beaches.

In 1980, the leatherback population was estimated at approximately 115,000 adult females globally (Pritchard 1982). That number, however, 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 under-estimated 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. However, at this time, Spotila et al. (1996) represents the best estimate of the global adult female leatherback population size. Since Spotila's 1996 estimate, the eastern Pacific leatherback population has continued to decline, leading some researchers to conclude that the leatherback is now on the verge of extinction in the Pacific Ocean (Spotila et al. 2000).

The status of the Atlantic leatherback population is less clear than the Pacific population. The total Atlantic population size is undoubtedly larger than in the Pacific, but overall population trends are unclear. In 1996, the entire western Atlantic population was characterized as stable at best (Spotila et al. 1996), with numbers of nesting females reported to be on the order of 18,800. A subsequent analysis by Spotila (personal communication) indicated that by 2000, the western Atlantic nesting population had decreased to about 15,000 nesting females. According to NMFS' Southeast Fishery Science Center (2001) the nesting aggregation in French Guiana has been declining at about 15 percent per year since 1987. However, from 1979-1986, the number of nests was increasing at about 15 percent annually which could mean that the current 15 percent decline could be part of a nesting cycle which coincides with the erosion cycle of Guiana beaches described by Schultz (1975). In Suriname, leatherback nest numbers have shown large recent increases (with more than 10,000 nests per year since 1999 and a peak of 30,000 nests in 2001), and the long-term trend for the overall Suriname and French Guiana population may show an increase (Girondot 2002 in Hilterman and Goverse 2003). The number of nests in Florida and the U.S. Caribbean has been increasing at about 10.3 percent and 7.5 percent, respectively, per year since the early 1980s but the magnitude of nesting is much smaller than that along the French Guiana coast (NMFS SEFSC 2001). Also, because leatherback females can lay 10 nests per season, the recent increases to 400 nests per year in Florida may only represent as few as 40 individual female nesters per year. The increase in nests observed in Florida can be explained by increases in nesting survey effort in recent years, as well as a real increase in documented nests.

In summary, the conflicting information regarding the status of Atlantic leatherbacks makes it difficult to characterize the current status. Increases in the number of nesting females have been noted at some sites in the Atlantic, but these are far outweighed by local extinctions, especially of island populations, and the demise of once large populations throughout the Pacific, such as in Malaysia and Mexico.

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 and Puerto Rico. In the Indian Ocean, leatherback nesting aggregations are reported in India and Sri Lanka.

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. 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).

Populations Exposed to the Hawaii-based Longline Fishery
Based on the limited genetic sampling from the action area, about 94% of the leatherback turtle sampled (17 of 18 genetic samples) originated from western Pacific nesting beaches (NMFS 2004, Peter Dutton, NMFS, personal communication, April, 2005). These turtles could represent individuals from Indonesia (Jamursba-Medi or War-Mon), Papua New Guinea (Kamiali or other areas of the Huon Gulf), Malaysia (Terrenganu), the Solomon Islands, or Fiji, although satellite tracks from leatherback turtles tagged in Papua New Guinea suggest that these turtles tend to migrate south instead of north, which would take them away from the action area. Further, 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 most likely.

The remaining 6% of the interactions would represent turtles from the eastern Pacific Ocean. These turtles could represent individuals from nesting aggregations along the coast of Mexico, Costa Rica, or Panama, although turtles from these nesting aggregations may only migrate into the action area when oceanic phenomena like El Nino 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 these turtles migrate toward the coast of South America where upwelling water masses provide an abundance of prey. Although these data suggest that the Hawaii-based longline fisheries are more likely to interact with leatherback turtles from Indonesia, over a period of several years, these fisheries may interact with turtles from the other, smaller nesting aggregations.

Western Pacific
Leatherback turtles originating from the western Pacific are threatened by poaching of eggs, killing of nesting females, human encroachment (development, beach armoring, beachfront lighting, etc.) on nesting beaches, incidental capture in fishing gear, beach erosion, and egg predation by animals. Little is known about the status of the western Pacific leatherback nesting populations but once major leatherback nesting assemblages are declining along the coasts of Malaysia and Indonesia, and anecdotal information suggest that population declines have also occurred in Papua New Guinea, the Solomon Islands, and Vanuatu. Low density and scattered nesting of leatherback turtles occurs in Fiji, Thailand, and Australia (primarily western and to a lesser extent, eastern).

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 Cooperative Workshop sponsored by the Council from May 17 -21, 2004, a total of 25 leatherback nesting sites were identified for the western Pacific region, of which 19 were previously unknown or poorly documented (Dutton et al. in press). Annual nesting among these 25 sites is estimated to be at least 2000 females. Spotila et al. (2000) estimated the number of nesting females in the western Pacific at 1,800. Recently reported nesting sites increase this estimate to *c*. 5,000 nesting females in the western Pacific (Dutton et al. in press).While this estimate is higher then that presented by Spotila et al. (2000) there are still indications of a long term decline in leatherback nesting in the western Pacific. Hitipeuw et al. (in press) note that due to the remoteness and lack of consistent monitoring, the status of most leatherback populations in the Pacific is unclear. Dutton et al. (in press) highlight the need to conduct beach monitoring and protection work at key nesting sites in the western Pacific.

Malaysia
The decline of leatherback turtles is severe at one of the most significant nesting sites in the western Pacific region - Terrenganu, Malaysia, with current nesting representing less than 2 percent of the levels recorded in the 1950s. The nesting population at this location has declined from an estimated 3,103 females nesting in 1968 to 2 nesting females in 1994 (Chan and Liew 1996). With one or two females reportedly nesting each year, this population has essentially been eradicated (P. Dutton, NMFS, personal communication, 2000).

Indonesia
The northwest coast of the province of Papua in Indonesia is thought to support the largest remaining leatherback nesting population in the Pacific (Hitipeuw et al. in press). In the state of Papua, leatherback nesting generally takes place on two major beaches: Jamursba-Medi (18 km long) and War-Mon beach (4.5 km long) (Starbird and Suarez 1994). Approximately 30 km of coastline separates the two nesting sites. Nesting activity was monitored at Jamursba-Medi from 2001 to 2004 and at War-Mon from 2002 to 2004 (Hitipeuw et al. in press). Number of nests

recorded at Jamursba-Medi ranged from 1,865 to 3,601 each season. At War-Mon Beach, 1,788 to 2,881 nests were recorded each season. Approximately 500 to 1500 females nest annually at Jamursba-Medi (Hitipeuw et al. in press). Although this population has not been monitored consistently, it appears there has been a long term decline since the 1970s. Hitipeuw et al. (in press) reanalyzed previous sporadic records of nesting activity at these beaches from 1981-2001 and found that while there are indications of a long term decline, the Papua, Indonesia population has not yet reached the severely depleted levels evident at other rookeries in the Pacific (Hitipeuw et al. in press).

Using lessons learned from a decade of field activities at Jamursba Medi and technical support from NMFS' Southwest Fishery Science Center and funding support from the Council, WWF-Indo implemented a conservation and monitoring project at War-mon Beach, Papua as part of a larger framework to conserve critically endangered Pacific leatherback turtles in Indonesia. The primary goals of this project are to quantify nesting population dynamics and maximize leatherback hatchling production by reducing predation and human induced impacts at this previously unmonitored and unmanaged leatherback nesting beach. Prior to implementation of this project, egg harvest and predation were considerable threats at War-mon (Irene Kinan, WPFMC personal communication, July 5, 2005; Starbird and Suarez 1994; Suarez et al. 2000). As documented by Starbird and Suarez (1994), poaching at unprotected War-mon Beach exceeded 60% and pig predation impacted the remaining 40%. With the establishment of a year-round monitoring project in 2003/04, coastal patrols are currently being conducted to prevent disturbance and exploitation of the beach (Hitipeuw 2003; Hitipeuw 2004). During the 2003/04 nesting season, a major reduction in impacts was realized. Of the, 2,881 nests laid, only 18% were predated upon and none were poached by humans. These population level benefits continue in 2005.

Population estimates for Papua must be treated with caution given the recent discovery of the large nesting aggregation at War-Mon Beach, Papua. It remains to be determined whether Jamursba-Media and War-Mon are two distinct nesting stocks (Dutton et al. in press). Information on leatherback nesting is lacking for a large area of coastline stretching from War-Mon and Jamursaba-Medi to the border with Papua New Guinea (Dutton et al. in press). Leatherback turtles have been protected since 1978 in Indonesia. Low density nesting also occurs 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).

Population growth rate parameters were calculated for Jamursba-Medi, Papua, Indonesia. These parameters apply only to the portion of the population represented by females in the adult stage. Population growth rate parameters were updated from the 2004 BiOp using the Dennis-Holmes running-sum method which corrects for observation error when the entire population is not surveyed (Holmes 2001; Morris and Doak 2002). Caution must be used in interpreting the results for Jamursba-Medi (Snover 2005). Using the running-sum methodology requires sequential years of data in the census, hence, only the data available from 1993 and on were used in this analyses, and the data point for 1998 had to be interpolated (Figure 5). Based on a census of this nesting beach in 1984, the current numbers of nesting females are roughly 25% of this earlier observation (Figure 5). In addition, it is uncertain whether current and past hatchling production from this and neighboring beaches are enough to sustain the adult population levels (Hitipeuw et al. in press).

The trend analysis of this nesting beach indicates that it is and has been relatively stable for the past decade; however the numbers of nesting females do not show increasing numbers indicating that they are recovering to historical levels (Table 5). Because the Jamursba-Medi nesting population is stable, increases in adult mortality or decreases in recruitment into the adult population (as from poor hatchling production) can cause the nest numbers to decline and the extinction risks presented here to change rapidly (Snover 2005). However, current analyses indicate that this population is at a low risk of quasi- and ultimate extinction over the next 100 years. Given the uncertainties in our estimates of μ and σ^2, however, the possibility of quasi-extinction occurring over a 25 yr time frame and ultimate extinction[7] occurring over a 50 yr time frame cannot be eliminated as a probability of almost 1 falls within the upper 95% CI for these time periods (Table 5).

[7] Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female.

Demographic Parameter		Estimate (baseline)
Log growth rate (μ)		-0.01 [-0.31, 0.29]
Variance in mean log growth rate (σ^2)		0.05 [0.02, 1.01]
Finite rate of change in population size (λ_A)		1.01 [0.74, 2.21]
Instantaneous rate of change in population size (r_A)		0.02 [-0.30, 0.79]
Risk of quasi-extinction		
Probability of quasi-extinction ever occurring		1 [0.15, 1]
Median time to quasi-extinction (yr)		>100
Probability of quasi-extinction in:	25 yr	0.01 [0, 0.970]
	50 yr	0.07 [0, 1]
	100 yr	0.26 [0, 1]
Risk of ultimate extinction		
Probability of extinction ever occurring		1 [0.02, 1]
Median time to extinction (yr)		>100
Probability of extinction in:	25 yr	0 [0, 0.14]
	50 yr	0 [0, 1]
	100 yr	0.01 [0, 1]

Table 5. Results of the Dennis-Holmes Model for leatherback turtles from Jamursba-Medi, Papua. Unless otherwise noted, values are reported as means with the lower and upper 95% confidence intervals in brackets. Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female. (Source: Snover 2005).

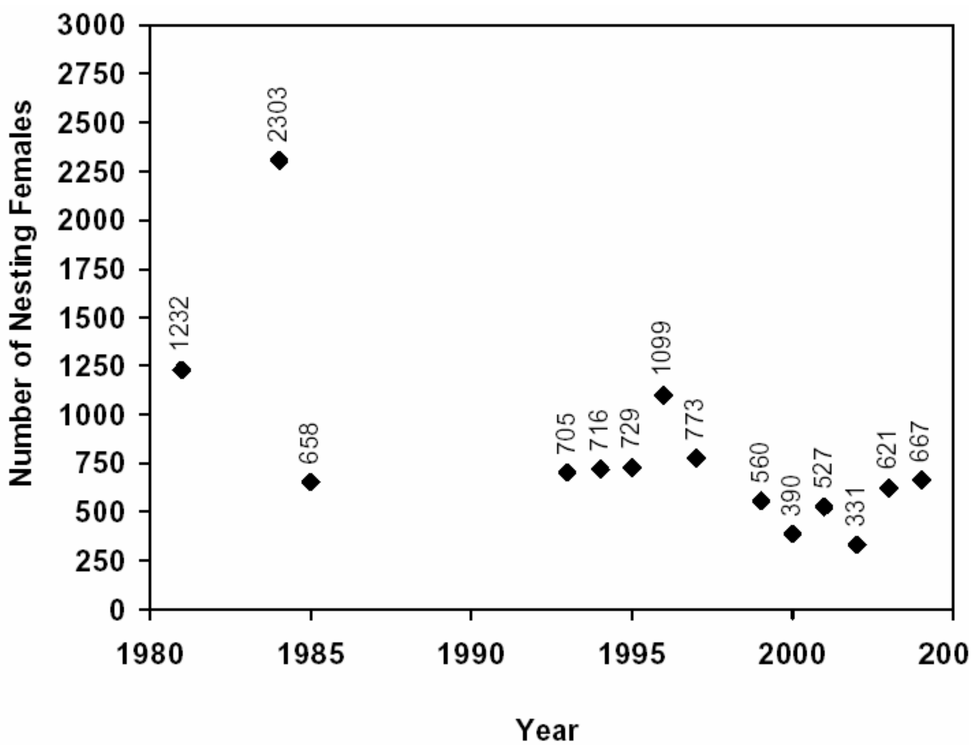

Figure 5. Estimated number of nesting leatherback turtles at Jamursba-Medi, Papua (Hitipeuw et al. in press). These data represent the lower number of nesting females estimated from nest counts. For the Dennis-Holmes model, only data from 1993-2004 were used so that the running-sum methodology could be incorporated. No data were reported for 1998, thus the intermediate value between 1997 and 1999 was interpolated to estimate 1998 nesting abundance. (Figure Source: Snover 2005).

Papua New Guinea

The number of leatherback turtles nesting on the north coast of Papua New Guinea (PNG) remains unknown but is likely much lower than in War-Mon and Jamursba-Medi, Indonesia (Benson et al. in press). In Papua New Guinea, leatherbacks nest primarily along the coast of the Huon Gulf in the Morobe Province. The Kamiali nesting beach (located in the Morobe Province and within the Kamiali Wildlife Management Area) is approximately 11 km long and is an important nesting area for leatherbacks. For the periods 2000-2001 and 2003-2004 a total of 41 and 71 nesting females were recorded, respectively (Benson et al. in press).

Due to increasing awareness and concern about the local declines in nesting leatherbacks, the Kamiali community agreed to a 100 meter no-take zone in 1999, increased to a 1 km no-take zone in 2000, and 0.5 km was added in 2001 (1.5 km total). The no-take zone is effective from December to February (nesting season). The Council sponsored a community meeting in Kamiali in October, 2003. At this meeting, the Kamiali community maintained this moratorium and expanded it by another 0.5 km (total of 2 km) effectively banning villagers and outsiders from harvesting eggs and meat for the entire 2003/04 nesting season. As of October 2004, the area was expanded to encompass the entire 10km stretch of beach at Kamiali Wildlife Management Area (Karol Kisokau, Kamiali Integrated Conservation Development Group, personal communication, May 19-21, 2004). To date, the Kamiali community implements a community-based nesting beach monitoring program (supported by the Council) and nests laid at Kamiali are conserved *in situ.*

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% 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 for nest numbers was 559 (Benson et al. in press).

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 in press). Past studies have identified four important nesting beaches in Isabel Province: Sasakolo, Lithoghahira, Lilika, and Katova. Egg harvest by humans has been reported in the past. In addition, lizards and iguanas have been documented predating on leatherback eggs (Rahomia et al. 2001).

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 5 per year, generally outside of Great Barrier Reef in southeast Queensland. Human related threats include incidental capture in fisheries and ingestion and entanglement in marine debris (Dobbs 2002).

Eastern Pacific
Leatherback nesting populations are declining at a rapid rate along the Pacific coast of Mexico and Costa Rica. 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, with few areas of high nesting (Sarti 2002).

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 6) (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).

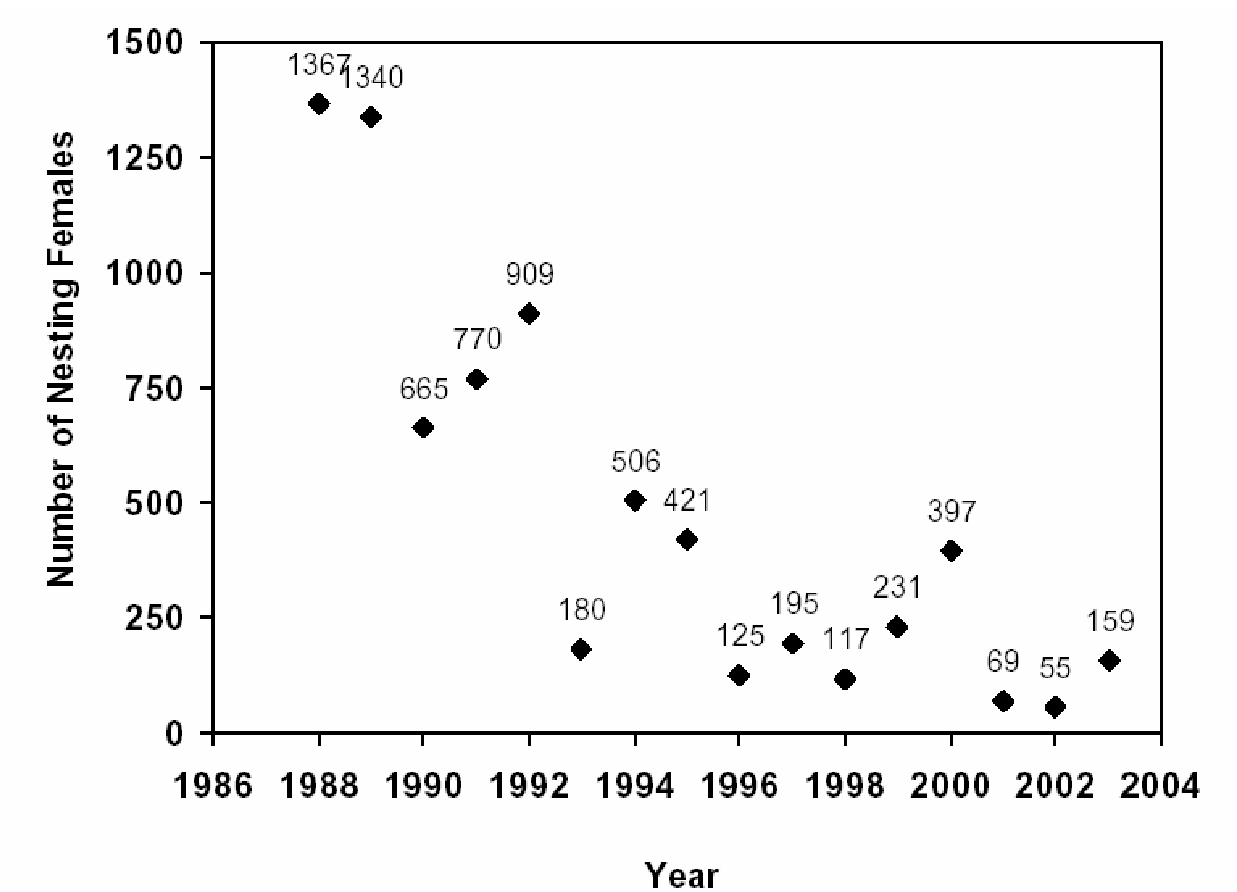

Figure 6. Estimated number of nesting female leatherback turtles at Playa Grande, Costa Rica (Spotila et al. 2000; Reina et al. 2002; numbers for the 2002/2003 and 2003/2004 seasons came from http://www.leatherback.org/pages/project/report/report0304.htm and were confirmed by personal communication from R. Reina to C. Fahey). The nesting season occurs over the winter months and hence over two calendar years. Therefore, the year on the x-axis is the earlier calendar year of the census and the season would be denoted year/yaer+1. (Figure Source: Snover 2005).

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 St. Croix, US 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 non-nesting years. Since 1993, environmental education and conservation efforts through active law enforcement have greatly reduced egg poaching in Costa Rica (Chaves et al. 1996). 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).

Population growth rate parameters were calculated for nesting female leatherbacks at Playa Grande, Costa Rica. These parameters apply only to the portion of the population represented by females in the adult stage. Population growth rate parameters were updated from the 2004 BiOp using the Dennis-Holmes running sum method which corrects for observation error when the entire population in not surveyed (Holmes 2001; Morris and Doak 2002). As evidenced by the trends in the nesting beach census data (Figure 6), there is a high probability of quasi- and ultimate extinction of this population of leatherbacks, consistent with Spotila et al. (2000). The mean and upper 95% CI are consistent with near certainty that the population will reach quasi-extinction thresholds within the next 20-25 yr and over the next 50-100 yr, the degree of certainty of quasi-extinction increases (Table 6) (Snover 2005). There is a high probability of ultimate extinction over a 50-100 yr time period as well (Table 6).

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. The 2 yr running sum estimated 124 total adult females as of 2002 for the Playa Grande population and a similar analyses of Mexican nesting beaches indicates 1,100 adult females as of 2001 (2004 BiOp). Thus, a total of 1,224 total adult females is estimated for the eastern Pacific (Snover 2005).

Demographic Parameter		Estimate (baseline)
Log growth rate (μ)		-0.15 [-0.33, 0.03]
Variance in mean log growth rate (σ^2)		0.02 [0.01, 0.67]
Finite rate of change in population size (λ_A)		0.87 [0.73, 1.43]
Instantaneous rate of change in population size (r_A)		-0.14 [-0.32, 0.36]
Risk of quasi-extinction		
Probability of quasi-extinction ever occurring		1 [0.90, 1]
Median time to quasi-extinction (yr)		8.99
Probability of quasi-extinction in:	25 yr	1 [0.22, 1]
	50 yr	1 [0.61, 1]
	100 yr	1 [0.91, 1]
Risk of ultimate extinction		
Probability of extinction ever occurring		1 [0.67, 1]
Median time to extinction (yr)		35.55
Probability of extinction in:	25 yr	0.02 [0, 0.95]
	50 yr	0.98 [0, 1]
	100 yr	1 [0.04, 1]

Table 6. Results of the Dennis-Holmes Model for leatherback turtles from Playa Grande, Costa Rica. Unless otherwise noted, values are reported as means with the lower and upper 95% confidence intervals in brackets. Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female. (Source: Snover 2005).

Mexico

The decline of leatherback subpopulations is even more dramatic off the Pacific coast of Mexico. Surveys indicate that the eastern Pacific Mexican population of adult female leatherback turtles has declined from 70,000[8] in 1980 (Pritchard 1982b, *in* Spotila et al. 1996) to approximately 60 nesting females during the 2002/03 nesting season, the lowest seen in 20 years (L. Sarti, UNAM, personal communication, June, 2003).

According to reports from the late 1970s and early 1980s, three beaches located on the Pacific coast of Mexico (Bahiá de Chacahua, Oaxaca, Tierra Colorada, Guerrero and Mexiquillo, Michoacán) sustained a large portion of all global nesting of leatherback turtles, perhaps as much as one-half. Because nearly 100% of the clutches in these areas were poached by local people, a monitoring plan was implemented to evaluate the nesting population and establish measures for the protection of eggs. From aerial surveys, daily beach surveys, and nightly patrols, the

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

following information has been determined for nesting leatherbacks on the Pacific coast of Mexico:

1. Four main nesting beaches: Mexiquillo, Michoacán; Tierra Colorada, Guerrero; and Cahuitan and Barra de la Cruz, in Oaxaca, comprise from 40-50% of total leatherback nests along the Mexican Pacific;
2. Four secondary nesting beaches: Chacahua, Oaxaca; La Tuza, Oaxaca; Playa Ventura, Guerrero, and Agua Blanca, Baja California Sur;
3. All eight beaches comprise approximately 75-80% of the total annual leatherback nests of the Mexican Pacific (Sarti, personal communication, December, 2003).

Monitoring of leatherback nesting assemblage at Mexiquillo, Mexico has been continuous since 1982. During the mid-1980s, more than 5,000 nests per season were documented along 4 kilometers of this nesting beach. By the early 1990s (specifically 1993), less than 100 nests were counted along the entire beach (18 kilometers) (Sarti 2002). According to Sarti et al. (1996), nesting declined at this location at an annual rate of over 22 percent from 1984 to 1995.

Censuses of four index beaches in Mexico during the 2000-2001 nesting season showed a slight increase in the numbers of females nesting compared to the all-time lows observed from 1996 through 1999 (Sarti et al. in prep). However, the number of nests during the 2001/2002 and 2002/2003 were the lowest ever recorded, as shown in Table 7.

Index Beach	2000-2001	2001-2002[1]	2002-2003[2]
Primary Nesting Beach (40-50% of total nesting activity)			
Mexiquillo	624	20	36
Tierra Colorada	535	49	8
Cahuitan	539	52	73
Barra de la Cruz	146	67	3
Secondary Nesting Beaches			
Aqua Blanca	113	No data	No data
Total – all index beaches	1,957	188	120
Total – Mexican Pacific	4,513	658	Not yet available

Table 7. Annual number of leatherback nests from 2000-2003 on primary and secondary nesting beaches.

1 Sarti, personal communication, March, 2002 – index beaches; Sarti et al. 2002 for totals;

2 Source: Sarti, personal communication, December, 2003 – index beaches, totals

A summary of total leatherback nests counted and total females estimated to have nested along the Mexican coast from 1995 through 2003 is shown in Table 8. During the 1980s, 30% of the nesting females per season were remigrants, but since the mid-1990s, there has been very little evidence of remigration (Sarti et al. 2000). During the 1999-2000 and 2000-01 nesting seasons, only a small increment in the number of remigrant turtles was observed (Sarti 2002).

Although the causes of the decline in the eastern Pacific nesting populations are not entirely clear, Sarti et al. (1998) surmise that the decline could be a result of intensive egg poaching on the nesting beaches, incidental capture of adults and juveniles in high seas fisheries, and natural fluctuations due to changing environmental conditions. Although leatherback turtles are not generally captured for their meat or skin in Mexico, the slaughter of female leatherback turtles has been detected on beaches such as Piedra de Tiacoyunque, Guerrero (Sarti et al. 2000). Leatherbacks were once harvested off Baja California but their meat is now considered inferior for human consumption (Nichols 2002). There is little information on incidental capture of adults due to coastal fisheries off Mexico, but entanglement in longlines and driftnets probably account for some mortality of leatherback turtles. Eckert (1997) speculates that the swordfish gillnet fisheries in Peru and Chile contributed to the decline of the leatherback in the eastern Pacific. The decline in the nesting population at Mexiquillo, Mexico occurred at the same time that effort doubled in the Chilean driftnet fishery.

Season	Nests	Females
1995-1996	5,354	1,093
1996-1997	1,097	236
1997-1998	1,596	250
1998-1999[1]	799[1]	67[2]
1999-2000	1,125	225
2000-2001	4,513	991
2001-2002	658	109-120

Table 8.Total leatherback nests counted and total number of females estimated to nest along the Mexican Pacific coast per season. (Source: Sarti et al. 2000 (1995-1999 data), Sarti et al. 2002 (2001-02 data), Sarti, personal communication, June, 2003 (2002-03 data).

1 Value corrected for E1 (error due to track and bodypit aging) and E2 (error due to difficulty of observation from the air) only.

2 Number of females only includes tagged females at the key beaches.

Most conservation programs aimed at protecting nesting sea turtles in Mexico have continued since the early 1980s, and there is little information on the degree of poaching prior to the establishment of these programs. However, Sarti et al. (1998) estimate that up to 100% of the clutches were taken from the Mexican beaches. Since protective measures have been in place, particularly emergency measures recommended by a joint U.S./Mexico leatherback working group meeting in 1999, there has been greater nest protection and nest success (Table 9).

The most recent results (2000-01) indicate that nearly 58% of clutches laid in key beaches in Mexico were relocated to hatcheries. This is a significant increase since 1996, when only 12% of nests were relocated. Although data are not available, most of the nests that were not moved are believed to have survived in situ in 2000-01, unlike previous years when it is assumed that all nests that are not relocated are taken by poachers. This has been due to successful involvement of community leaders in Cahuitan, the most important leatherback beach in the nest protection program. At this beach 24,797 eggs representing 80% of the nests laid were protected, producing a total of 12,275 hatchlings (L. Sarti, INP Preliminary Report).

Nesting Season	Number of clutches laid	Number of clutches protected	Percentage of clutches protected
1996-97	445	86	19.3
1997-98	508	101	19.9
1998-99	442	150	33.9
1999-00	1590	943	58.7
2000-01	1,732	933	57.04
2001-02	171	116	67.9

Table 9. Nest protection at index beaches on the Pacific coast of Mexico (Source: Sarti et al., personal communication, December, 2003)

Nicaragua
In Nicaragua, small numbers of leatherbacks nest on Playa El Mogote, and Playa Chacocente, both beaches within 5 kilometers of one another and located in the Rio Escalante Chacocente Wildlife Refuge. From October through December, 1980, 108 leatherbacks were sighted nesting on Playa Chacocente, while during January, 1981, 100 leatherbacks reportedly nested in a single night on Playa El Mogote (Arauz 2002). Similar to many of the leatherback nesting beaches along the eastern Pacific, the abundance of nesting females has decreased. An aerial survey conducted during the 1998-1999 season estimated a nesting density in Playa El Mogote of only 0.72 turtles per kilometer (Sarti et al. 1999 in Arauz 2002). During the 2000-01 nesting season, community members near Playa El Mogote noted that 210 leatherback nests had been deposited. Of these, 31 nests produced hatchlings, while the rest were poached (85% poaching rate). During the 2001-02 nesting season (monitored from October through March), leatherbacks successfully nested 29 times. Of these, 6 nests were protected in a hatchery and 23 were poached (79.3% poaching rate) (Arauz 2002).

Conclusions on the status of leatherbacks in the Pacific
Although quantitative data on human-caused mortality are scarce, the available information suggests that leatherback mortality on many nesting beaches remains at unsustainable levels (Tillman 2000). Published assessments of the extinction risks of leatherback turtles in the Pacific Ocean have concluded that these turtles have a very high risk of disappearing from the Pacific Ocean within one or two human generations (Spotila et al. 1996, 2002). Based on our review of the available information, eastern Pacific leatherback populations appear to be at much lower levels of abundance than western Pacific leatherback populations and the status of leatherbacks in the Pacific is worse than the status of Atlantic populations. Recent information (Dutton et al. in press) reveals that the status of nesting female leatherback populations in the south western Pacific region appears to be better than previously stated in Spotila (2000) 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 (Dutton et al. in press) thus, no statements can be made describing the anticipated outlook for these

populations for which we have no trend data. Different nesting aggregations of sea turtles are effectively isolated from one another; female leatherback turtles from other nesting beaches will not re-colonize beaches where nesting activity has become extinct. Therefore, if a nesting aggregation becomes extinct, it will remain extinct.

7.3.4 Loggerhead Turtles

Global Status
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. Loggerhead sea turtles inhabit the Atlantic Ocean, Pacific Ocean, Indian Ocean, Caribbean Sea and Mediterranean Sea.

In the Atlantic Ocean, absolute population size is not known, but based on nesting information, loggerheads are likely much more numerous than in the Pacific Ocean. NMFS recognizes five subpopulations of loggerhead sea turtles in the western north Atlantic based on genetic studies. There are no detectable nesting trends for the two largest western Atlantic subpopulations: the South Florida subpopulation and the northern subpopulation. Because of its size, the South Florida subpopulation may be critical to the survival of the species in the Atlantic Ocean. In the past, this nesting aggregation was considered second in size only to the nesting aggregation on islands in the Arabian Sea off Oman (Ross 1979, Ehrhart 1989, NMFS and USFWS 1991). However, the status of the Oman colony has not been evaluated recently and it is located in an area of the world where it is highly vulnerable to disruptive events such as political upheavals, wars, catastrophic oil spills, and lack of strong protections for sea turtles (Meylan et al. 1995). Given the lack of updated information on this population, the status of loggerheads in the Indian Ocean basin overall is essentially unknown.

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

Genetics
Of the loggerheads taken in the Hawaii-based longline fishery, all were determined to have originated from Japanese nesting beaches, based on genetic analyses (P. Dutton, NMFS, personal communication, August 9, 2005). Therefore, this fishery is impacting a subpopulation that consists of approximately 1,500 nesting females (Kamezaki et al. 2003).

Populations Exposed to Hawaii-based Longline Fisheries
In the Pacific Ocean, loggerhead turtles are represented by a northwestern Pacific nesting aggregation (located in Japan) and a smaller southwestern nesting aggregation that occurs in eastern Australia (Great Barrier Reef and Queensland) and New Caledonia (NMFS SEFSC 2001). All interactions in Hawaii-based fisheries are with loggerheads from Japanese rookeries.

The 2004 BiOP explains in detail, the numerous threats posed to loggerhead populations in their pelagic and terrestrial environments. Loggerhead turtles are heavily impacted by natural and anthropogenic factors at all phases of their lifecycle. The risks to loggerheads described in the 2004 BiOp remain. However, in addition to the loggerhead nesting beach monitoring and protection in the Atlantic, the Council, in collaboration with the Sea Turtle Association of Japan, began supporting nesting beach management activities at Hii-Horikiri and Minabe-Senri beaches, and Inakahama and Maehama beaches of Yakushima Island, Japan in 2004. Activities to protect loggerhead nests and hatchlings 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. During the 2004 nesting season, management efforts were successful and resulted in an estimated 99,239 hatchlings and 54,281 hatchlings produced at Inakahama Beach and Maehama Beach, respectively, and 3,447 hatchlings from Hii-Horikiri and Minabe-Senri (Matsuzawa 2005).

As described in the 2004 BiOp, loggerhead turtles are affected by a completely different set of anthropogenic threats in the marine environment. These include oil and gas exploration, coastal development, and transportation; marine pollution; underwater explosions; hopper dredging, offshore artificial lighting; power plant entrainment and/or impingement; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; poaching, and fishery interactions. In the pelagic environment, loggerheads are exposed to a series of offshore fisheries. In the benthic environment in waters off the coastal U.S., loggerheads are exposed to a suite of fisheries in federal and state waters including trawl, purse seine, hook and line, gillnet, pound net, longline, dredge, and trap fisheries. In 2004, the Council contracted with organizations working in Baja California, Mexico to reduce the incidental capture of juvenile loggerhead turtles in the seasonal halibut gillnet fishery. Objectives of the project are being met through activities involving outreach, education, gear research, and increased patrolling.

Japan

In the western Pacific, the only major nesting beaches are in the central and southern part of Japan (Dodd 1988). Balazs and Wetherall (1991) speculate that 2,000 to 3,000 female loggerheads nested annually in all of Japan. Latest estimates of number of nests on almost all of the rookeries were provided by the Sea Turtle Association of Japan (Table 10).

Year	Loggerhead Nests
1998	2,479
1999	2,255
2000	2,589
2001	3,122
2002	4,035
2003	4,519

Table 10. Total nests observed from 1998-2003 at all nesting beaches in southern Japan. (Source: Sea Turtle Association of Japan).

Considering multiple nesting estimates, Kamezaki et al. (2003) estimate that less than approximately 1,000 female loggerheads return to Japanese beaches per nesting season.

In Japan, loggerheads nest 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. There are nine "major nesting beaches" (defined as beaches having at least 100 nests in one season within the last decade) and six "submajor nesting beaches" (defined as beaches having 10-100 nests in at least one season within the last decade), which contain approximately 75% of the total clutches deposited by loggerheads in Japan (Kamezaki et al. 2003).

Two of the most important beaches in Japan, Inakahama Beach and Maehama Beach, located on Yakushima Island in the Nansei Shoto Archipelago, account for approximately 30% of all loggerhead nesting in Japan. 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. Sea turtle conservation and research is growing in Japan, resulting in more widespread beach summaries; however, there are limited reports describing the trends and status of loggerheads in this country (Kamezaki et al. 2003).

According to the latest status and trend information, as reviewed in Kamezaki et al. (2003):

> "In the 1990s, there has been a consistent decline in annual nesting, especially in Hiwasa Beach (89% decline) and Minabe (74% decline) [both of these are 2 of 9

> major nesting beaches]. For most beaches, the lowest nesting numbers recorded have been during the recent period of 1997-1999.
>
> In the 1980s, there were increases in nesting numbers. However, nesting at the beginning of the 1980s was in most instances greater than nesting at the same beach some 20 years later at the end of the 1990s.
>
> There are indications that the 1970s was a period of approximate population stability with respect to breeding numbers.
>
> For the one population with census data extending back to the 1950s (Kamouda Beach) [one of 6 submajor nesting beaches], there is a clear indication that the population has greatly declined."

In general, during the last 50 years, loggerhead nesting populations have declined 50-90% (Figure 7). Recent genetic analyses on female loggerheads nesting in Japan suggest that this "subpopulation" is comprised of genetically distinct nesting aggregations (Hatase et al. 2002) with precise natal homing of individual females. As a result, Hatase et al. (2002) indicate that loss of one of these aggregations would decrease the genetic diversity of Japanese loggerheads; recolonization of the site would not be expected on an ecological time scale.

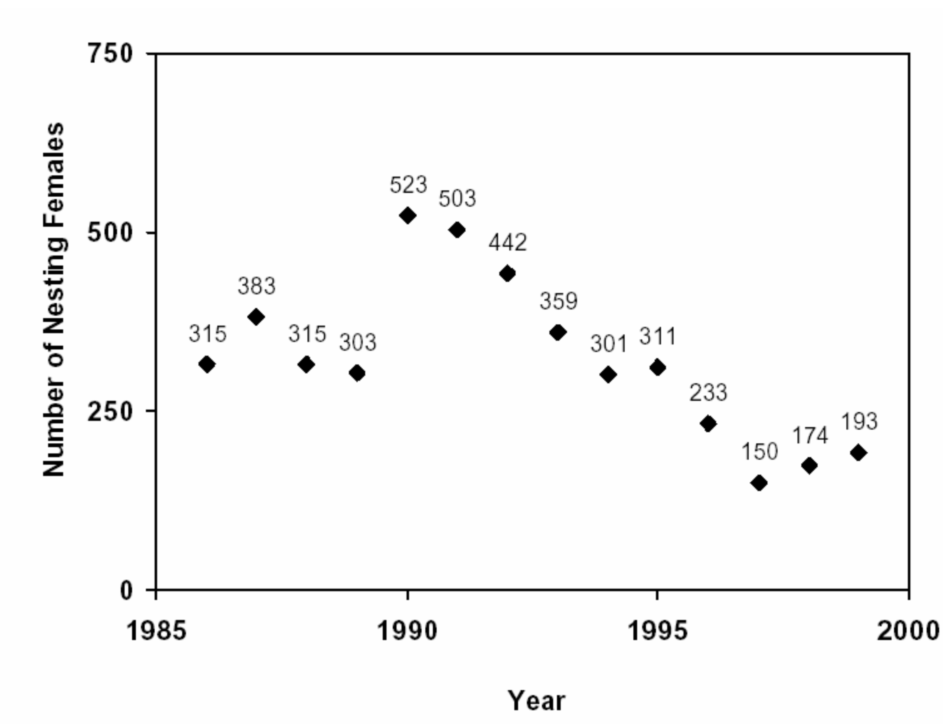

Figure 7. Estimated number of nesting female loggerhead turtles in Japan. Shown are the sums of nest counts for Hiwasa, Omaezaki, Minabe Senri, Inakahama, and Miyazaki (Kamezaki et al. 2003). Kamezaki et al. (2003) report nest numbers and these values were divided by 3.49, the average number of clutches per female

in a nesting season for loggerheads (van Burskirk and Crowder 1994), to estimate number of females. (Figure Source: Snover 2005).

Snover (2005) calculated population growth rate parameters for nesting female loggerhead turtles using a sum of the nesting data from 5 of the major nesting sites in Japan: Hiwasa, Omaezaki, Minabe Senri, Inakahama, and Miyazaki provided in Kamezaki et al. (2003). These parameters apply only to the portion of the population represented by females in the adult stage. Similar to other species, the confidence intervals around the extinction estimates are very wide and range from 0 to 1. Mean values, however, indicate increasing risks of both quasi- and ultimate extinction over the next 100 yr, with a high probability of quasi-extinction within 50 yr (Table 11). There is enormous variability about the mean log growth rate, yet the estimated time to quasi-extinction is estimated to be approximately 53 years (Table 11).

For the extinction risk calculation the value of 1,500 adult females was used as Kamezaki et al. (2003) estimate that less than 1,000 females nested in Japan annually from 1998-2000. Lewison et al. (2004) used the value of 1,500 adult females in the Japanese rookery as well.

Demographic Parameter		Estimate (baseline)
Log growth rate (μ)		-0.05 [-0.44, 0.34]
Variance in mean log growth rate (σ^2)		0.10 [0.04, 2.34]
Finite rate of change in population size (λ_A)		1.0 [0.66, 4.51]
Instantaneous rate of change in population size (r_A)		-0.00 [-0.42, 1.51]
Risk of quasi-extinction		
Probability of quasi-extinction ever occurring		1 [0.38, 1]
Median time to quasi-extinction (yr)		53.38
Probability of quasi-extinction in:	25 yr	0.13 [0, 1]
	50 yr	0.46 [0, 1]
	100 yr	0.81 [0, 1]
Risk of ultimate extinction		
Probability of extinction ever occurring		1 [0.12, 1]
Median time to extinction (yr)		>100
Probability of extinction in:	25 yr	0 [0, 0.57]
	50 yr	0.02 [0, 1]
	100 yr	0.30 [0, 1]

Table 11. Results of the Dennis-Holmes Model for loggerhead turtles from Japan. Unless otherwise noted, values are reported as means with the lower and upper 95% confidence intervals in brackets. Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female. (Source: Snover 2005).

7.3.5 Olive Ridley Turtles

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).

In the Atlantic, there has been a decline in abundance of olive ridleys since they were listed in 1978. Since 1967, the western North Atlantic (Surinam and adjacent areas) nesting population has declined more than 80 percent. In general, anthropogenic activities have negatively affected each life stage of the olive ridley turtle populations, resulting in the observed declines in abundance of some olive ridley turtle nesting aggregations. Other aggregations, 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.

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 Marianas Islands, Australia, Indonesia, Malaysia, and Japan (western Pacific), and Mexico, Costa Rica, Guatemala, and South America (eastern Pacific). In the Indian Ocean, nesting aggregations have been documented in Sri Lanka, east Africa, Madagascar, and 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.

Genetics

Recent genetic information analyzed from 44 olive ridleys taken in the Hawaii-based longline fishery 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), indicating the animals from both sides of the Pacific converge in the north Pacific pelagic environment.

Populations exposed to the Hawaii-based Longline Fishery

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

Eastern Pacific Ocean
In the eastern Pacific Ocean, nesting occurs all along the Mexican and Central American coast, with large nesting aggregations occurring at a few select beaches located in Mexico and Costa Rica. Few turtles nest as far north as southern Baja California, Mexico (Fritts et al*.* 1982) or as far south as Peru (Brown and Brown 1982). As mentioned previously, where population densities are high enough, nesting takes place in synchronized aggregations known as arribadas. The largest known arribada*s* in the eastern Pacific are off the coast of Costa Rica (~475,000 - 650,000 females estimated nesting annually) and in southern Mexico (~800,000+ nests/year at La Escobilla, in Oaxaca (Millán, 2000).

Mexico
The nationwide ban on commercial harvest of sea turtles in Mexico, enacted in 1990, has improved the situation for the olive ridley. Surveys of important olive ridley nesting beaches in Mexico indicate increasing numbers of nesting females in recent years (Marquez et al.1995; Arenas et al. 2000). Annual nesting at the principal beach, Escobilla Beach, Oaxaca, Mexico, averaged 138,000 nests prior to the ban, and since the ban on harvest in 1990, annual nesting has increased to an average of 525,000 nests (Salazar et al. 1998). At a smaller olive ridley nesting beach in central Mexico, Playon de Mismalayo, nest and egg protection efforts have resulted in more hatchlings, but the population is still "seriously decremented and is threatened with extinction" (Silva-Batiz et al. 1996). There is discussion in Mexico that the species should be considered recovered (Arenas et al. 2000).

Costa Rica
In Costa Rica, 25,000 to 50,000 olive ridleys nest at Playa Nancite and 450,000 to 600,000 turtles nest at Playa Ostional each year (NMFS and USFWS 1998e). In an 11-year review of the nesting at Playa Ostional, (Ballestero et al. 2000) report that the data on numbers of nests deposited is too limited for a statistically valid determination of a trend; however, there does appear to be a six-year decrease in the number of nesting turtles. Under a management plan, the community of Ostional is allowed to harvest a portion of eggs. Between 1988 and 1997, the average egg harvest from January to May ranged between 6.7 and 36%, and from June through December, the average harvest ranged from 5.4 to 20.9% (Ballestero et al. 2000). At Playa Nancite, concern has been raised about the vulnerability of offshore aggregations of reproductive individuals to "trawlers, longliners, turtle fishermen, collisions with boats, and the rapidly developing tourist industry" (Kalb et al. 1996).

The greatest single cause of olive ridley egg loss comes from the nesting activity of conspecifics on *arribada* beaches, where nesting turtles destroy eggs by inadvertently digging up previously laid nests or causing them to become contaminated by bacteria and other pathogens from rotting nests nearby. At a nesting site in Costa Rica, an estimated 0.2 percent of 11.5 million eggs laid during a single *arribada* produced hatchlings (NMFS and USFWS 1998e). Hatching success at both arribada beaches (Playa Ostional and Playa Nancite) is very low. Hatching success rates were estimated to be *c.* 8% per year for Playa Ostional (Arauz and Mo 1994) and as low as 1-4% at Playa Nancite (Cornelius and Robinson 1983). Low natural hatching success rates were used persuasively to permit a limited, legal egg harvest at Ostional (Cambell 1998).

Some female olive ridleys nesting in Costa Rica have also been found afflicted with the fibropapilloma disease (Aguirre et al. 1999).

Guatemala

In Guatemala, the number of nesting olive ridleys nesting along their Pacific coast has declined by 34% between 1981 and 1997. This is only based on two studies conducted 16 years apart, however; in 1981, the estimated production of olive ridley eggs was 6,320,000, while in 1997, only 4,300,000 eggs were estimated laid (Muccio 1998). Villagers also report a decline in sea turtles; where collectors used to collect 2-3 nests per night during the nesting season 15 years prior, now collectors may find only 2-4 nests per year due to fewer turtles and more competition. This decline most certainly can be attributed to the collection of nearly 95% of eggs laid, and the incidental capture of adults in commercial fisheries (Muccio 1998).

Nicaragua

In Nicaragua, there are two primary *arribada* beaches: Playa La Flor and Playa Chacocente, both in the southern Department of Rivas. At Playa La Flor, the second most important nesting beach for olive ridleys on Nicaragua, Ruiz (1994) documented 6 *arribadas* (defined as 50 or more females nesting simultaneously). The main egg predators were domestic dogs and vultures (*Coragyps atratus* and *Cathartes aura*). During the largest *arribada*, 12,960 females nested from October 13-18, 1994 at Playa La Flor (*in* NMFS and USFWS, 1998e). Von Mutius and Berghe (2002) reported that management of this beach includes a six-month open season for egg collection, during a time when the *arribadas* is small. During this time, all eggs are taken by locals, and during the “closed period,” approximately 10-20% of eggs are given to the locals to consume or sell. At Playa Chacocente, approximately 5,000 to 20,000 females may nest over the course of five days (Camacho and Cáceres 1994 *in* Arauz 2002). Here, the harvest and commercialization of sea turtle eggs is allowed and somewhat controlled. During a monitoring project conducted on nearby Playa El Mogote from October, 2001 through March, 2002, researchers documented olive ridleys nesting 327 times. Of these, 99.7% of the nests were poached (Arauz 2002).

Indian Ocean

In the eastern Indian Ocean, olive ridleys nest on the east coast of India, Sri Lanka, and Bangladesh.

India

In India, a few thousand olive ridleys nest in northern Tamil Nadu, Andhra Pradesh, and the Andaman and Nicobar Islands (Shanker et al. 2003). However, the largest nesting aggregation of olive ridleys in the world occurs in the Indian Ocean along the northeast coast of India (Orissa). Not surprisingly then, olive ridleys are the most common sea turtle species found along the east coast of India, migrating every winter to nest en-masse at three major rookeries in the state of Orissa: Gahirmatha, Devi River mouth, and Rushikulya (Shanker et al. 2003). Sporadic nesting occurs between these mass nesting beaches.

The Gahirmatha rookery, located along the northern coast of Orissa, hosts the largest known nesting concentration of olive ridleys. Shanker et al. (2003b) provide a comprehensive report on the status and trends of olive ridleys nesting in Orissa since monitoring began in 1975. No estimates are available for arribadas at the Devi River mouth and Rushikulya. Current population sizes are estimated to be between 150-200,000 nesting females per year. Based on analyses of the data, while there has been no drastic decline in the nesting population at Gahirmatha in the last 25 years, there are differences in trends between decades. For example, trend analyses suggest stability or increase in the size of the 1980s arribadas, which may be due to enforcement of legislation in the late 1970s, stopping the directed take of turtles. However, the 1990s data show that the population is declining or on the verge of a decline, which may be consistent with the recent increase in fishery related mortality and other threats (see below). No arribadas occurred on this nesting beach in 1997, 1998, and 2002, which is the highest documented incidence of failure since this rookery has been monitored (Shanker et al. 2003).

Uncontrolled mechanized fishing in areas of high sea turtle concentration, primarily illegally operated trawl fisheries, has resulted in large scale mortality of adults during the last two decades. Records of stranded sea turtles have been kept since 1993. Since that time, over 90,000 strandings (mortalities) of olive ridleys have been documented (Shanker et al. 2003), and much of it is believed to be due to illegal gillnet and shrimp trawl fishing in the offshore waters. Fishing in coastal waters off Gahirmatha was restricted in 1993 and completely banned in 1997 with the formation of a marine sanctuary around the rookery. Marine turtles in Orissa are protected by a prohibition of all mechanized fishing within 5 km of the coast and within 20 km of the Gahirmatha coast (~35 km). Despite these rules, mortality due to shrimp trawling reached a record high of 13,575 ridleys during the 1997-98 season, and none of the approximately 3,000 trawlers operating off the Orissa coast use turtle excluder devices in their nets (Pandav and Choudhury 1999), despite mandatory requirements passed in 1997. "Operation Kachhapa" was developed in the late 1990s to protect sea turtles and their habitat by enabling strict enforcement of the 5 km non-mechanized fishing zone limit, as well as putting forward efforts to monitor nestings and educate local inhabitants and fishermen (Shanker and Mohanty 1999). However, shrimp boats continue to fish close to shore within this protected zone and continue to not use turtle excluder devices. Current mortality rates are estimated to be ~15,000 turtles per year (B. Mohanty, personal communication, *in* Shanker et al. 2003). Threats to these sea turtles also include artificial illumination from coastal development and unsuitable beach conditions, including reduction in beach width due to erosion (Pandav and Choudhury 1999).

Genetic studies indicate that olive ridleys originating from the east coast of India are distinct from other ridleys worldwide, increasing the conservation importance of this particular population (Shanker et al. 2000 *in* Shanker et al. 2003).

Western Pacific Ocean

In the western Pacific, olive ridleys are not as well documented as in the eastern Pacific, nor do they appear to be recovering as well. There are a few sightings of olive ridleys from Japan, but no report of egg-laying. Similarly, there are no nesting records from China, Korea, the Philippines, or Taiwan. No information is available from Vietnam or Kampuchea (Eckert 1993).

Indonesia

Indonesia and its associated waters also provides habitat for olive ridleys, and there are some recently documented nesting sites. The main nesting areas are located in Sumatra, Alas Purwo in East Java, Paloh-West Kalimantan and Nusa Tenggara. On Jamursba-Medi beach, on the northern coast of Papua, 77 olive ridley nests were documented from May to October, 1999 (Teguh, 2000 *in* Putrawidjaja, 2000). However, as mentioned in the leatherback subsection, extensive hunting and egg collection, in addition to rapid rural and urban development, have reduced nesting activities in this area. In Jayapura Bay, olive ridleys were often seen feeding, and in June, 1999, an estimated several hundred ridleys were observed nesting on Hamadi beach, despite heavy human population in the nearby area. Locals report daily trading and selling of sea turtles and their eggs in the local fish markets (Putrawidjaja 2000). At Alas Purwo National Park, located at the eastern-most tip of East Java, olive ridley nesting was documented from 1992-96. Recorded nests were as follows: from September, 1993 to August, 1993, 101 nests; between March and October, 1995, 162 nests; and between April and June, 1996, 169 nests. From this limited data, no conclusions could be reached regarding population trends (Suwelo 1999); however, recently, Dermawan (2002) reports that there were up to 250 females nesting at this site in 1996, with an increasing trend.

Malaysia

Olive ridleys nest on the eastern and western coasts of peninsular Malaysia; however, nesting has declined rapidly in the past decade. The highest density of nesting was reported to be in Terrenganu, Malaysia, and at one time yielded 240,000 *eggs* (2,400 nests, with approximately 100 eggs per nest) (Siow and Moll 1982 *in* Eckert 1993), while only 187 *nests* were reported from the area in 1990 (Eckert 1993). In eastern Malaysia, olive ridleys nest very rarely in Sabah and in low numbers (Basintal 2002), and only a few records are available from Sarak (*in* Eckert 1993).

Thailand

In Thailand, olive ridleys occur along the southwest coast, on the Surin and Similan islands, and in the Andaman Sea. On Phra Thong Island, on the west coast of Thailand, the number of nesting turtles have declined markedly from 1979 to 1990. During a 1996-97 survey, only six olive ridley nests were recorded, and of these, half were poached, and one was predated by feral dogs. During the 1997-98 survey, only three nests were recorded. The main threats to turtles in Thailand include egg poaching, harvest and subsequent consumption or trade of adults or their parts (i.e. carapace), indirect capture in fishing gear, and loss of nesting beaches through development (Aureggi et al. 1999).

Central Pacific Ocean

There are no records of olive ridley nesting on the unincorporated U.S. territories in the North Pacific. In the central Pacific, a single nesting was reported in September, 1985 on the island of Maui, Hawaii but the eggs did not hatch and the event was most likely an anomaly (Balazs and Hau 1986 *in* NMFS and USFWS 1998e). In October 2002, an olive ridley turtle was reported to have nested on the shores of Hilo Bay, on the Island of Hawaii. This nesting event marks the second recorded nesting of an olive ridley in the main Hawaiian Islands.

Population growth rate parameters were calculated for nesting female olive ridley turtles at Escobilla Beach, Oaxaca, Mexico based on data from Marquez-M. et al. (2002). Estimates of nesting females at Escobilla Beach from the early 1970s to 2000 are shown in Figure 8. Trends for the primary nesting beach of olive ridleys in the eastern Pacific are very promising and the conservation efforts that have resulted in the dramatic increases are commendable (Marquez et al. 1996). Probabilities of extinction risks indicate negligible risks over the next several decades given that current conservation practices are continued (Table 12) (Snover 2005). As with all population of marine turtles, these trends can change quickly with changes in conservation efforts.

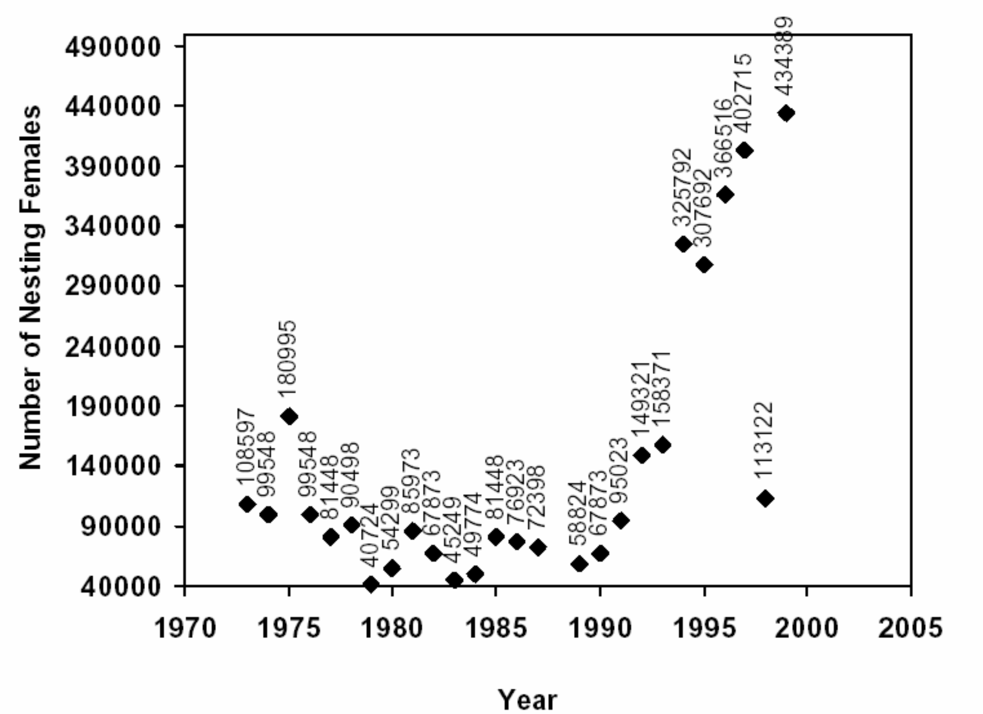

Figure 8. Estimated numbers of nesting olive ridley turtles at Escobilla Beach, Oaxaca, Mexico (Marquez-M et al. 2002).

Demographic Parameter	Estimate (Baseline)
Log growth rate (μ)	0.06 [-0.11, 0.23]
Variance in mean log growth rate (σ^2)	0.11 [0.06, 0.54]
Finite rate of change in population size (λ_A)	1.12 [0.92, 1.64]
Instantaneous rate of change in population size (r_A)	0.12 [-0.08, 0.50]
Risk of quasi-extinction	
Probability of quasi-extinction ever occurring	0 [0, 1]
Median time to quasi-extinction (yr)	NA
Probability of quasi-extinction in: 25 yr	0 [0,0]
50 yr	0 [0, 0.05]
100 yr	0 [0, 0.51]
Risk of ultimate extinction	
Probability of extinction ever occurring	0 [0, 1]
Median time to extinction (yr)	NA
Probability of extinction in: 25 yr	0 [0, 0]
50 yr	0 [0, 0]
100 yr	0 [0, 0.12]

Table 12. Results of the Dennis-Holmes Model for olive ridleys turtles from Escobilla Beach, Oaxaca, Mexico. Unless otherwise noted, values are reported as means with the lower and upper 95% confidence intervals in brackets. Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female.

Here we provide an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species. As stated previously, the species considered in this Opinion are highly migratory and their life history patterns require them to cross ocean basins between their breeding and feeding grounds. Therefore, past and present factors affecting the current health of the populations occurring within the action area also affect the current health and status of the species throughout the Pacific Ocean Basin. Therefore, this Opinion considers past and present natural and human impacts affecting sea turtle populations in the Pacific Ocean.

7.4 Sea Turtle Conservation Projects in the Western Pacific Region

Over the past several years, the Council in collaboration with NMFS' Pacific PIFSC, PIR, and Southwest Fishery Science Center (SWFSC) have laid the groundwork for significant turtle conservation efforts in the Western Pacific Region. These conservation efforts are aimed at increasing the capacity for the continued survival and recovery of Pacific sea turtle populations in the wild.

Priorities for the region's sea turtle conservation program are directed towards the following five areas of concentration and function in coordination with all relevant regional organizations: data management to fill information gaps; conservation measures to reduce direct harvest of sea turtles and protect nesting beach habitat; education and outreach about sea turtle conservation; international management and networking; and fishery mitigation through research and transfer of gear technologies designed to reduce bycatch of sea turtles to foreign fisheries. Recommendations outlined in Kaplan (2005) with regard to increasing recovery efforts through decreased mortality of sea turtles in coastal sources and international fisheries have already commenced and are being supported by the Council and NMFS.

To date, within the five areas of concentration, six projects have been implemented and have reached completion (Table 13). Table 14 lists ongoing sea turtle research and conservation projects in progress since November 2004, sponsored by the Council or NMFS. Table 15 lists sea turtle projects initiated by NMFS PIR with 2005 fiscal year funds. The conservation programs listed in the following tables were developed to result in effective information gathering and conservation of sea turtle populations in the Pacific. The cooperating organizations have initiated programs aimed at increasing research and information related to sea turtle bycatch in the Pacific Ocean, increasing understanding of Pacific sea turtle ecology, biology, and population status, and increased education and outreach to various countries whose populations interact with sea turtles either through direct harvest and consumption or via fisheries bycatch through the many and varied efforts described in the following tables. In addition to the projects listed below, numerous meetings and workshops regarding and sea turtle conservation planning and strategizing and reducing sea turtle bycatch in the world's fisheries have been supported by either the Council or NMFS PIR. These efforts were developed and initiated with the overall goal of increasing the capacity for sea turtle recovery in the Pacific and are anticipated to result in beneficial effects for sea turtle populations in the Pacific Ocean.

Recently completed Sea Turtle Projects in the Western Pacific Region			
Project Name	**Region**	**Funding Agency**	**Purpose**
Education to Reduce Adverse Interactions Between Commercial Fishing Operations and Sea Turtles	Federated States of Micronesia (FSM)	PIR (S-K grant)	To improve the capabilities of observers in recognizing, handling, and reporting interactions between turtles and commercial tuna fisheries in FSM
Leatherback satellite tagging (March 2003: 10 ARGOS and 4 PAT satellite tags deployed)	Papua New Guinea (PNG)	PIR/SWFSC	To provide clues to additional nesting sites, and will be used as a basis to design aerial surveys.
Sea turtle in-water survey	Confederated States of Northern Mariana Islands (CNMI)	PIR	Population assessments, capacity building
Tagging & surveys	Guam	DAWR/PIR	Population assessments, capacity building
Tagging & surveys	America Samoa	DMWR/PIR	Population assessments, capacity building
Cultural survey	Republic of the Marshal Isl. (RMI)	MIRFA/GPA/ PIR	Define parameters for potential research. ID past and ongoing research; literature search; feasibility and logistics study

Recently completed Sea Turtle Projects in the Western Pacific Region			
Project Name	**Region**	**Funding Agency**	**Purpose**
International Meetings 1) 2nd International Fishers Forum -IFF 2) 23rd Annual Sea Turtle Symposium 3) Japan Fisheries Agency 4) People & the Sea Conference 5) Bellagio, Italy 6) IATTC Bycatch (PIRO) Other A) www.seaturtle.org Server fund donation B) Marine Turtle Newsletter (MTN) – Publication support	Liaison & Networking: 1) Hawaii, U.S.A. 2) Malaysia 3) Japan 4) Amsterdam, Netherlands 5) Bellagio, Italy 6) Japan	Council	1) IFF2: Forum for fishermen and scientists to exchange information and ideas on technologies and strategies to mitigate sea turtle and seabird interactions with longline fisheries. 2) 23rd Sea Turtle Symp.: Travel support to Kuala Lumpur for 30 Pacific Islanders and Asian participants. 3) Japan Fisheries Agency: Liaison & collaboration activities to develop sea turtle mitigation measures 4) People & the Sea: (Sept.2003) Increase awareness of Pacific Island sea turtle issues 5) Bellagio, Italy: (Nov. 2003) Conservation and sustainable management of sea turtles in the Pacific Ocean 6) IATTC Bycatch: (Jan 2004) Sea Turtle working group meeting in Kobe, Japan
Hawksbill Simulation Model	Pacific Oceanic Region	Council	To develop an interactive simulation model of hawksbill turtle population dynamics for stocks exposed to various mortality risks in the Oceania region.
Tagging & surveys	Federated States of Micronesia (FSM)	MIRFA/GPA/ PIR	Yap tagging and monitoring program, re-initiate genetic stock identification.
Ostional Wildlife Refuge – workshops	Costa Rica	Council	Fishermen Workshops to increase awareness to reduce sea turtle mortality
Transfer sea turtle conservation technology	PNG & MI	PIR/NFA	Efforts to take the FSM "success" on the road to transfer conservation technology and assist with observer training implementation

Table 13. Western Pacific Region sea turtle conservation and monitoring projects completed prior to November, 2004.

Ongoing Council and PIR funded Sea Turtle Projects in Progress since 2004

Project Name	Region	Funding Agency	Purpose
Leatherback Aerial Survey	PNG	PIR/SWFSC	Four year study to quantify leatherback nesting stocks of the W. Pac. Region. Year one (Jan –Feb 2004): logistics & feasibility
Leatherback satellite tagging	PNG	PIR/SWFSC	To fill information gaps regarding migratory movements.
Green & hawksbill turtle survey	Palau	PMRD/PSC/TNC/PIR	Population assessment, education & outreach
Education & Outreach	Guam	Council	Education Poster
Regional Tagging Database	Western Pacific Region (SPREP)	Council	Rehabilitate SPREP's tagging database in collaboration with five international colleagues
Policy Post-Doc	Pacific Ocean basin	SWFSC/PIR	A two-year post-doctoral position in the economics of sea turtle conservation.
War-mon Beach	Papua	Council	Leatherback nesting beach management: Dec 2003 – Oct. 2004
Kei Islands	Western Papua	Council	To study and reduce direct harvest pressure of leatherbacks in foraging grounds. Nov 2003 – Oct 2004
Kamiali Wildlife Area	Papua New Guinea	Council	Leatherback nesting beach management: Nov 2003 – April 2004
Japan Loggerheads	Japan	Council	Loggerhead nesting beach management to save doomed eggs at four sites: May – Sept 2004
Baja, Mexico Loggerheads	Baja, Mexico	Council	Measure to reduce incidental capture of juvenile loggerheads in the halibut gillnet fishery: March – Sept 2004

Ongoing Council and PIR funded Sea Turtle Projects in Progress since 2004			
Project Name	**Region**	**Funding Agency**	**Purpose**
TED Introduction - Observer Training and Capacity Building	PNG	PIR/NFA	Measure to implement TED's in the shrimp fishery in the Gulf of Papua, PNG
Mitigation of sea turtle bycatch	Ecuador	Council	To introduce mitigation measures (circle hooks/mackerel bait) to artesinal longline fishers to reduce interaction rates.
International Meetings (Liaison & Networking)	1) Costa Rica 2) Bangkok 3) Second Council Sea Turtle Workshop	Council	1) 24th Annual Sea Turtle Symp – Feb. 22-29, 2004 2) 2nd IOSEA MoU meeting Conference support, Bangkok -March 16, 2004 3) Council office – Hawksbill & Leatherbacks May 17-21, 2004
Capacity building, assessments	Guam, CNMI Am. Samoa,	PIR/PIFSC	Year 2 - Continue beach monitoring, tracking, education and outreach
Observer Training and Capacity Building	WWF-Bali, Indonesia	PIR	Application being processed by the NOAA GMD - expected start in fourth calendar quarter of 2004
Observer Training and Capacity Building	Solomon Is.	SWFSC	Evaluation of the longline regulatory impacts
Observer Training and Capacity Building	Marshall Islands	PIR	Field work under way as of August 2004

Table 14. Ongoing sea turtle conservation and research projects sponsored by the Council or NMFS PIR in progress since 2004.

Current Sea Turtle Projects in the Western Central Pacific Ocean – Implemented with FYO5 Funding			
Project Name	**Region**	**Funding Agency**	**Purpose**
Leatherback Aerial Survey Year 3	PNG	PIR/SWFSC	Four year study to quantify leatherback nesting stocks of the W. Pac. Region.
Leatherback satellite tagging Year 3	PNG	PIR/SWFSC	To fill information gaps regarding migratory movements.
Green & hawksbill turtle survey Year 2	Palau	PMRD/PSC/TNC/PIRO	Population assessment, education & outreach
Capacity Building and Research Support Year 3	Guam	DAWR	Provide for determination of local sea turtle population status, including nesting beach surveys and outreach and education
Capacity Building and Research Support (on-going)	American Samoa	DMWR	Provide for determination of local sea turtle population status, including nesting beach surveys and outreach and education
Capacity Building and Research Support Year 2	CNMI	DFW	Provide for determination of local sea turtle population status, including nesting beach surveys and outreach and education.
Population Assessment Year 2	CNMI	PIR/DFW/ PIFSC	In-water assessment of local turtle populations.
WCPO Resource Economist and Policy analysis Year 3	Pacific Ocean basin	SWFSC/PIR	A three-year post-doctoral position to review the economics and policy implications of sea turtle conservation.
Observer training augmentation	WCPO	FFA/PIR/ NMFS Enforcement	Support integration of protected species id, reporting, handling, and mitigation with regional in-country training.
Evaluation of technical assistance	FSM	NMFS/Contractor	Review of impacts of training previously (2002) provided to in-country observers
TED Introduction - Observer Training and Capacity Building Year 2	PNG	PIR/NFA	Measure to implement TED's in the shrimp fishery in the Gulf of Papua, PNG, continued assistance to national observer program
Nesting Beach Tagging	Yap State FSM	PIR/PC/SWFSC Yap State MRMD	Tagging (conventional and sat.) of nesting females on Ulithi Atoll (10 year review of previous effort).
Situation Report	Solomon Islands	PIR/Contractor	Review applicability and appropriateness for in-country support and capacity building

Current Sea Turtle Projects in the Western Central Pacific Ocean – Implemented with FYO5 Funding			
Project Name	**Region**	**Funding Agency**	**Purpose**
Observer Training and Capacity Building Year 2	Solomon Islands	PIR/Contractor	Assistance to national observer program and institutional capacity building
Research Support	PNG	PIR/SWFSC	Support for technical assistance with nesting beach research
Research Support	Central Pacific	PIR/SWFSC	Support for sea-going technician.
Research Support	WCPO	PIFSC/SPC	Analyst support for regional assessments, including by-catch issues as requested by the WCPFC
Observer Training and Capacity Building	Vietnam	PIFSC/PIR	Support for the development of observer capacity with regard to gear mitigation studies
Observer Training and Capacity Building Year 2	Indonesia	PIR/WWF Indonesia	Expanded support for implementation of observer program
Observer Training and Capacity Building	Indonesia	PIR/WWF Indonesia/WWF USA	Support for implementation of observer portion of a gear experiment.
Policy research –Year 2	Solomon Island and Indonesia	SWFSC/ENGO	Investigate options for sustainable land based marine turtle conservation activities in the WCPO
Observer Training and Capacity Building Year 3	Marshall Islands	PIR/ Contractor	Continuation of technical support to observer program, and support for outer island reporting
Project Liaison Officer	Regional	PIR/JIMAR	Regional Project administrative and technical assistance

Table 15. Sea turtle projects currently in progress or about to begin with 2005 fiscal year funding and sponsored by NMFS PIR.

7.4.1 Pelagics FMP Sea Turtle Conservation Measures

As provided in the 2004 amendments to the Pelagics FMP, under the auspices of the Council, five specific projects were implemented beginning in 2004 to conserve leatherback and loggerhead sea turtles in the Pacific in response to effects caused by the Hawaii-based longline fisheries. These projects are a collaborative effort between the Council, NMFS PIR, PIFSC, HLA, and experienced non-governmental organizations such as the World Wildlife Fund – Indonesia, Kamiali Integrated Conservation Development Group of Papua New Guinea, the Sea Turtle Association of Japan and ProPeninsula in Baja California, Mexico. These projects and their conservation goals are described in detail in section 8.2 of the 2004 FEIS (NMFS 2004a).

The Council formed a Turtle Advisory Committee (TAC) at the 114th Council meeting in August, 2002 to direct and advise the Council's turtle conservation activities. The TAC comprises eight distinguished turtle biologists and scientists from several countries who generally meet once a year to review the Council's turtle program. During their first meeting, held July 29-30, 2003, the TAC introduced priority projects, identified locally-based non-governmental organizations (NGOs) selected to implement each project, and outlined conservation objectives for each project.

Of the species of concern in the Pacific Ocean, leatherback and loggerhead turtles are the species most often captured by the Hawaii-based longline fishery and are the populations in general decline. Thus, the Council's conservation measures primarily focus on leatherback and loggerhead populations. The following projects were identified as priority projects for sea turtle conservation by the TAC: (1) leatherback turtle nesting beach management at War-mon beach, Jamursba-Medi Bird's Head Peninsula, Papua, Indonesia; (2) conservation of leatherback turtles in coastal foraging habitats in western Papua's Kei Kecil islands; (3) leatherback turtle nesting beach management at the Kamiali Wildlife Management Area, Papua New Guinea; (4) conservation of loggerhead turtles in coastal foraging habitats of Baja, California, Mexico; and (5) loggerhead turtle nesting beach management at Yakushima, Japan. These projects are described in more detail in the respective species' sections above.

In the first year of implementation, all five conservation projects succeeded in achieving their year 1 goals. Upon review of year 1 progress by the TAC, they recommended continuation of all projects and expansion of nesting beach projects if possible (WPRFMC 2005). The Council's conservation projects have met the first test described in the 2004 FEIS for evaluating the potential net benefit of the projects to the species: the certainty that the measures will be implemented (NMFS 2004a). The second criterion for assessing beneficial effects to the population is the certainty of the measures being effective. The progress achieved in year one bodes well for the efficacy of the program and NMFS shares the TAC's recommendation for continuation of the program and will continue to track the success of the conservation projects for realized increases in recruitment to reproductive life stages. The technical/scientific oversight of these projects, partnerships with local organizations and exploration of long-term funding opportunities provide encouraging signs for the continued, long-term success of the program, though at this time the population benefits likely to result from these important conservation programs cannot be quantified, though estimates of the population level benefits expected in the long-term are presented in the 2004 FEIS (NMFS 2004a).

Additionally, the Council is funding the implementation of a region-wide sea turtle tagging database referred to as the Regional Sea Turtle Research and Tagging Database System (TREDS) to facilitate dissemination of information used to help understand population status and trends of Pacific sea turtles. This project was funded by the Council in 2003 to revitalize SPREP's outdated tag database and is an ongoing project (WPRFMC 2005).

The Council contracted with the Inter American Tropical Tuna Commission (IATTC) to coordinate, design, and implement projects designed to test potential measures for reducing sea turtle bycatch in the mahi-mahi and tuna longline fleets in Ecuador. Though the level of interactions with the Ecuadorian fishery is unknown, five species of sea turtles occur in the area of the fishery and are threatened by fisheries interactions. Through the contract with the IATTC, the Council is funding educational workshops, transferring current sea turtle mitigation measures to the fishery shown to be effective at reducing sea turtle interactions in Atlantic longline experiments, and building a team of Ecuadorian researchers, fishermen, and students to bring continuity to the task. Preliminary data from Ecuador indicate that replacement of traditional hooks with circle hooks in the artesinal mahi mahi fishery resulted in a 65% reduction of sea turtle bycatch and a 73% reduction in the mortality of the sea turtles captured (based on results from the Council's first year of conservation measures)(WPRFMC 2004). NMFS is also funding fishery gear technology experiments in collaboration with the IATTC in Latin America and is supportive of exploring methods and technologies for reducing sea turtle bycatch in both U.S. fisheries and foreign fisheries.

7.5 Sea Turtle Bycatch in Pacific Fisheries

For most fishing fleets throughout the world, little or no data exists regarding the incidental take of sea turtles. Lewison et al. (2004) and Kaplan (2005) provide crude estimates of total sea turtle interactions and mortalities in global and Pacific fisheries by extrapolating limited data from the few fisheries with monitoring data on sea turtle bycatch. Given such data, coupled with distribution and abundance records for the various species, one can at least gain a sense of the possible impacts of those fisheries for which no information exists. The following sections present sea turtle bycatch information for known fisheries, including some of which are likely to have significant impacts on sea turtle populations, simply due to the enormous amount of effort, the broad areas fished and the basic nature of the fishing strategy.

7.5.1 State of Hawaii Authorized Fisheries

The State of Hawaii regulates commercial and recreational fishing activities within the waters of the State, which extend 2 miles from shore around the Hawaiian Islands. Interactions with sea turtles are known to occur as a result of the practices of certain types of these fisheries.

Two primary types of fishing gear known to cause injury and death to sea turtles (Chaloupka 2004) in State of Hawaii waters are slide-bait rigs and lay nets. Slide-bait rigs are used for shore casting at rocky shores and generally include a long fishing rod, heavy monofilament fishing line, and a heavy weight with projecting "claws" to grab hold of the bottom. The weight is cast offshore (approximately 100 m) and the hooks are baited on a short line and then sent down the main line. Turtle and seal interactions with the slide-bait fishery can occur with both the hook and the line and can cause injuries or lead to the death. Sea turtles can be hooked internally or externally; external hooking is thought to be less serious. Hooked turtles trailing slide-bait gear can entangle other objects or lodge on the bottom, preventing the animal from surfacing or foraging. It is generally thought that the most severe injuries result from entanglement with the monofilament line. The non-decaying line can wrap around the turtle's neck and lead to strangulation, or when wrapped around a flipper can result in the loss of the limb.

Currently, data do not exist on the extent of sea turtle interactions in the state authorized fisheries. An analysis of sea turtle strandings (turtles washed ashore dead or morbid) in the Hawaiian Archipelago from 1982-2003 was conducted by Chaloupka (2004). The stranding analysis provided one source of information for evaluating the potential impact of inshore fishing activity on Hawaiian sea turtle populations. Approximately 74% of the reported strandings were green turtles. Hook and line fishing activity accounted for approximately 7% of all turtle strandings reported since 1982, while gillnet fishing accounted for approximately 5% of the 3,861 strandings in the database (Chaloupka 2004). There were 31 occurrences of olive ridley turtles in the stranding database, five leatherbacks, and 1 loggerhead. The available data are not sufficient to determine the relative impact of the state managed fishery on sea turtle populations though they do provide some indication of the relative sources of mortality and species occurrence in the Hawaiian archipelago.

Presently, there are no specific State regulations for the slide-bait fishery. Research has been proposed in order to determine appropriate regulatory measures to protect sea turtles from incidental impacts of this State managed activity.

Lay nets consist of panels of nets that can be placed at any depth in the water column. They are passive gear made of monofilament line. Fish that swim into the net are snagged by their gills or entangled in the mesh. Sea turtles can become entangled in lay nets and drown. Where a cause could be determined approximately one third of reported sea turtles strandings, resulted from lay nets. In addition, it appears that green turtles with fibropapilloma tumors have an increased likelihood of becoming entangled than those without.

By State regulations, lay nets must have a minimum mesh size of 2¾ inches and limited soak time. In addition, nets must be inspected every two hours and all undersized, illegal, or unwanted fish must be removed. It is also unlawful to leave any lay net in the water for a period of more than four hours in any twenty-four hour period. The State of Hawaii is investigating additional regulations on lay nets in State waters to further protect listed species.

The State of Hawaii and NMFS PIR have worked together over the past year to develop and refine mitigation measures to reduce threats from inshore fisheries to sea turtles and will continue to work together in the future to implement them. The measures fall into three general categories: monitoring, take reduction and habitat protection and are expected to result in increased conservation to sea turtles in State managed fisheries in the long term.

7.5.2 Foreign longline fisheries

Australian longline fisheries

Australia has two fisheries that target pelagic fish within and beyond its Australian Fishing Zone (AFZ) using longlines: (1) the Eastern Tuna and Billfish Fishery (ETBF), which extends along the east coast of Australia from Cape York, Queensland to the South Australia-Victorian border, targeting yellowfin tuna, bigeye tuna, and swordfish; and (2) the Southern and Western Tuna and Billfish Fishery (SWTBF), which extends from Cape York, Queensland across the northern coastline, down the western coastline of Western Australia and east to the South Australian-Victorian border, also targeting bigeye, yellowfin, and swordfish. Hooks are often set around sea mounts. Since Japanese longliners were denied access to fishing within the AFZ since 1997, both fleets have developed rapidly. In 2001, the ETBF consisted of approximately 150 active vessels, which deployed 11,250,000 hooks, while during that same year, the SWTBF consisted of 44 active vessels deploying 6,183,000 hooks. Both fisheries generally set shallow, at maximum depths of between 20 and 100 meters, although occasionally gear is set to depths greater than 150 meters (Robins et al. 2002a).

Sea turtle catch rate estimates in these two fisheries were calculated using data from skipper logbooks and interviews. Since 1997, Australian pelagic longline skippers have been required to log all sea turtle interactions. From 1997 to 2001, skippers logged a total of 272 turtles taken in both fisheries. Without verified catch data, however, it was difficult for researchers to determine the accuracy of the data. In 2001, skippers were interviewed regarding their sea turtle bycatch, and through these interviews, researchers determined that logbook data was likely inadequate, since very few fishers indicated that they had never caught sea turtles (Robins et al. 2002a).

Sea turtle catch rates and total turtle take by both fisheries were estimated from fisher interviews. The average sea turtle catch rate was 0.024 turtles/1,000 hooks, with a standard deviation of 0.027. Given this catch rate and the amount of effort in the fishery yields an estimated total of 402 sea turtles (95% confidence limits of 360 to 444) taken by the ETBF and SWTBF. Of the sea turtles identified to species, leatherbacks were most commonly reported as taken, with 66% in the ETBF and 90% in the SWTBF. However, 70% and 41% of all reported turtles were not reported to species in the ETBF and SWTBF, respectively. Therefore, these percentages may be underestimates. Because of the greater difficulties in identifying hard-shelled species, the proportion of other species composition in these fisheries was undeterminable (Robins et al. 2002a).

Costa Rican longline fisheries

Several studies have been undertaken in recent years in order to document the incidental capture of sea turtles in Costa Rican longline fisheries. The longline fleet consists of a “medium” artisanal fishery, which targets mahi mahi and tunas within the country’s EEZ, and an “advanced” fleet, which targets billfish and tunas within and outside the EEZ.

Two studies in 1997 and 1998 on two longline fishing cruises (one experimental) documented a high incidental take of sea turtles. On one cruise east of the Galapagos Islands targeting billfish and shark (mean depth of 25-50 meters), a total of 34 turtles (55% olive ridleys and 45% east Pacific green turtles) were taken on two sets containing 1,750 hooks (19.43 turtles per 1,000 hooks). Mortality was 8.8%. One additional set caught two leatherbacks. The second cruise took place within the EEZ of Costa Rica and targeted billfish and mahi mahi. Researchers documented the incidental take of 26 olive ridleys, with 1,804 hooks deployed (14.4 turtles per 1,000 hooks). Mortality was 0%; however, of the turtles captured, 88.5% were hooked in the mouth (Arauz et al. 2000).

An observer program was put in place on advanced artisanal vessels from August, 1999 through February, 2000 within the EEZ of Costa Rica. In this fishery, "mother lines" are set from between 12 and 15 miles with hooks attached every 5 to 10 meters, for a total of 400-800 hooks/set. Seventy seven longline sets were observed on 9 cruises; seven of the cruises targeted mahi mahi (daytime soak) and 2 of the cruises targeted yellowfin tuna (night-time soak). Of the nearly 40,000 hooks deployed, turtles represented 7.6% of the total catch, with olive ridleys constituting the second most abundant species captured (catch per unit effort of 6.364 turtles/1,000 hooks). The results are shown in Table 16. Immediate sea turtle mortality was 0%, likely because the sets were shallow (0-27 meters, but average of approximately five meters), and most of the hooks were removed prior to release (Arauz 2001).

Species/condition	Number
Olive ridley	
Hooked in mouth	216
Hooked in flipper	26
Hooked in neck	1
Entangled	4
Total	**247**
Green turtle	
Hooked in mouth	8
Hooked in flipper	4
Total	**12**

Table 16. Costa Rican longline fleet - observed number and condition of sea turtles taken on nine cruises, August, 1999 - February, 2000. Source Arauz 2001.

Peruvian artisanal longline fishery for shark and mahi mahi

The fishing industry in Peru is the second largest economic activity in the country, and over the past few years, the longline fishery has rapidly increased. Currently, nearly 600 longline vessels fish in the winter and over 1,300 vessels fish in the summer. An observer program was initiated in 2003 to document sea turtle bycatch in the artisanal longline fishery.

From September, 2003 to November, 2004, observers were placed on artisanal longline vessels operating out of the port of Ilo, home to one of the largest year-round artisanal longline fleets. There are two seasons for this fleet: from December through March, the fleet targets mahi mahi, making up to 6-day trips, in an area 20-70 nm from the coast; and from April through November, the fleet targets mako and blue shark, making up to 20-day trips, in an area 250-500 nm from the coast. The fleet uses surface longlines.

During the observation period, 588 sets were observed during 60 trips, and 154 sea turtles were taken as bycatch. Loggerheads were the species most often caught (73.4%), followed by green turtles (18.2%), olive ridleys (3.8%), and leatherbacks (2.6%). Species were most often entangled (74%); the rest were hooked. Of the loggerheads taken, 68% were entangled, 32% were hooked. Of the two fisheries, sea turtle bycatch was highest during the mahi mahi season, with 0.597 turtles/1,000 hooks, while the shark fishery caught 0.356 turtles/1,000 hooks (Alfaro-Shigueto et al. 2005). Sea turtles are rarely released into the sea after being caught as bycatch in this fishery; therefore, the mortality rate in this artisanal longline fishery is likely high because sea turtles are retained for future consumption or sale.

Mexican longline fisheries

The Mexican longline fishery for sharks has been observed since at least 1994. Table 17 shows the results of these data; however caution should be noted in interpreting the data since there is no information on what percentage of the fleet was observed, where the effort was located, or any details regarding the fishery. Perhaps the most relevant information from this table comes from the rate of capture of turtles per 1,000 hooks (SAGARPA, Instituto Nacional de la Pesca 2003). Mortality rates ranged from 2-10% (Santana-Hernández 2003).

Year/# species	**1994**	**1995**	**1997**	**1998**	**2000**	**2001**	**2002**	**2003**
green/black	1	0	12	1	2	1	16 (3)	6
loggerhead	0	0	4	0	13	0	0	0
olive ridley	18 (2)	5 (1)	42	19	23 (1)	0	19	1
unidentified	0	0	0	6	0	0	0	0
TOTAL	**19**	**5**	**58**	**26**	**38**	**1**	**35**	**7**
Rate of capture per 1,000 hooks	**.6968**	**.1598**	**.2515**	**.1750**	**.2458**	**.0218**	**.2473**	**.6092**

Table 17. Number of observed sea turtles taken per year (mortality, in parenthesis, is a subset of the take) and rate of incidental capture of turtles each per 1,000 hooks by longline boats in the Mexican Pacific Ocean.

There is also a Mexican longline fishery for swordfish, but little is known regarding the incidence of sea turtle bycatch. In 1999 and 2000, observers recorded target species and bycatch species on board drift gillnet and longline vessels targeting swordfish off Baja California, Mexico. During 26 trips and 132 sets, observers recorded 10,774 organisms, with 0.44% comprised of sea turtles, all of which were released without apparent harm (Instituto Nacional de la Pesca 2001).

7.5.3 Gillnet fisheries

CA/OR drift gillnet fishery

The California/Oregon (CA/OR) drift gillnet fishery targets swordfish and thresher shark off the west coast of the US. The fishery occurs primarily within 200 nautical miles of the California coastline and to a lesser extent off the coast of Oregon. The fishery has been observed by NMFS since July, 1990, and observer coverage has ranged from 4.4 percent in 1990 to an estimated 22.9 percent in 2000. Between July 1990 and January 31, 2003, NMFS has observed a total of 6,720 sets. One of the management measures in place for this fishery includes a requirement that the maximum length of the drift gillnet on board the vessel shall not exceed 6,000 feet. In 1997, regulations implementing under the Marine Mammal Protection Act required all drift gillnet fishers to attach a number of acoustic “pingers” to the top and bottom of the net, lower the top of the net to a minimum of 36 ft below the sea surface, and attend annual “skipper workshops” to facilitate the exchange of information with NMFS regarding marine mammal interactions in the fishery.

From July, 1990 to January, 2000, the CA/OR drift gillnet fishery was observed to take 1 green turtle (mortality), 23 leatherbacks (14 killed, 9 released alive), 17 loggerheads (12 released alive, 1 injured, and 4 killed), and 1 olive ridley (released alive). Based on a worst-case scenario, NMFS estimates that a maximum of 6 green turtles, 27 leatherbacks (5 leatherbacks observed taken in 1995/572 sets observed in 1995 = 0.009 turtles per set x 3,000 maximum sets expected per year), 33 loggerheads ((8 loggerheads observed taken in 1993/728 sets observed in 1993) x 3,000 maximum expected sets per year), and 6 olive ridleys in a given year could be incidentally taken by the CA/OR drift gillnet fleet (NMFS 2000).

Survival rates for sea turtle interactions in the CA/OR drift gillnet fishery were estimated based on incidental capture data collected by observers from July, 1990 to January, 2000. Leatherbacks caught in this fishery had a 39% survival rate (9 released unharmed/23 total captured), while the hard-shelled turtles had a combined survival rate of 68 % (13 released unharmed/19 total captured). The total survival rate for all species combined is approximately 52 percent (22 released unharmed/42 total captured), 2.5% were released injured (1 injured/42 total), and 43% were killed accidentally (18 killed/42 total). The disposition of 1 turtle was reported as unknown (NMFS 2000).

NMFS 2000 biological opinion concluded that the level of sea turtle interactions incidental to the CA/OR drift gillnet fishery “jeopardized the continued existence of” loggerheads and leatherbacks (NMFS 2000). In this case, the consulting agency (NMFS PRD Southwest Region) was required to provide a reasonable and prudent alternative to the action (i.e. the fishery). In order to protect an important foraging area for leatherback sea turtles off central and northern California and southern Oregon, NMFS implemented a time and area closure north of Point Conception during the late summer and fall months. The CA/OR drift gillnet fishery has not been observed to take any leatherback sea turtles since the closure was implemented. One loggerhead was caught in the CA/OR drift gillnet fishery in the 2001-02 fishing season. To reduce the likelihood of interactions with loggerhead sea turtles, in 2001, NMFS closed areas to drift gillnet fishing off southern California during El Nino events from June 1 through August 31, when loggerheads are likely to move into the area following one of their favorite prey species, pelagic red crabs. Following the 2001 closure, fishing effort dropped significantly, as vessels originating from northern ports lost access to their prime fishing grounds.

The management team and the advisory subpanel for the Pacific Fishery Management Council are currently looking at alternatives to the 2001 time/area closure for the drift gillnet fishery. Following a NEPA analysis, a preferred alternative will likely serve as a proposed action for a Section 7 consultation. Alternatives are being explored to provide limited fishing opportunities using large mesh drift gillnet to target HMS in areas and seasons currently closed to the drift gillnet fishery.

Halibut set gillnet fishery, Baja California Sur, Mexico
A halibut set gillnet fishery operates off the Pacific coast of Baja California Sur (BCS), Mexico, primarily in the Puerto A. Lopez Mateos and Puerto Magdalena regions. An estimated 50-70 boats fish in this fleet out of Lopez Mateos. Halibut nets are usually 4-6 meters in height and soak for a minimum of 24 hours.

Anecdotal reports have indicated high interaction/mortality rate of sea turtles captured in this fishery. For example, in 2003, 308 loggerheads stranded from May to August at Playa San Lazaro, which coincided with the primary halibut gillnet season. In addition, researchers conducted 30 semi-structured interviews of fishers in August, 2003 in Puerto Adolfo Lopez Mateos, BCS, which is adjacent to Playa San Lazaro. These interviews revealed that, on average, 4 loggerheads are captured per week, per boat (range 0-40/day/boat) throughout the halibut season, and 90% of turtles are reported to be dead. Given this estimate, along with an estimated 50-70 small boats in the Lopez Mateos halibut fleet, researchers estimate a minimum "bykill" rate of 1,800 loggerheads for this region. Given that this fishing community is just one among many along the coast of Baja California, Mexico, the total loggerhead mortality in this area is likely to be much greater (Peckham et al. 2004).

In 2004, the Council with partners, ProPeninsula, Grupo Tortuguero and NMFS, implemented the ProCAGUAMA project to conserve loggerhead turtles at their critical foraging habitats and nursery grounds in Bahia Magdelena, Baja California. The project components include: Community Networks, Environmental Education, Conservation Research and Bycatch Reduction in the halibut gillnet fishery. The first season of work with the halibut fishermen in 2004 considered alternatives to their fishing gear and strategy. Experimental gillnet sets were conducted (n = 117) utilizing alternatives such as reduced net height and decreased soak times and pulling nets at dawn to investigate if these measures would reduce loggerhead turtle interactions, since loggerhead dive data indicate that these turtles feed intensively in the hours following dawn. Results from the first year are preliminary and additional data and effort are needed to understand the complete picture; however, researchers report 58% less strandings in 2004, compared to 2003. More work is planned for 2005 (H. Peckham, Blue Ocean Institute, personal communication, 2005).

7.5.4 Shrimp Trawl Fisheries

Central American shrimp trawl fishery

Shrimp fishery operations were initiated throughout Central America during the mid 1950s. In the Pacific, vessels pull one standard 50 to 75 foot headrope length two seam balloon trawl or one standard flat net from each outrigger. Target species include white and small shrimp in shallow waters (9-20 meters deep), pink and brown shrimp in water depths ranging from 55 to 85 meters, and deep shrimp “fidel” or “camello” in deeper waters (150-225 meters depth). Beginning in 1996, the U.S. has required countries on the Pacific coast of Central America, and all other relevant countries, to meet the requirements of Section 609 of U.S. Public Law 101-162, including the adoption of a sea turtle protection program comparable in effectiveness to that of the U.S., in order to be certified to export shrimp from commercial fisheries. Though compliance with Section 609 has generally been good, it has been inconsistent for some countries. Costa Rica and Panama have both had Section 609 certification withdrawn or withheld in the past over concerns about the effectiveness of their program. As of June 2005, Panama is not certified to export commercially caught shrimp to the U.S. due to the fishery’s impacts on sea turtles.

Arauz (1996) estimated that over 60,000 sea turtles were taken by shrimp trawlers on the Pacific coast of Central America. Mortality rates were not estimated. Olive ridleys were the species most commonly taken, and foraging grounds for these turtles overlap with shrimp trawling grounds. Table 18 shows the estimated turtle catch by shrimp trawlers in Central America, by country, for 1993.

Country	# Vessels	Total CPUE turtles/hr	Turtles/year
Guatemala	58	?	(10,000)
El Salvador	70	0.0511	21,280
Nicaragua	21	?	(8,000)
Costa Rica	55	0.0899	20,762
Total	**204**		**60,042**

Table 18. Estimated turtle catch by shrimp trawlers for the Pacific coast of central America, 1993. (Note: figures in parenthesis are estimated. Source: Arauz, 1996).

Observers have also been deployed on shrimp trawling operations off the Pacific coast of Costa Rica. An analysis was undertaken by Arauz et al. (1998) to synthesize information collected by observers during four separate projects and summarized from 1993-97. The fisheries included the white shrimp fishery (average depth from 9 to 40 meters) and the pink shrimp fishery (average depth from 65-85 meters). The deep fidel and camello fishery, which fishes on average at depths of 100-300 meters was assumed not to catch turtles. During 2,556.5 hours of observation, 281 sea turtles were incidentally captured. Of those captured, 90% were olive ridleys (253 observed taken), 9.6% were Pacific greens (27 observed taken) and 0.4% were hawksbills (1 observed taken). Mortality estimates were 37.55% for olive ridleys and 50% for green turtles. Catch per unit effort estimate was 0.1019 sea turtles/hour. Given the effort, Arauz et al. (1998) estimated that over 15,000 sea turtles are taken annually off the Pacific coast of Costa Rica by the shrimp fleet.

Northern Australia shrimp trawl fishery

The Northern Australian prawn fishery (NPF), is made up of both a banana prawn fishery and a tiger prawn fishery, and extends from Cape York, Queensland (142ºE) to Cape Londonberry, Western Australia (127ºE). The fishery is one of the most valuable in all of Australia and in 2000 was comprised of 121 vessels fishing approximately 16,000 fishing days. Vessels in 2000 were between 16 and 27 meters in length and towed twin-gear with a total length of from 16 to 27 fathoms (Robins et al. 2002b).

In 2000, the use of TEDs in the Northern Australia prawn fishery (NPF) was made mandatory, due in part to several factors: (1) objectives of the Draft Australian Recovery Plan for Marine Turtles; (2) requirement of the Australian Environment Protection and Biodiversity Conservation Act for Commonwealth fisheries to become ecologically sustainable; and (3) the 1996 US import embargo on wild-caught prawns taken in a fishery without adequate turtle bycatch management practices (Robins et al. 2002b).

Data was primarily collected by volunteer fishers who were trained extensively in the collection of scientific data on sea turtles caught as bycatch in their fishery. Prior to the use of TEDs in this fishery, the NPF annually took between 5,000 and 6,000 sea turtles as bycatch, with a mortality rate of an estimated 40%, due to drowning, injuries, or being returned to the water comatose (Poiner and Harris 1996 (*in* Robins et al. 2002b)). Since the mandatory use of TEDs has been in effect, the annual bycatch of sea turtles in the NPF has dropped to less than 200 sea turtles per year, with a mortality rate of approximately 22% (based on recent years). This lower mortality rate may also be based on better sea turtle handling techniques adopted by the fleet. Table 19 shows the estimated catch rate (#turtles/day) by fishery, as recorded before TEDs were implemented and after TEDs were implemented. In general, flatback sea turtles are the species most commonly taken, with olive ridleys coming in second, loggerheads third, and small amounts of green and hawksbill turtles.

	Estimated catch rate (# turtles/day) ± standard error	
TED Classification	**Banana prawn season**	**Tiger prawn season**
Before TEDs	0.238 ± 0.029	0.302 ± 0.012
After TEDs	0.007 ± 0.003	0.009 ± 0.003

Table 19. Estimated catch rate (#turtles/day) before and after introduction of TEDs for the NPF banana prawn and tiger prawn season. Source: Robins et al. 2002b.

7.5.5 U.S. albacore troll fishery

Sea turtles are rarely documented interacting with troll gear. Troll fisheries may interact with sea turtles when the hook and line dragged through the water column snags or entangles an animal. Troll fisheries occur off the west coast of North America, and the target species is most often albacore tuna and salmon. The west coast-based U.S. albacore fishery is comprised of vessels that predominantly troll for albacore using jigs and, to a lesser extent, live bait. There have been anecdotal reports of sea turtles being snagged by troll lines off California (NMFS 2004d). Since most gear is retrieved nearly immediately, any sea turtle snagged is likely to be released alive and unharmed, provided the hook and line are removed.

7.5.6 Mexican (Baja California) fisheries and direct harvest

Sea turtles have been protected in Mexico since 1990, when a federal law decreed the prohibition of the "extraction, capture and pursuit of all species of sea turtle in federal waters or from beaches within national territory ... [and a requirement that] ... any species of sea turtle incidentally captured during the operations of any commercial fishery shall be returned to the sea, independently of its physical state, dead or alive" (*in* Garcia-Martinez and Nichols 2000). Despite the ban, studies have shown that sea turtles continue to be caught, both indirectly in fisheries and by a directed harvest of eggs, immatures, and adults. Turtles are principally hunted using nets, longlines and harpoons. While some are killed immediately, others are kept alive in pens and transported in trucks, pick-ups, or cars. The market for sea turtles consists of two types: the local market (consumed locally) and the export market (sold to restaurants in cities such as Tijuana, Ensenada, Mexicali, and U.S. cities such as San Diego and Tuscon). Consumption is highest during holidays such as Easter and Christmas (Wildcoast et al. 2003).

Based on a combination of analyses of stranding data, beach and sea surveys, tag-recapture studies and extensive interviews, all carried out between June, 1994 and January, 1999, Nichols (2002) conservatively estimated the annual take of sea turtles by various fisheries and through direct harvest in the Baja California, Mexico region. Although there are no solid estimates of fisheries-related sea turtle mortality rates for the region, sea turtles are known to interact with (and be killed by) several fisheries in the area. As in other parts of the world, shrimp trawling off Baja California is a source of sea turtle mortality, although since 1996, shrimp fishermen are required to use TEDs. Prior to this requirement, Figueroa et al. (1992 *in* Nichols 2002) reported that nearly 40% of known mortality of post-nesting green turtles tagged in Michoacán was due to shrimp trawlers. Based on stranding patterns, Nichols et al. (2000) speculated that mortality of loggerheads due to local fishing in Baja California may primarily be due to a net-based fishery, likely the halibut (*Paralichthys californicus*) gillnet fishery, which reports regular loggerhead bycatch and coincides with the movement of pelagic red crab into the shallower continental shelf (see summary in gillnet section). Fishermen also report the incidental capture of sea turtles, primarily loggerheads, by pelagic longlines and hook sets used to catch sharks and pelagic fish. Lastly, sea turtles have occasionally been found by fishermen entangled in buoy and trap lines, although this is apparently a rare occurrence (Nichols 2002). Although fishermen may release sea turtles alive after being entangled in or hooked by their gear, based on information on the directed harvest and estimated human consumption of sea turtles in this region, incidentally caught sea turtles are likely retained for later consumption.

Sea turtle mortality data collected between 1994 and 1999 indicate that over 90% of sea turtles recorded dead were either green turtles (30% of total) or loggerheads (61% of total) (Table 20) and signs of human consumption were evident in over half of the specimens. Most of the loggerheads were immature, while size ranges for both green and olive ridleys indicated representation from both immature and mature life stages (Nichols 2002).

Species	Gulf of California	Pacific	Totals
green turtle	30	276	**306**
leatherback	1	0	**1**
loggerhead	3	617	**620**
olive ridley	1	35	**36**
unidentified	0	57	**57**
Total	**35**	**985**	**1,020**

Table 20. Recorded sea turtle mortality by species during 1994-1999 on the Gulf of California coast and the Pacific coast of Baja California, Mexico. Source: Nichols (2002).

A more focused study was conducted from June to December, 1999 in Bahia Magdalena, a coastal lagoon to determine the extent of sea turtle mortality. Researchers searched for sea turtle carapaces in local towns and dumps as well as coastal beaches. The majority (78%) of the carapaces were found in towns and dumps and green and loggerhead turtles most frequently observed. Both species found were generally smaller than the average size of nesting adults. Researchers estimated that the minimum sea turtle mortality rate for the Bahía Magdalena region was 47 turtles per month, or 564 turtles per year. Based on observations, approximately 52% were green turtles, 35% were loggerheads, 2% olive ridleys, and 1% hawksbills (10% unidentified) (Gardner and Nichols, 2002). A study conducted from 1995 to 2002 in Bahía de los Angeles, a large bay that was once the site of the greatest sea turtle harvest in the Gulf of California, revealed that the populations of green turtles in the area had decreased significantly since the early 1960s. Despite the 1990 ban, sea turtle carcasses were found at dumpsites, so human activities continue to impact green turtles in this important foraging site (Seminoff et al. 2003).

Based on surveys conducted in coastal communities of Baja California, extrapolated to include the entire coastal peninsula, Nichols (2002) estimated the annual mortality of green turtles in this region to be *greater* than 7,800 turtles, impacting both immature and adult turtles. Mortality of loggerhead turtles, based on stranding and harvest rates, is estimated at 1,950 annually, and affects primarily immature size classes. The primary causes for mortality are the incidental take in a variety of fishing gears and direct harvest for consumption and [illegal] trade. With the local declines of green turtles, a market for loggerhead meat has developed in several Pacific communities. Olive ridleys are not found as commonly in Baja California waters as loggerheads and greens; however, they are consumed locally and occasionally strand on beaches. No annual mortality estimates of olive ridleys in the area were presented. Lastly, anecdotal reports of leatherbacks caught in fishing gear or consumed exist for the region; however, these instances are rare, and no annual mortality estimates of leatherbacks were presented (Nichols 2002). A recent estimate by Wildcoast et al. (2003) reiterates that there is likely high mortality of turtles in the Californias [9] estimating 15,600 to 31,200 sea turtles consumed annually (no differentiation between species).

The latest research on fisheries mortality and poaching of sea turtles in Mexico focused again on the Bahia Magdalena region of Baja California. In this area, small-scale artisanal fisheries are very important. The most commonly used fishing gear are bottom set gillnets and have been documented interacting at high rates with loggerheads and green turtles. From April 2000 to July, 2003 throughout this region (including local beaches and towns), Koch et al. (in press) found 1,945 sea turtle carcasses. Of this total, 44.1% were loggerheads and 36.9% were green (also known as "black") turtles. Of the sea turtle carcasses found, slaughter for human consumption was the primary cause of death for all species (91% for green turtles, 63% for loggerheads). Mortality due to fisheries bycatch was difficult to document, simply because evidence of trawl and gillnet interactions is rarely seen on a sea turtle carapace. Less than 1% of mortality was documented as due to fisheries bycatch. Over 90% of all turtles found were juveniles or subadults. Koch et al. (in press) estimate conservatively that at least 15,000 sea turtles are killed per year for the Baja California peninsula. Again, no differentiation is made between species; however, the percentages of the various sea turtle species found in Bahia Magdalena may provide an idea of the species composition taken throughout the peninsula.

In 2004, the Council with partners, ProPeninsula, Grupo Tortuguero and NMFS, implemented the ProCAGUAMA project to conserve loggerhead turtles at their critical foraging habitats and nursery grounds in Bahia Magdelena, Baja California. The project components include: Community Networks, Environmental Education, Conservation Research and Bycatch Reduction in the halibut gillnet fishery. The novelty and strength of this approach has yielded a conservation constituency among fishers characterized by local pride, empowerment, and stewardship. Two years into this five-year initiative, preliminary results indicate decreased sea turtle bycatch, poaching, changes in local attitude and an emerging "sea ethic". Enforcement agents and local councils are pursuing sea turtle violations that in the past were ignored. Increasing numbers of fishermen are self-enforcing sea turtle protection amongst themselves and between and within their cooperatives. Fishermen, students and their families are celebrating sea turtles through festivals, artwork, and music. All of this translates into sea turtles spared and steps toward population recovery. Finally, there are indications that this emerging "sea ethic," borne by people's increasing interest in sea turtle conservation, is leading them to manage fisheries such as for lobster and abalone more sustainably, an unexpected but welcomed result.

7.6 Effects of the December 26, 2004 Tsunami on Sea Turtles

The tsunami that occurred on December 26, 2004 affected many nations in the Indian Ocean basin. Many of these nations - including Indonesia, Malaysia, Thailand, India, and Sri Lanka - contain important areas for sea turtle foraging and nesting. It is reasonable to expect, that sea turtle populations will be affected by this natural disaster. What is less clear is the nature and extent of any effects on sea turtle populations or their habitat.

In the months following the event national and international level rapid ecological assessments were prepared in an attempt to begin to assess the types and degrees of environmental damage in

[9] The "Californias" as defined here is the region encompassing the Gulf of California (including the coast of Sonora and Sinaloa, Mexico); Baja California and Baja California Sur, Mexico, and California, USA.

the region (UNEP 2005, IOSEA 2005, Bambaradeniya et al. 2005, Adulyanukosol and Thongsukdee 2005). Sea turtles and their habitat were specifically addressed in many of these reports in varying degrees. It is important to note that these reports represent rapid, preliminary assessments of damage.

In these initial reports, negative impacts to sea turtle populations included inundation of nesting beaches and loss of eggs (India, Sri Lanka, Indonesia, Seychelles), damage to seagrass beds and coral reefs (Seychelles), increased capture of nesting sea turtles for meat (Sri Lanka), and destruction of sea turtle conservation project facilities and loss of staff (India, Sri Lanka, Thailand). Information is not yet available for areas such as Indonesia which may have lost 50% of sandy beaches on the western coast (UNEP 2005, IOSEA 2005). Some impacts to nesting beaches may have a longer duration than others. Renewed nesting has already been observed in areas such as Sri Lanka where green and olive ridley nests were destroyed (Bambaradeniya et al. 2005).

Stories have appeared in the popular press regarding impacts to sea turtles from the tsunami. Reports in the general press in the months following the event present mixed findings. One report notes that the destruction of the coastal fishing industry regions of India has been a benefit to olive ridley sea turtles in the short term by reducing bycatch (Kabra 2005). Other reports note minor damage to nesting beaches in Sri Lanka (Bhaumik 2005) and extensive damage to leatherback nesting beaches in the Nicobar Islands (Denyer 2005).

In summary, the December 26, 2005 tsunami has likely affected sea turtles and their foraging and nesting habitat throughout Southeast Asia, quantifiable information on immediate population effects are unavailable and long term population level effects may not be known for many years.

7.7 Summary of Species Status

7.7.1 Summary of Humpback Whale Status

The number of humpback whales in the North Pacific may have numbered approximately 15,000 individuals prior to exploitation (Rice 1978). Intensive commercial whaling removed more than 28,000 animals from the North Pacific during the 20th century and may have reduced this population to as few as 1,000 before it was placed under international protection after the 1965 hunting season (Rice 1978).

Current population estimates for the central north Pacific stock range from a minimum of 3,698 to 4,005 (Angliss and Outlaw 2005; Calambokidis et al. 1997). The best estimate of the current rate of increase for the population is 7% per year and is considered a conservative estimate of the maximum net productivity rate for the central north Pacific stock of humpback whales (Angliss and Outlaw 2005).

The total estimated annual mortality and serious injury rate for the entire stock is 4.14, of which 3.4 is fishery related. The PBR for the entire stock of central north Pacific humpback whales is 12.9 animals per year (Angliss and Outlaw 2005). While the total estimated annual mortality and serious injury rate of 4.14 is below the PBR of 12.9 this should be considered as a minimum estimate of annual mortality and serious injury.

7.7.2 Summary of Green Turtle Status

The eastern and central Pacific green turtle populations which interact with the Hawaii-based longline fisheries include the endangered Mexican and the threatened Hawaiian Archipelago nesting aggregations. Commercial exploitation and uncontrolled subsistence harvest of nesters and eggs has resulted in a dramatic decline of nesting females at the two main nesting beaches in Michoacan, Mexico. A conservative estimate of the total number of adult females at these locations is 4,238. This population is considered to be stable for now and estimated extinction probabilities indicate very low risks of quasi-extinction over the next 100 years (Snover 2005).

The nesting population of Hawaiian green sea turtles has shown a steady increase and the stock is well on the way to recovery following more than 25 years of protection under the ESA (Balazs and Chaloupka 2004). This recovery is attributed to harvest prohibition and cessation of habitat damage at nesting beaches. Despite the occurrence of fibropapillomatosis, and spirochidiasis, both of which are major causes of stranding of this species, nester abundance has continued to increase (Balazs and Chaloupka 2004).

Fisheries occurring outside the action area that are known to incidentally take green sea turtles as bycatch include the Costa Rican and Mexican longline fisheries, the Peruvian artisanal longline fishery, the CA/OR drift gillnet fishery, and the Mexican, Central American, and northern Australian shrimp trawl fisheries. Although some green sea turtle nesting populations are stable or increasing, it is estimated that the number of nesting females has declined globally by 48% to 67% over the past 150 years (Seminoff 2004).

7.7.3 Summary of Leatherback Turtle Status

Based on leatherback genetic information collected in the fishery, the most likely source of interaction with the deep-set longline fishery is the Indonesian leatherback turtle nesting population, although a small percentage may be from the eastern Pacific (Dutton et al. 2000).

Although reporting of previously unknown nesting sites in the western Pacific has increased estimates of the number of nesting females to approximately 5,000 individuals, there are still indications of a long-term decline in nesting. A severe decline has been observed at one of the most significant western Pacific nesting sites located in Malaysia, from an estimated 3,103 nesting females observed in 1968 to only 2 in 1994 (Chan and Liew 1996). The largest nesting population in the Pacific is thought to be in the province of Papua, Indonesia (Hitipeuw et al. in press). Current analyses indicate this population is at low risk of quasi- and ultimate extinction over the next 100 years (Snover 2005).

Leatherback nesting populations are also declining at a rapid rate along the eastern Pacific coasts of Mexico and Costa Rica. A total of 1,224 adult females are estimated for the eastern Pacific (Snover 2005). The number of adult females in the eastern Pacific Mexican subpopulation has declined from 70,000 in 1980 (Pritchard 1982b, in Spotila et al.1996) to approximately 60 during the 2002/03 nesting season (L. Sarti, UNAM, personal communication, June 2003). Population growth rate parameters calculated for the Playa Grande, Costa Rica nesting population indicate near certainty of quasi-extinction within 20-25 years and a high probability of ultimate extinction within 50-100 years.

Several leatherback conservation projects have either been completed or are currently underway as part of a collaborative effort among the Council, PIFSC, PIR, and SWFSC. These include satellite tagging, aerial surveys, and nesting beach management, as well as meetings and workshops regarding conservation planning and strategizing. Although the results may not be immediately realized, these projects are anticipated to have beneficial effects on leatherback sea turtle populations in the long term.

Fisheries occurring outside the action area that are known to incidentally take leatherback sea turtles as bycatch include the Australian and Costa Rican longline fisheries, the Peruvian artisanal longline fishery, and the CA/OR drift gillnet fishery. Estimates of the global population of leatherback sea turtles indicate that the species has declined by approximately 70% since 1980. Conflicting information makes it difficult to characterize the status of the Atlantic leatherback population. However, the eastern Pacific population has continued to decline, leading some researchers to conclude that the species is now on the verge of extinction in the Pacific Ocean (Spotila et al. 2000).

7.7.4 Summary of Loggerhead Turtle Status

All subpopulations of loggerhead sea turtles are negatively affected by direct take, incidental capture in various fisheries, and alteration and destruction of nesting habitat. The Hawaii-based deep-set longline fishery interacts only with subpopulations originating from Japanese nesting beaches. Total abundance of nesting females from all Japanese subpopulations is approximately 1,500 nesting females (Kamezaki et al. 2003). During the last 50 years, these nesting populations have declined 50-90%. Council-led conservation efforts to protect nests and hatchlings aim to slow the decline of these subpopulations. Current trends indicate a high probability of quasi-extinction of these subpopulations within 50 years (Snover 2005).

Conservation projects are in progress as of 2004 as part of a collaborative effort among the Council, PIFSC, PIR, and SWFSC. Projects include loggerhead nesting beach management, measures to reduce incidental capture by Mexico’s halibut gillnet fishery, educational programs, and meetings and workshops regarding conservation planning and strategizing. These projects are anticipated to have beneficial effects on loggerhead sea turtle populations in the long term.

Fisheries occurring outside the action area that are known to incidentally take loggerhead sea turtles as bycatch include the Mexican longline fishery, the Peruvian artisanal longline fishery, the CA/OR drift gillnet fishery, the Mexican halibut set gillnet fishery, and the Mexican and northern Australian shrimp trawl fisheries.

In the Atlantic Ocean, absolute population size is not known, but based on nesting information, loggerheads are likely much more numerous than in the Pacific Ocean. In the Indian Ocean basin the overall population status of loggerheads is essentially unknown.

7.7.5 Summary of Olive Ridley Turtle Status

Olive ridley sea turtles are considered the most abundant sea turtle in the world (NMFS and USFWS 1998e). Recent genetic information indicates that 75% of the Hawaii-based longline fisheries interactions with this species are from the eastern Pacific subpopulations and 25% are from the Indian and western Pacific rookeries (P. Dutton, NMFS, personal communication, August 9, 2005).

Although increasing numbers of nests and nesting females have been observed in Mexico in recent years, the decline of the species continues in the eastern Pacific countries of Costa Rica, Guatemala, and Nicaragua. Egg loss has occurred from both legal and illegal collection, as well as natural loss due to nesting turtles inadvertently digging up previously laid nests. Population growth rate parameters calculated for the primary nesting site of Escobilla Beach, Oaxaca, Mexico indicate a negligible risk of extinction over the next several decades, given that current conservation practices are continued (Snover 2005).

The largest known rookery in India is estimated to be between 150-200,000 nesting females. This subpopulation is being impacted by illegally operated trawl fisheries resulting in large scale mortality of adults. Despite mandatory requirements passed in 1997, none of the approximately 3,000 trawlers use turtle excluder devices (Pandav and Choudhury 1999).

Limited information is available on western Pacific subpopulations. Nesting has been observed in Indonesia, Malaysia, and Thailand. Reports indicate these subpopulations are rapidly declining in most areas due to egg poaching, harvest and trade or consumption of adults, nesting beach development, and indirect capture in fishing gear (Eckert 1993; Aureggi et al. 1999).

Fisheries occurring outside the action area that are known to incidentally take olive ridley sea turtles as bycatch include the Costa Rican and Mexican longline fishery, the Peruvian artisanal longline fishery, the CA/OR drift gillnet fishery, the Mexican halibut set gillnet fishery, and the Central American and northern Australian shrimp trawl fisheries.

8.0 Environmental Baseline

The environmental baseline for the proposed action includes past and present impacts of all Federal, State, or private actions and other human activities that occur in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation.

8.1 Other fisheries authorized under the Pelagics FMP

In addition to the deep-set component of the Hawaii-based, pelagic, deep-set longline fishery, other fisheries are authorized under the Pelagics FMP. These fisheries were analyzed and explained in detail in the 2004 BiOp, the 2001 FEIS on the Pelagics FMP (NMFS 2001), and the 2004 FSEIS (NMFS 2004a). These additional components include the Hawaii-based shallow-set longline fishery which primarily targets swordfish; the Hawaii-based troll, handline, and pole-and-line fisheries; the Pacific Remote Island Areas (PRIA) pelagic troll/handline fishery; the

America Samoa-based pelagic longline and troll fisheries; and pelagic fisheries in the Territory of Guam and in the Commonwealth of the Northern Mariana Islands.

The Hawaii-based longline fishery is the largest commercial fishery in the western Pacific region. Between 1994 and 1999, before the imposition of measures to protect sea turtles, the shallow-set fishery averaged annual catches of 6.5 million pounds of swordfish. The 2004 BiOp predicted a decline of 45% in the swordfish catches relative to the 1994-1999 baseline under the new sea turtle protection measures. During this era, the shallow-set fishery caught hundreds of leatherback and loggerhead turtles per year (McCracken 2004). The Hawaii-based shallow-set longline fishery was closed by a court order in April 2001. The shallow-set fishery was reopened at much reduced levels of effort and with a suite measures designed to mitigate fishery impacts on sea turtles in April of 2004.

A decrease in fishing effort combined with increased information on loggerhead foraging distribution (Polovina et al. 2004) and new gear technologies to reduce sea turtle bycatch have resulted in a disproportionately low sea turtle bycatch in the shallow-set fishery relative to the decrease in effort since the 1990s (Figure 10). Additional safeguards are in place with the annual limit of 16 leatherback and 17 loggerhead interactions in the shallow-set fishery. If 16 leatherbacks or 17 loggerheads are incidentally taken in the shallow-set fishery, the fishery is put on a one week notice that it will close and closes one week later (NMFS 2004c).

Sea turtle bycatch rates in shallow-set longline fisheries are generally much greater than in deep-set fisheries; however, implementation of circle hooks and mackerel-type bait appears to significantly reduce sea turtle bycatch. While bycatch rates are typically higher in the shallow-set fisheries relative to the deep-set longline fishery, the likelihood of turtles surviving interactions in the shallow-set fishery is much higher (Boggs 2005). Swordfish-target (shallow) fishing differs from tuna target (deep) fishing as it is set at a shallower depth, usually between (~30-90m). Shallow-set longline gear is generally set at night, with luminescent light sticks, thought to attract swordfish, attached to the gangions. 4-6 gangions are typically clipped to the mainline between floats. A typical set for swordfish uses about 700-1,000 hooks. The historical swordfish fishery used squid as bait, but under the April 2004 Final Rule (NMFS 2004c) circle hooks with mackerel bait are required for shallow-sets. The proposed action only allows for 2,120 shallow sets each year by the Hawaii longline fleet.

All five species of sea turtles may be taken in the other fisheries authorized by the Pelagics FMP. These fisheries include all of the handline fisheries, troll fisheries, pole and line fisheries managed under the Pelagics FMP as well as the longline fisheries based out of American Samoa. The known level of effort and the selectivity of the gear used in most of these fisheries have led NMFS to conclude that few sea turtles, if any, are captured, injured, or killed by these fisheries. These fisheries are not observed and most of the sea turtles that have been reported to have been captured in these fisheries have not been identified to species, therefore we identify the species as hardshell (green, hawksbill, loggerhead, and olive ridley sea turtles) or leatherback sea turtles.

The number of sea turtle interactions expected to occur incidental to the Hawaii-based pelagic, shallow-set longline fishery and the handline, troll, and pole-and-line fisheries managed under the Pelagics FMP as well as the longline fisheries based out of America Samoa are shown in Table 21 and Table 22.

Sea Turtle Species	Number Captured	Number Killed
Green	1	1
Leatherback	16	2
Loggerhead	17	3
Olive Ridley	5	1

Table 21. The annual number of turtles expected to be captured or killed incidental to the Hawaii-based pelagic, shallow-set longline fishery (Source: 2004 BiOp).

Sea Turtle Species	Number Captured	Number Killed
Hardshell sea turtle	6	1
Leatherback	1	0

Table 22. The annual number of turtles expected to be captured or killed in the handline fisheries, troll fisheries, and pole and line fisheries managed under the Pelagics FMP as well as the longline fisheries based out of America Samoa.

Observations of the Hawaii-based shallow-set longline fishery between 1994 and the present recorded no interactions with Central North Pacific humpback whales. There are also no information available documenting interactions between Central North Pacific humpback whales and the Hawaii based troll, handline and pole and line fisheries or the PRIA, American Samoan, Guam or CNMI based fisheries, although these fisheries are not observed. Given level of effort, selectivity of gear, and location of fishing effort relative to Central North Pacific humpback stock, NMFS expects that interactions between Central North Pacific humpbacks and these fisheries would be rare.

8.2 Foreign longline fisheries in the western and central Pacific Ocean

The western and central Pacific Ocean (area west of 150ºW longitude, and between 10ºN and 45ºS) contains the largest industrial tuna fisheries in the world. Much of the effort takes place in the EEZs of Pacific island countries, in the western tropical Pacific area (10ºN - 10ºS). Annual tuna catches in this area have averaged around 1.5 million metric tons, with around 60% of the catch taken by purse seine vessels, and the rest taken by longline vessels and other gears (e.g. pole-and-line, troll, ring-net).

Approximately 6,000 commercial longliners operate throughout the western and central Pacific (45ºN to 45ºS), using up to 3,000 baited hooks per line to catch tuna. The proportion of the number of vessels originating from countries throughout the world have changed in the past decade and may consist of large freezer vessels that undertake long voyages and operate over large areas of the region to smaller domestically-based vessels operating in more tropical areas. The distant-water fleets operate throughout the western and central Pacific Ocean, targeting bigeye and yellowfin in tropical waters and albacore in the subtropical waters. Meanwhile, the offshore fleets generally fish in the tropical waters of the Federated States of Micronesia, Indonesia, Marshall Islands, Palau, and Solomon Islands and the adjacent international waters, where they will target bigeye and yellowfin tuna (Oceanic Fisheries Programme 2001).

Observers have been placed on both purse seiners and longliners in this area, and operate and report to the Oceanic Fisheries Programme of the Secretariat of the Pacific Community (SPC). Considering the low observer coverage (<1%) for the longline fisheries, patterns of observed interactions show that sea turtles are more likely to encounter gear in tropical waters and that they are much more likely (by an order of magnitude) to encounter gear that is shallow-set versus deep-set. When encountered on deep-set gear, sea turtles were likely to be taken on the shallowest hooks.

From available observer data, the longline fisheries operating in the western and central Pacific are estimated to take 2,182 sea turtles per year, with 500-600 expected to die as a result of the encounter (23-27% mortality rate). Based on the data, 1,490±376 turtles (0.06 turtles/1,000 hooks) are estimated taken by offshore/fresh tuna vessels using shallow-night sets, 129±79 turtles (0.007 turtles/1,000 hooks) are estimated taken by offshore/fresh tuna vessels on deep-day sets, and 564±345 turtles (0.007 turtles/1,000 hooks) are estimated taken by distant water freezer vessels on deep-day sets. The species observed taken include (ranked by highest occurrence first): olive ridley, green, leatherback, loggerhead and hawksbill. Given the low observer coverage, this estimate has very wide confidence intervals (Oceanic Fisheries Programme 2001).

8.3 Japanese tuna longliners in the eastern tropical Pacific

The most recent sea turtle bycatch information for Japanese tuna longliners is based on data collected during 2000. At a bycatch working group meeting of the IATTC, held in Kobe, Japan on January 14-16, 2004, a member of the Japanese delegation stated that based on preliminary data from 2000, the Japanese tuna longline fleet in the eastern tropical Pacific was estimated to take approximately 6,000 turtles, with 50 percent mortality. Little information on species composition was given; however, all species of Pacific sea turtles were taken, mostly olive ridleys, and of an estimated 166 leatherbacks taken, 25 were dead (Meeting Minutes, 4th Meeting of the Working Group on Bycatch, IATTC, January 14-16, 2004).

8.4 Tuna purse seine fishery in the eastern tropical Pacific

The international fleet represents the majority of the fishing effort and carrying capacity in the ETP tuna fishery, with much of the total capacity consisting of purse seiners greater than 400 short tons (st). The latest information from the IATTC shows that the number of active purse seiners of all sizes is 242 vessels, with Mexico and Ecuador comprising the majority of the fleet (77 and 87 vessels, respectively) (Source: IATTC, 2005 (www.iattc.org)).

Data from observers on both U.S. and foreign tuna purse seine vessels have been gathered collectively by the IATTC since the early 1990s. The most recent data from the IATTC indicate that between approximately 9 and 55 total sea turtles per year were killed by vessels over 400 st (363 mt) in the ETP purse seine fishery from 1993-2003. The primary species taken were olive ridleys (Table 23; M. Hall, IATTC, personal communication, 2005), likely because they are proportionately more abundant than any other sea turtle species in the ETP and they have been observed to have an affinity for floating objects (Arenas and Hall 1992). The mortality estimates contain fractions because while the IATTC has a known number of sets and turtle mortality from their observer database, they only have a known number of sets (not turtle mortality) from the national observer programs. Therefore, the mortality is pro-rated to make up for the sets for which the IATTC has no known turtle mortality data. The majority of sea turtles were taken in sets on floating objects (Table 23).

Since 1999, seminars have been given by the IATTC to skippers and their crews to educate them on, among other issues, status of sea turtles, and handling and recovery of turtles taken by purse seiners in the ETP. In addition, during the meeting held in Lima, Peru from June 14-18, 2004, the IATTC passed Consolidated Resolution C-04-05. Under the resolution, purse seine fishermen are required to promptly release unharmed, to the extent practicable, all sea turtles. In addition, crews are required to be trained in techniques for handling turtles to improve survival after release. Vessels should be encouraged to release sea turtles entangled in FADs and recover FADs when they are not being used in the fishery. Specific to the purse seine fishery operation, whenever a sea turtle is sighted in the net, all reasonable efforts should be made to rescue the turtle before it becomes entangled, including, if necessary, the deployment of a speedboat. If a sea turtle is entangled in the net, net roll should stop as the turtle comes out of the water and should not start again until the turtle has been disentangled and released. If a turtle is brought aboard the vessel, all appropriate efforts to assist in the recovery of the turtle should be made before returning it to sea (IATTC Resolution C-04-05, Action #4).

The numbers of sea turtles killed by the fishery dropped significantly in 2002 and 2003, likely as a result of increased awareness by fishermen through educational seminars given by the IATTC. Given the passing of the latest IATTC Resolution on Bycatch, sea turtle mortalities should continue to decrease.

Name	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Green	15.0	16.1	13.0	12.0	13.0	9.0	10.9	6.1	7.8	2.1	0.0
Hawksbill	0.0	1.8	0.0	1.0	0.0	3.0	2.0	1.0	1.3	0.0	0.0
Leatherback	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Loggerhead	3.6	1.8	2.0	0.0	4.6	1.0	4.0	1.8	1.3	0.0	0.0
Olive Ridley	77.8	80.1	91.3	65.8	93.8	107.6	109.1	92.1	74.2	30.7	17.1
Unidentified	21.0	45.3	34.0	37.6	42.0	41.0	46.2	29.4	55.3	13.8	9.1
Total	**117.4**	**146.3**	**140.3**	**116.4**	**153.4**	**161.6**	**172.2**	**130.4**	**139.9**	**46.6**	**26.2**

Table 23. Estimated sea turtle mortality by species for the ETP tuna purse seine fishery (including US) from 1993 to 2003. Includes only large (364 metric ton capacity and greater) vessels. [Source: M. Hall, IATTC, 2005]

The data contained in Table 24 indicate that some sea turtles killed by the entire tuna purse seine fishery were "unidentified," although the reasons for this were not given. Assuming that these unidentified turtle mortalities occurred in the same proportions as the identified turtle mortalities, 86% would be olive ridleys, 10.8% would be green turtles, 2.1% would be loggerheads, 1% would be a hawksbill, and 0.1% would be leatherbacks.

Year/type of set	Dolphin sets	Floating object sets	Unassociated (tuna school) sets	Total
1998	28	103	31	162
1999	17	128	27	172
2000	17	72	41	130
2001	16	88	33	137
2002	11	26	9	46
2003	7	17	2	26

Table 24. Number of sea turtles killed (or had sustained injuries judged likely to lead to death) by all ETP purse seine fisheries (including US), by set type, from 1998-2003.

As mentioned, the U.S. fleet (large vessels only) has 100 percent observer coverage; therefore, the fate of every sea turtle taken is documented. Because the U.S. fleet does not set on dolphins, sea turtles are taken in school sets and log/FAD sets. Therefore, the fate of sea turtles that interact with the U.S. purse seine fleet during such sets may only be comparable to the non-U.S. fleet that sets on logs/FADs and tuna schools. Table 25 documents sea turtle interactions with the US purse seine fleet from 1998 through 2003. Similar to the entire purse seine fleet (Table 25), the majority of the sea turtles taken by the fishery are olive ridleys, and as shown in Table 25 most sea turtles are released unharmed.

Name	Fate	1998	1999	2000	2001	2002	2003
Green	Released unharmed	3	5	2	2	1	5
Hawksbill	Released unharmed	0	0	0	1	1	0
Loggerhead	Released unharmed	0	1	5	0	0	0
Olive Ridley	Released unharmed	38	27	3	16	10	34
	Escaped/evaded net	0	0	1	0	0	0
	Light injuries*	4	6	2	0	0	7
	Grave injuries**	1	0	0	3	0	0
	Killed	0	0	0	0	0	1
Unidentified	Released unharmed	2	0	3	6	1	10
	Escaped/evaded net	2	1	1	0	0	0
	Light injuries*	0	0	0	1	0	0
	Other/Unknown	1	0	0	0	0	1
Total		**51**	**40**	**17**	**29**	**13**	**58**

Table 25. Sea turtle interactions with the US tuna purse seine fleet (large (>363 mt (400 st)) vessels only) in the ETP, 1998-2003. [Source: M. Hall, IATTC, 2005]
***Light injuries are considered to be non-lethal injuries.**
****Grave injuries are considered to be eventually lethal to the turtle.**

8.5 Purse seine fisheries in the western tropical Pacific Ocean (WTP)

There are nearly 400 active purse seine vessels originating from a variety of countries and operating nearly exclusively in tropical waters of the central and western Pacific Ocean. The purse seine fishery in the WTP is observed, and observer effort generally covers the extent of the fleet's activity. Although there has been less than 5% observer coverage for the entire fishery, the US fleet has maintained up to 20% coverage since the mid-1990s. For the purse seine fisheries operating in the WTP, an estimated 105 sea turtles are taken per year, with approximately 17% mortality rate (less than 20 sea turtles dead per year). The species included green turtles, hawksbills and most often olive ridleys. Encounters with sea turtles appeared to be more prevalent in the western areas of the WTP, where log sets are more prevalent. However, observer data for both the Philippines and Indonesia, which both fish in the east, were unavailable. These countries have purse seiners and ring-net fleets that fish predominantly on a variety of anchored FADs in this area (Oceanic Fisheries Programme 2001); therefore, the sea turtle take estimate in this fishery is likely underestimated.

The highest incidence of sea turtle encounter (1.115, 0.807, and 0.615 encounters per 100 sets, respectively) occurred in drifting log and anchored-FAD sets and animal-associated sets where animals, such as schools of porpoise alert fishers to the presence of tuna. In contrast, drifting FAD sets were observed to have only 0.07 encounters per 100 sets. With less than 5% observer coverage, confidence intervals for these estimates are also very wide (Oceanic Fisheries Programme 2001).

8.6 Summary of Environmental Baseline

8.6.1 Past Impacts

8.6.1.1 Sea Turtles

Observations of the Hawaii-based shallow-set longline fishery between 1994 and 1999 recorded hundreds of leatherback and loggerhead turtles incidentally taken as bycatch per year. Shallow-set longline fishery bycatch rates are generally much greater than in deep-set fisheries, although the likelihood of turtles surviving these interactions is much higher (Boggs 2005). The shallow-set longline fishery was closed by a court order in April 2001, and reopened in April 2004 at much reduced levels of effort and with regulations designed to mitigate sea turtle interactions with the fishery.

Longline fisheries in the western and central Pacific have been estimated to take 2,182 sea turtles per year with a 23-27% mortality rate, although this estimate has a very wide confidence interval due to the low observer coverage (Oceanic Fisheries Programme 2001). Japanese tuna longline fisheries were estimated to have incidentally caught 6,000 turtles with 50% mortality based upon data collected in 2000.

The tuna purse seine fishery in the eastern tropical Pacific was estimated to have killed between 9 and 55 sea turtles per year from 1993-2003. The primary species caught was olive ridleys, likely because they are more abundant than other species in the ETP and have an affinity for floating objects. Purse seine fisheries in the western tropical Pacific are estimated to have taken 105 sea turtles per year, with a 17% mortality rate (Oceanic Fisheries Programme 2001).

Other past actions that may have affected protected species populations in the action area include certain practices used by commercial and recreational fisheries in State of Hawaii waters. Entanglement in lay nets and hooking or entanglement by slide-bait fisheries has been known to occur and can cause injury or death to sea turtles (Chaloupka 2004). Documentation of these interactions has seldom been recorded; therefore, the extent of past impacts on sea turtle populations is unknown.

8.6.2 Present Impacts and Previously Consulted-On Actions

8.6.2.1 Sea Turtles

The incidental catch of sea turtles by the Hawaii-based shallow-set longline fishery has decreased substantially under the 2004 final rule, which decreased fishing effort and required use of new gear technologies that reduce turtle bycatch.

All five species of sea turtles may be incidentally taken in the other fisheries authorized by the Pelagics FMP, which include the Hawaii-based troll, handline, and pole-and-line fisheries, the PRIA pelagic troll/handline fishery, the American Samoa-based pelagic longline and troll fisheries, and pelagic fisheries in the Territory of Guam and the Commonwealth of the Northern Mariana Islands. Although these fisheries are not observed, NMFS has concluded that few, if any, sea turtles are taken by these fisheries due to the level of effort and the selectivity of the gear being used.

The western and central Pacific and Japanese longline fisheries and the western tropical Pacific purse seine fisheries continue to incidentally catch sea turtles. Current information is not available; however, it can be assumed that the rates of turtle bycatch are similar to those documented in 2000/2001.

The numbers of sea turtles killed by the eastern tropical Pacific tuna purse seine fishery dropped significantly in 2002 and 2003, likely as a result of educational seminars aimed at increasing fishermen's awareness. Sea turtle mortalities are expected to continue to decrease given the passing of the IATTC Resolution on Bycatch.

The State of Hawaii is considering additional regulations on use of lay nets to protect listed species. Currently there are no State regulations for the slide-bait fishery. The State has also cooperated with NMFS PIR on responses to hooking incidents and turtle nest management efforts.

9.0 Effects of the Proposed Action

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. §1536), requires federal agencies to insure that their actions are not likely to jeopardize the continued existence of any listed species[10] or result in the destruction or adverse modification of critical habitat.

[10] In this case "species" refers to species as defined by 16 U.S.C. 1532 (16).

The ESA defines "species" to include any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." This Opinion assesses the effects of the continued authorization of the Hawaii-based pelagic, deep-set longline fishery under the Pelagics FMP on threatened and endangered species. NMFS has previously concluded that the Hawaii-based pelagic, deep-set longline fishery is likely to adversely affect listed species through gear interactions that are known to injure or kill individuals of these species.

In the *Description of the Action* section of this Opinion, NMFS provided an overview of the fishery. In the *Status of the Species* and *Environmental Baseline* sections of this Opinion, NMFS provided an overview of the threatened and endangered species that are likely to be adversely affected by the Hawaii-based pelagic, deep-set longline fishery authorized under the Pelagics FMP.

In this section of a biological opinion, NMFS assesses the probable direct and indirect effects of the deep-set longline fishery on threatened and endangered species. 'Effects of the action' refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). The purpose of this assessment is to determine if it is reasonable to expect that the fishery can be expected to have direct or indirect effects on threatened and endangered species that appreciably reduce their likelihood of surviving and recovering in the wild for both the survival and recovery of threatened and endangered species in the wild. Preceding the analyses will be a discussion of the approach to the assessment, the evidence available for our assessment, and assumptions made to overcome gaps in the available information.

9.1 Effects of the Hawaii-based Deep-set Longline Fishery

The primary effects of the Hawaii-based pelagic, deep-set longline fishery on threatened and endangered species result from direct interactions with the fishing gear. Fishery effects on the listed species considered in this Opinion result from capture and subsequent injury or death of individuals that interact with the longline gear. The operation of the longline fishery (i.e., vessel operations, longline gear deployment and retrieval) is not expected to impact any habitat features of significance to sea turtles in the pelagic environment. Sea turtles do not forage on the longline fishery's target or bycatch species, so prey competition is not a factor. Therefore, all analyses will be based on direct effects.

9.2 Exposure Analysis

This section of the Opinion evaluates the available information to determine the likelihood of a listed species interacting with the Hawaii-based pelagic, deep-set longline fishery. As part of our exposure analyses, we consider the probable duration, frequency, and severity of these interactions.[11] This analysis assumes that sea turtles and humpback whales are not likely to be

[11] In this effects analysis the terms 'interaction' and 'interact' refer to incidences where a sea turtle or humpback whale becomes hooked and/or entangled in longline gear.

adversely affected by a fishery if they do not interact with the fishery; these analyses also assume that the potential effects of the fishery are proportional to the number of interactions between the deep-set longline fishery and sea turtles or humpback whales.

Information available for this analysis includes reports of actual interactions between the deep-set longline fishery and sea turtles and humpback whales derived from observer programs and logbooks. These sources do not allow us to determine the abundance of humpback whales or sea turtles from different nesting aggregations that occur in the action area and *could* interact with the deep-set component of the Hawaii-based longline fishery (that is, the number of turtles or whales that are susceptible to interactions with the fishery). Therefore, this interaction analysis assumes that the spatial and temporal patterns derived from reported interactions between the fishery and turtles and whales represent the actual spatial and temporal distribution of the sea turtle and whale populations in the action area. Given the distribution of their nesting aggregations, turtles probably occur throughout the entire fishing area, though they are not likely distributed homogeneously throughout the action area.

9.2.1 Deep-set Longline Fishery (Tuna) Gear Configuration

Vessels targeting tuna in the Pacific Ocean deploy about 34 horizontal miles of main line in the water. Vessels targeting tuna typically use a line shooter. The line shooter increases the speed at which the main line is set which causes the main line to sag in the middle (more line between floats), allowing the middle hooks to fish deeper. The average speed of the shooter is 9 knots. The vessel speed is about 6.8 knots. No light sticks are used as the gear soaks. The float line length is about 22 meters (72 feet) and the branch line lengths are about 13 meters (43 feet). The average number of hooks deployed per set was 2,007 hooks in 2004 with about 27 hooks set between each float. There are approximately 66 floats used during each set. The average target depth is 167 meters. The gear is allowed to soak during the day and the total soak time typically lasts about 19 hours, including setting and hauling of gear. Deep-set fishing rarely occurs north of 25° N.

Deep set vessels use saury (sanma) as bait and the hook type used are “tuna” hooks. The tuna hook or Japanese tuna hook tends to be the smallest of the longline hooks used in Hawaii fisheries. Many types of hooks can be obtained in a wide range of sizes (Figure 9) and Hawaii-based pelagic, deep-set longline fishermen are not restricted in thier choice of hook size or style. The most common hooks in the Hawaii-based deep-set longline fishery are size 3.6 and 3.8 sun tuna hooks. The "sun" is a Japanese unit of measurement and the 3.6 and 3.8 sun sizes range from 3.1 to 3.7 cm in minimum width. The tuna hook is similar in shape to the "J" shaped hooks which were previously the most common hooks used by U.S. Hawaii- and New England-based swordfish longline fisheries prior to new regulations requiring size 18/0 (ca. 4.9 cm minimum width) circle hooks. Like circle hooks, tuna hooks have a point that points more inward towards the shank than the point of "J" shaped hooks, though the curve is moderate and higher in the shank near the eye in comparison to a circle hook (Figure 9). In a study conducted in the Azores, the extra curve (referred to as the “offset”) in a tuna hook was not found to reduce internal hooking of sea turtles (Bolten et al. 2002).

Figure 9. Three hooks commonly used in longline fisheries. (Source: Christopher Boggs, PIFSC).

9.2.2 Assessing Exposure to the Proposed Action

In this stage of the analysis we estimate how many individuals of each species are likely to be exposed to impacts from the Hawaii-based pelagic, deep-set longline fishery. Different methods were used to estimate the exposure of sea turtles to the fishery than were used to estimate the exposure of humpback whales. To estimate the exposure of humpback whales to the deep-set longline fishery, we relied on the draft 2005 Stock Assessment Report (SAR) for the central north Pacific stock of humpback whales prepared per requirements of the Marine Mammal Protection Act (MMPA) (Angliss 2005). MMPA SARs are prepared annually and include a description of the stock's geographic range, a minimum population estimate, current population trends, current and maximum net productivity rates, optimum sustainable population levels and allowable removal levels, and estimates of annual human-caused mortality and serious injury through interactions with commercial fisheries and subsistence hunters. The SARs document and characterize interactions between U.S. commercial fisheries and marine mammal stocks and provide the best source of current information on the estimated magnitude of effects of commercial fisheries on marine mammal stocks.

The sea turtle exposure analysis relies on (1) information on the estimated number of interactions between a protected species and the deep-set longline fishery that occurred in the past; (2) the anticipated number of interactions projected to occur in the future; (3) length data from sea turtles interactions previously observed in the fishery; and (4) genetic samples from past sea turtle interactions which provide insight into the animals' region of natal origin (nesting beach). Combining these sources of information, we assume that patterns observed in the past represent future patterns, and that turtle populations will be exposed in proportion to their relative abundance by nesting beach origin and age class (inferred from length data), in the action area.

The 2004 BiOp considered the effects of all of the fisheries managed under the Pelagics FMP (NMFS 2004). In the 2004 BiOp, the number of sea turtles likely to be exposed to the proposed fisheries was determined by calculating the rate of observed interactions in the 1994-1999 fisheries and estimating the number of interactions likely to occur in deep and shallow longline sets under the proposed management regime. Interaction rates observed in the 1994-1999 fisheries were applied to projected levels of fishing effort for 2004 and beyond to determine the number of turtles likely to be exposed to the fisheries.

For this analysis, the range of years used to calculate anticipated exposure of individuals to the fishery was revised from the analysis in the 2004 BiOp. Several scenarios were examined in the process of selecting the preferred scenario for calculating the number of individuals likely to interact with the deep-set fishery in 2005 and beyond. The analysis in the 2004 BiOp used 1994-1999[12] fishery data as the baseline for fishing effort.

However, due to operational changes in the fisheries since 1994, changes in percent observer coverage, and in order to increase precision in estimating the number of interactions in the deep-set fishery, it is less ambiguous to use 2002-2004 fishery and observer data for projecting interactions in the deep-set longline fishery than the 1994 – 1999 fishery baseline. The Hawaii-based deep-set longline fishery was operational from 2001-2003 while the shallow-set fishery was closed. In 2004, effort in the deep-set longline fishery was consistent with recent trends despite the reopening of the shallow-set fishery in April of 2004. The shallow-set fishery closed in April of 2001 and many vessel operators were either converting from shallow set longlining to deep-set or moving to California to continue shallow-set longlining in that year. Therefore, the time series from 2002-2004 was deemed a more appropriate range of years to evaluate interactions occurring in the deep-set fishery for the purpose of projecting anticipated interactions likely to occur in the future.

As demonstrated in Figure 10 and explained in Lewison et al. (2004) and Kaplan (2005), sea turtle interaction rates are typically at least ten times greater in shallow-set swordfish longline fisheries than in deep-set tuna fisheries. Because interaction rates are highly disparate between the two components of the longline fishery and because the fisheries regulatory regime has been highly dynamic over time; using data from recent years which reflect the current management regime for the fishery and isolating deep-set fishery interactions results in more precise projections of anticipated interactions in the deep-set component of the Hawaii-based longline fishery.

[12] This time period was selected as the baseline for the analysis in the 2004 BiOp as it preceded litigation that resulted in several subsequent years of openings and closures in the fisheries based on court rulings.

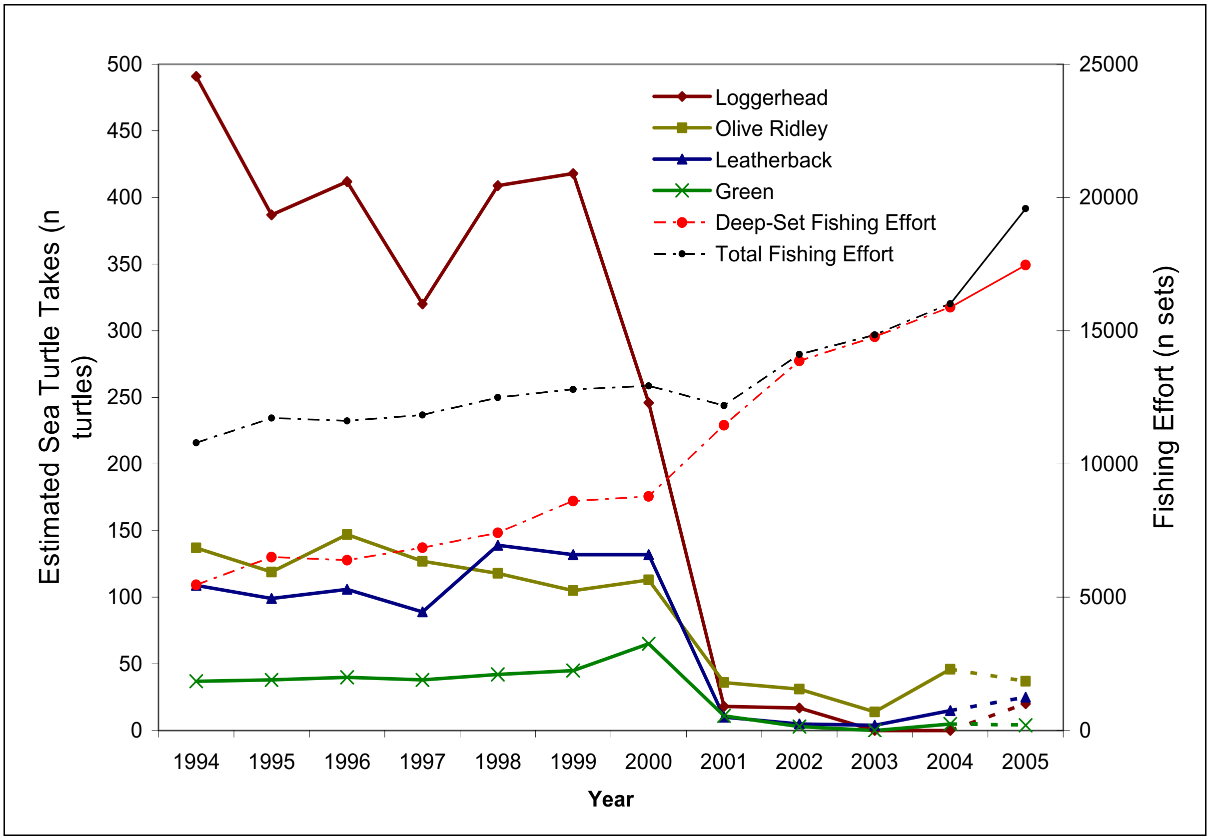

Figure 10. Estimated (1994 – 2004) and projected (2005) sea turtle interactions and Hawaii-based pelagic longline fishing effort. Interactions projected for 2005 were based on the mean number of interactions in the deep-set fishery from 2002-2004 combined with shallow-set interaction limits specified in the 2004 BiOp (NMFS 2004). Fishing effort was projected for 2005 by increasing the actual 2004 deep-set fishing effort by 10% and adding the maximum 2,120 sets authorized for the shallow-set fishery.

In recent years, the amount of observer coverage has increased in the Hawaii-based longline fisheries. Overall observer coverage ranged from 3.3 to 5.3% from 1994-1999 and different sampling schemes were employed between 1994-1996 and 1997-1999. The observer sampling scheme was modified to comply with terms and conditions of a Court Order in 2000 and changed again in 2001. Unstratified random sampling of vessels for observer placement was initiated when the entire fleet converted to targeting tuna in 2001. In May, 2002, a formal systematic sampling scheme, developed by the PIFSC, was implemented to facilitate data analysis. The sampling scheme in the deep-set fishery has remained unchanged since 2002. The observer program maintained observer coverage levels for the Hawaii-based longline fleet above 20% in 2001 and 2002. In the early part of 2002, coverage rates over 30% were attained when monies and personnel became available to the program. NMFS' practice is to maintain observer coverage rates in the deep-set fishery slightly above 20%. NMFS' observer program completed four to five times the number of observed trips per year in 2001 and 2002 than in years prior to 2000 (see Table 26 for summary).

Year	Observer Coverage
1994	5.3%
1995	4.5%
1996	4.9%
1997	3.6%
1998	4.1%
1999	3.3%
2000	10.4%
2001	22.5%
2002	24.6%
2003	21.0%
2004	24.6%

Table 26. Percent observer coverage in the Hawaii-based longline fisheries from 1994-2004.

The number of protected species individuals taken incidental[13] to Hawaii-based deep-set longline fishing operations is estimated on a quarterly and annual basis. A Horvitz-Thompson estimator is used to extrapolate protected species interactions occurring during observed longline fishing trips to the total number of trips to estimate fleet-wide interactions in a year. The annual incidental take estimates are used to determine if specified incidental take levels[14] have been exceeded (PIFSC Unpublished Report, July, 2004). The sampling design is constructed to provide a systematic probability sample on a quarterly basis, based on the number of vessels calling in to report a trip departure. As a result, confidence intervals are calculated for the quarterly estimates, but not for the annual estimates.

There are at least two sources of uncertainty in the annual incidental take estimates which may result in estimates that are higher or lower than the actual fleet-wide incidental take. The main sources of uncertainty are natural variability within a given year (process error) and sampling variability (measurement error). Natural variability results from the suite of random processes determining if there is an interaction between a given animal and the fleet. The number and potential distribution of interactions depend on the distribution of fishing effort relative to the distribution of turtles or whales. Sampling variability leads to uncertainty in the incidental take estimates as only a small fraction of the fleet is monitored. Assuming random and representative sampling, a reasonable approximation of the additional variance in estimated takes (interactions)

[13] For the analysis used to determine the number of protected species interactions occurring in the fishery each quarter, "incidental take" refers to an animal that was hooked and/or entangled in longline gear and is interchangeable with the term "interaction" in this Opinion.

[14] "Specified incidental take levels" refer to take levels specified in previously issued Incidental Take Statements which are issued through the formal section 7 consultation process.

due to sampling error is to multiply the (process) variance for actual takes by 1/f, where f is the sampling fraction. At 20% sampling, f = 0.2 and thus the expected variance of the distribution of estimated takes will have 5 times the variance of the distribution for actual takes.

	Sea Turtles			
Year	**Loggerhead**	**Leatherback**	**Olive Ridley**	**Green**
2002	17	5	31	3
2003	0	4	14	0
2004	0	15	46	5

Table 27. Estimated protected species interactions in the Hawaii-based, pelagic, deep-set longline fishery 2002-2004. Source Final PIFSC Reports.

9.2.2.1 Methods for Projecting Exposure (Anticipated Interactions)

Longline logbook data (1990 – 2004, obtained March 15, 2005 from C. Tokita, PIFSC/OMD/SIS) and longline observer data (trips #1 - #1535 spanning March 1994 –January 2005, obtained April 8, 2005 from M. McCracken, PIFSC/FBSAD/SAP) were used in a stratification /expansion approach to predict sea turtle takes. The data were filtered to only include deep sets with a gear haul date from 2002-2004. Observed sea turtle interactions occurring in the deep-set fishery during this time period were expanded to the total deep-set fishing effort baseline based on 2002-2004 logbook data. An individual deep-set was the common denominator and simple ratios of takes per set were used as multipliers. All observed sea turtle interactions occurring in the deep-set fishery from 2002-2004 were used to populate the deep-set stratum to calculate average take rates for each species. The longline observer database was bootstrapped (resampled) 200 times, and a stratification / expansion exercise was accomplished for each bootstrapped data set to evaluate the uncertainty in the expanded interaction estimates. The resultant distributions of sea turtle interactions were sorted and sampled using the percentile method. Values for the 95% and 80% confidence bounds are shown in Table 28. These values have been rounded up to the nearest integer.

Species	**Point Estimate**	**95% CI**		**80% CI**	
		Lower	**Upper**	**Lower**	**Upper**
Loggerhead	3	0	7	1	6
Leatherback	8	2	16	4	13
Olive Ridley	32	20	47	25	41
Green	3	0	8	0	7

Table 28. Number of sea turtle interactions by species anticipated to be exposed to the Hawaii-based deep-set longline fishery in 2005 and beyond based on interactions in the fishery from 2002-2004 (Source: Kobayashi 2005).

9.2.2.2 Anticipated Level of Interactions

Results to the exposure analysis for 2005 and beyond are summarized in Table 28. The point estimates represent the number of sea turtles expected to be incidentally caught by the deep-set longline fishery each year based on recent patterns in the fishery. We refer to these estimates as '*anticipated interactions*' and distinguish between the '*estimated interactions'* discussed in the previous section. As discussed with the estimated interactions, there is uncertainty about the anticipated number of sea turtle interactions. In addition to sampling variability and natural variability within a given year, the anticipated interactions have an additional source of error; natural variability between years. The approach used to generate the number of anticipated interactions assumes that the abundance and distribution patterns of turtles (relative to the fishery) are similar from year to year. Table 27 shows that estimates based on the number of observed interactions are highly variable from year to year.

For example, the number of estimated interactions for olive ridley turtles in the deep-set fishery was 31, 14, and 46 in 2002, 2003, and 2004. Based on three years of fishery and observer data, the most likely number of interactions on an annual basis is *anticipated* to be 32 olive ridleys (Table 28). However, based on the estimated interactions, the number of interactions in any year may be much higher or much lower than the anticipated level. While 32 interactions per year is the most likely value anticipated given the pooled expansion approach, 46 interactions were estimated to have occurred in the fishery in 2004.

9.2.2.3 Anticipated vs. Estimated Interactions

Actual interactions observed in the fishery are used to derive anticipated and estimated interactions, yet the purpose of each requires that different approaches be used to calculate probable interaction levels. It is important to reconcile the two estimates and consider their respective assumptions and uncertainty as the anticipated interactions are evaluated in the biological opinion to determine the level of exposure likely to occur in the future and the estimated interactions are used following a year of fishing to determine if the levels analyzed in the biological opinion were exceeded.

When the data are pooled, we see a narrower range of values in the distribution than the range we observe in the estimates generated independent of other years (Figure 11 and Figure 12). In going from the estimated distribution based on one year of observations (Figure 12) to an estimate of the 'actual' distribution (Figure 11) based on the bootstrap procedure, the probability distribution of the estimated annual interactions may not be contained in the actual estimated distribution. An explanation for why this occurs is that the estimated interactions contain sampling error and the actual distribution is tighter than the estimates suggest. Thus, future anticipated interactions may have a high probability of exceeding a given confidence interval because the intervals pertain to the 'anticipated (actual)' and not 'estimated' interactions.

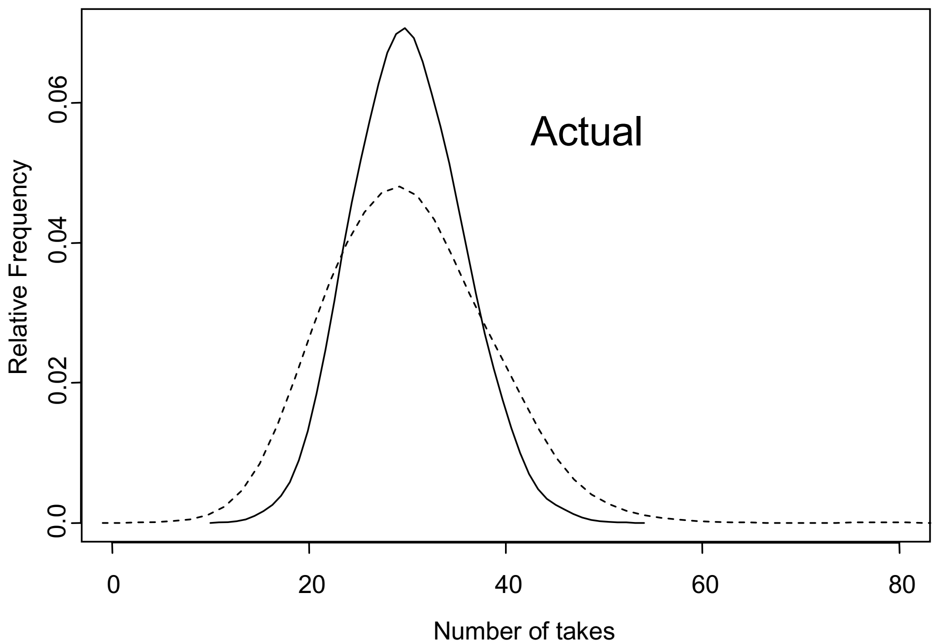

Figure 11. Hypothetical distribution of anticipated interactions (the actual distribution of sea turtle interactions) based on the resampling procedure (bootstrap approach) with data pooled across years.

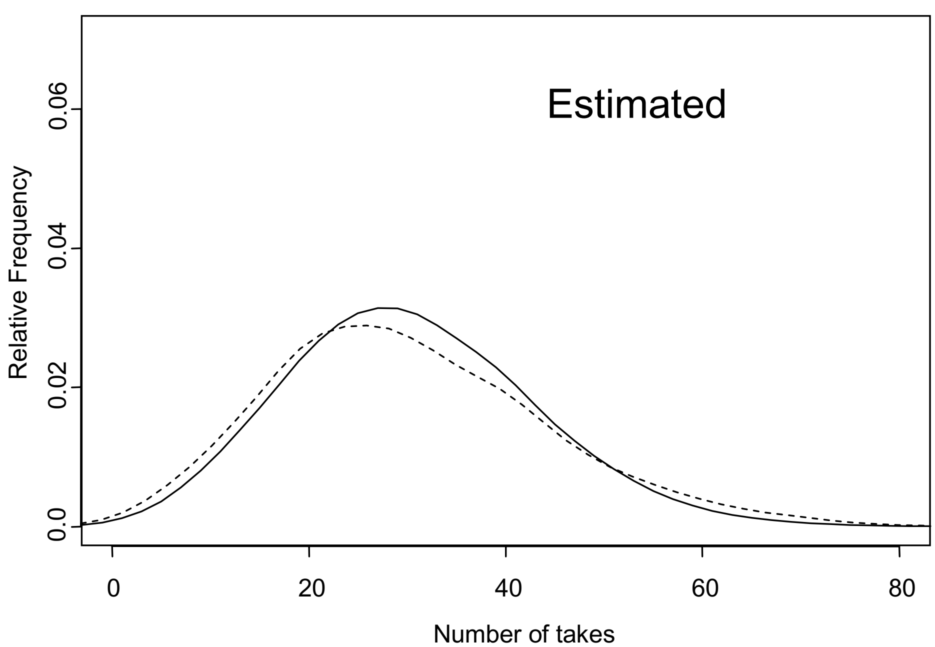

Figure 12. Hypothetical distribution of estimated interactions (takes) based on 20% observer coverage (sampling probability *c.* 0.2).

9.2.2.4 Anticipated Interactions

The level of anticipated interactions in this Opinion is based on three years of fishery and observer data (2002-2004). While previous anticipated interaction levels were based on a longer time series of data (1994-1999), we expect the revised estimates to be more precise with respect to anticipated interactions in the deep-set fishery as data from recent years are a more accurate representation of current operations in the fishery and do not require us to make assumptions about the effect of operational changes in the fishery due to new regulations or changes in participation. While we expect the point estimate of the anticipated interaction levels derived for this Opinion to be more precise with respect to the level of exposure of sea turtles to the deep-set fishery, we acknowledge that there is uncertainty due to interannual variability in takes as evidenced by Table 27.

In the 2004 BiOp the mean point estimate of anticipated takes was analyzed as the level of exposure expected to occur in the fishery on an annual basis (NMFS 2004). To take a more conservative approach accounting for uncertainty (natural and sampling variability) and recognizing differences between the estimated interactions and the anticipated interactions in Table 29, we assessed a higher level of interactions likely to occur in the fishery than the mean point estimate of the anticipated level of interactions.

Sea Turtles					
	Year	**Loggerhead**	**Leatherback**	**Olive Ridley**	**Green**
Estimated Interactions [a]	2002	17	5	31	3
	2003	0	4	14	0
	2004	0	15	46	5
Anticipated Interactions (Mean Point Estimate)[b]		**3**	**8**	**32**	**3**

Table 29. Estimated interactions of sea turtles incidental to the Hawaii-based pelagic, deep-set fishery.
[a] Source: PIFSC Annual Reports
[b] Source: Kobayashi 2005

The upper 80% CI (the 90th percentile of the probability distribution) and the upper 95% CI (the 97.5 percentile of the probability distribution) were evaluated as potential options to use as a conservative estimate of future interactions likely to occur in the deep-set fishery. The upper 80% CI was selected as the values contained by the upper 80% CI more closely resemble the interactions estimated for individual years from 2002 – 2004 and provide conservative, yet reasonable approximations of the level of exposure expected to occur in the fishery on an annual basis. The upper 95% CI is also deemed to be a conservative estimate of the number of interactions likely to occur in the fishery in any particular year, yet based on what was observed from 2002-2004, likely overstates the level of effects we expect in the Hawaii-based pelagic deep-set fishery on an annual basis. Our objective is to determine a conservative and realistic characterization of the effects using the best available information. Thus, the following section analyzes the level of exposure of each species to the deep-set longline fishery based on the upper 80% CI (Table 30).

Species	Anticipated Interactions	
	2004 Biop[a]	2005 Opinion[b]
Loggerhead	4	6
Leatherback	18	13
Olive Ridley	37	41
Green	6	7

Table 30. Number of interactions by species, anticipated to occur on an annual basis incidental to the Hawaii-based deep-set longline fishery in 2005 and beyond.
[a] Source: 2004 Biop (NMFS 2004)
[b] Source: Upper 80% CI based on bootstrap approach by Kobayashi 2005

9.2.2.5 Exposure Probabilities by Species

The 2004 BiOp (pg. 148-160) describes demographic, behavioral, spatial, and temporal patterns of sea turtle exposure to the pelagic fisheries for each species (NMFS 2004; pgs. 148 – 160). Demographic patterns of exposure are updated for the deep-set component of the Hawaii-based pelagic longline fishery in this section. We refer to the 2004 BiOp (NMFS 2004) for a complete discussion behavior, spatial, and temporal patterns of exposure.

9.2.2.6 Green Sea Turtles

Anticipated Level of Interactions
Green turtles are exposed to the deep-set component of the Hawaii-based longline fishery. With the proposed fishery management regime, about 7 (95% confidence interval = 0 - 8) green turtles are expected to interact with the Hawaii-based deep-set longline fishery each year.

Impacted life stage
Life history information collected by observers suggests that the Hawaii-based longline fisheries are likely to interact with sub-adult and adult green turtles (straight carapace lengths ranged from 28.5 cm to 73.5 cm with an average of 51.5 cm). Additional life-stages may be present in the action area, yet to be conservative, we assume that all individuals interacting with the fishery are adults.

Sex Ratio
A 50:50 male to female sex ratio is assumed for the green turtles captured incidental to the Hawaii-based pelagic, deep-set longline fishery.

Nesting Beach Origin
Green turtles captured by the Hawaii-based longline fisheries will be members of the endangered Mexican (Pacific coast) or threatened Hawaiian (French Frigate Shoals) nesting aggregations. Out of fourteen green turtles caught by the deep-set component of the Hawaii-based longline fishery, genetic analyses concluded that eight (57%) represented nesting aggregations from the eastern Pacific (Mexico), six turtles (43%) represented the Hawaiian nesting aggregations (P. Dutton, NMFS, personal communication, August 9, 2005).

If the longline fishery affects green turtle populations proportional to their relative abundance in the action area, about 4 of the 7 green turtles that are expected to interact with the Hawaii-based longline fishery each year would represent endangered green turtles from the eastern tropical Pacific, while 3 of the 7 turtles would represent turtles from the Hawaiian nesting aggregations.

Exposure probabilities
The probability distribution of annual anticipated green turtle interactions is shown in Figure 13. The probability distribution is based on 200 estimates generated by resampling actual interactions observed in the fishery from 2002 – 2004.

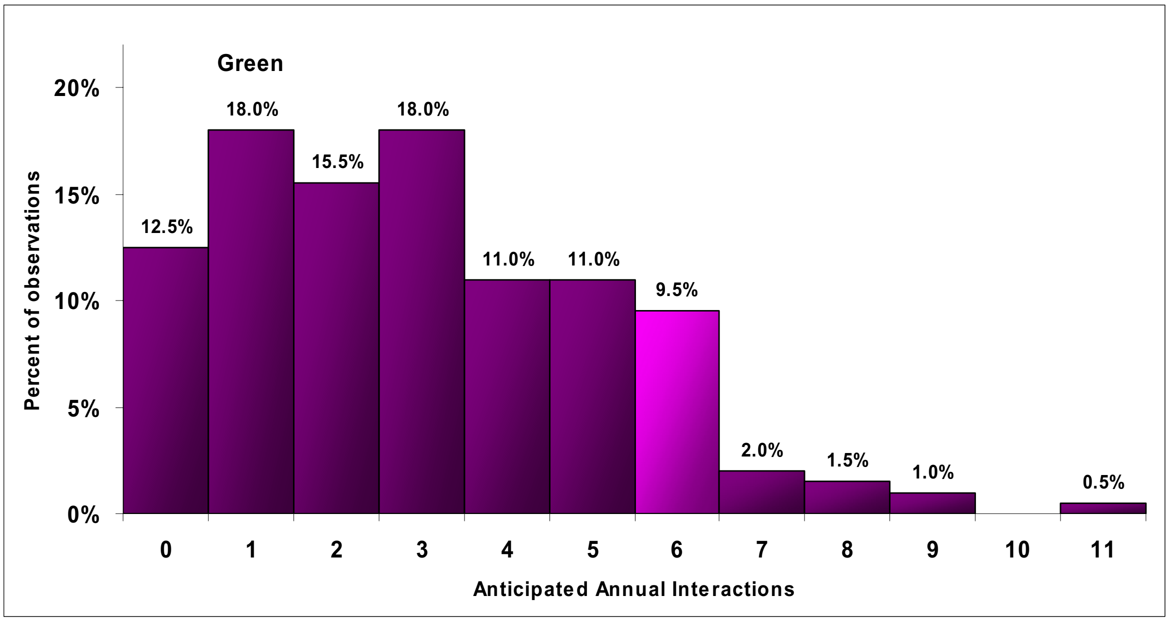

Figure 13. Probability frequency distribution for anticipated annual green turtle interactions in the deep-set fishery based on n = 200 bootstrap estimates. (Source: Kobayashi 2005).

9.2.2.7 Leatherback Sea Turtle

Anticipated Level of Interactions
Leatherback sea turtles are exposed to the deep-set component of the Hawaii-based longline fishery. With the proposed fishery management regime, about 13 (95% confidence interval = 2 - 16) leatherbacks are expected to be incidentally captured by the Hawaii-based deep-set longline fishery each year.

Impacted life stage
Observers collected life history records for 34 leatherback turtles, but only five of the turtles captured in the fishery had been measured (the unmeasured turtles may have been too large to be safely brought on board; therefore they may have been adults). The straight carapace lengths for the five turtles were 71, 80, 87.5, 110, and 130 centimeters, the smallest four of these turtles were probably early pelagic juveniles (n = 1) and late pelagic sub-adults (n = 3) based on growth rates that have been assumed for Malaysian turtles (Bolten et al. 1996). If the larger (>130 cm) leatherback turtle was from the western Pacific, it would have been a sub-adult turtle, if it was from the eastern Pacific nesting aggregations, it could have been an adult (P. Dutton, NMFS, personal communication, January, 2001). In either case, to be conservative, we assume that the leatherback turtles that are exposed to the Hawaii-based longline fishery are adult turtles.

Sex Ratio
A 50:50 male to female sex ratio is also assumed for the leatherbacks captured incidental to the Hawaii-based pelagic deep set longline fishery.

Nesting Beach Origin
Genetic analyses of leatherback turtles captured previously in the Hawaii-based longline fishery, identified 17 of 18 leatherback turtles from nesting aggregations in the southwestern Pacific; one turtle, which were captured in the southern range of the fishery, was from nesting aggregations in the eastern Pacific (Dutton et al. in press and P. Dutton, NMFS, personal communication, August 9, 2005). Based on these data we assume that most of the leatherback turtles that are exposed to the deep-set Hawaii-based longline fishery are from two nesting aggregations: the eastern Pacific region (Mexico and Costa Rica), and the western Pacific region (Indonesia, Malaysia, Papua New Guinea, Fiji, and the Solomon Islands).

If the longline fishery affects leatherback populations proportional to their relative abundance in the action area, almost all (12 to 13) of the 13 leatherbacks that are anticipated to be captured by the Hawaii-based longline fishery each year would represent endangered leatherbacks from the western Pacific region, while no more than 1 turtle would likely represent eastern Pacific nesting aggregations.

Exposure probabilities
The probability distribution of annual anticipated leatherback interactions is shown in Figure 14. The probability distribution is based on 200 estimates generated by resampling actual interactions observed in the fishery from 2002 – 2004.

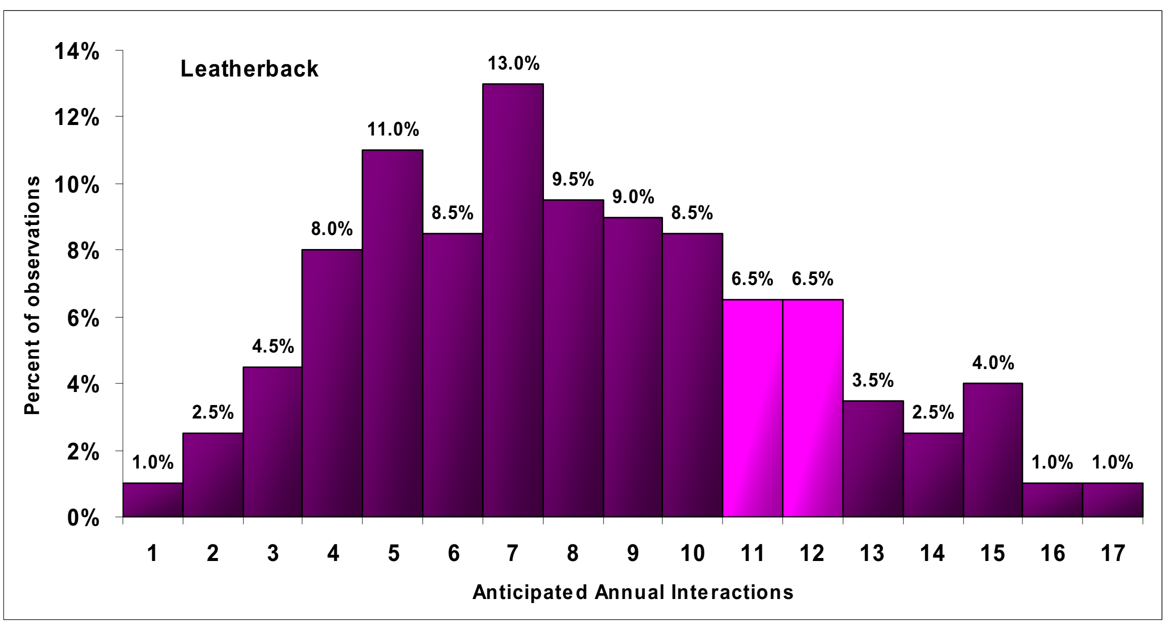

Figure 14. Probability frequency distribution for anticipated annual leatherback interactions in the deep-set fishery based on n = 200 bootstrap estimates. (Source: Kobayashi 2005).

9.2.2.8 Loggerhead Sea Turtle

Anticipated Level of Interactions
Loggerhead turtles are exposed to the deep-set component of the Hawaii-based longline fishery, however to a much lesser extent than in the shallow-set fishery. With the proposed fishery management regime, about 6 (95% confidence interval = 0- 7) loggerheads are expected to be incidentally captured by the Hawaii-based deep-set longline fishery each year.

Impacted life stage
The proposed fishery would primarily capture or interact with loggerhead sea turtles in the oceanic juvenile stage of development (Bolten 2003). However, to be conservative, we analyzed the impact to the population of removing as many adults from the affected population as our analysis does not account for differential effects (e.g. of the net reproductive potential of juveniles vs. adults) of removing sub-adult animals from the population.

Sex Ratio
A 50:50 male to female sex ratio is also assumed for the loggerheads captured incidental to the Hawaii-based pelagic deep set longline fishery.

Nesting Beach Origin
Based on genetic analyses of 135 loggerheads captured previously in the Hawaii-based shallow and deep-set longline fisheries, almost all of the loggerhead turtles that are exposed to the fishery are from the Japanese nesting aggregations (P. Dutton, NMFS, personal communication August 9, 2005). The majority of these turtles represent the 40 different nesting beaches in southern Japan while a small percentage (about 5 percent of the turtles sampled) represent a rare genetic type that is unique to two nesting beaches on Yakushima Island off southern Japan (Kamezaki et al. 2003).

Exposure probabilities
The probability distribution of annual anticipated loggerhead interactions is shown in Figure 15. The probability distribution is based on 200 estimates generated by resampling actual interactions observed in the fishery from 2002 – 2004.

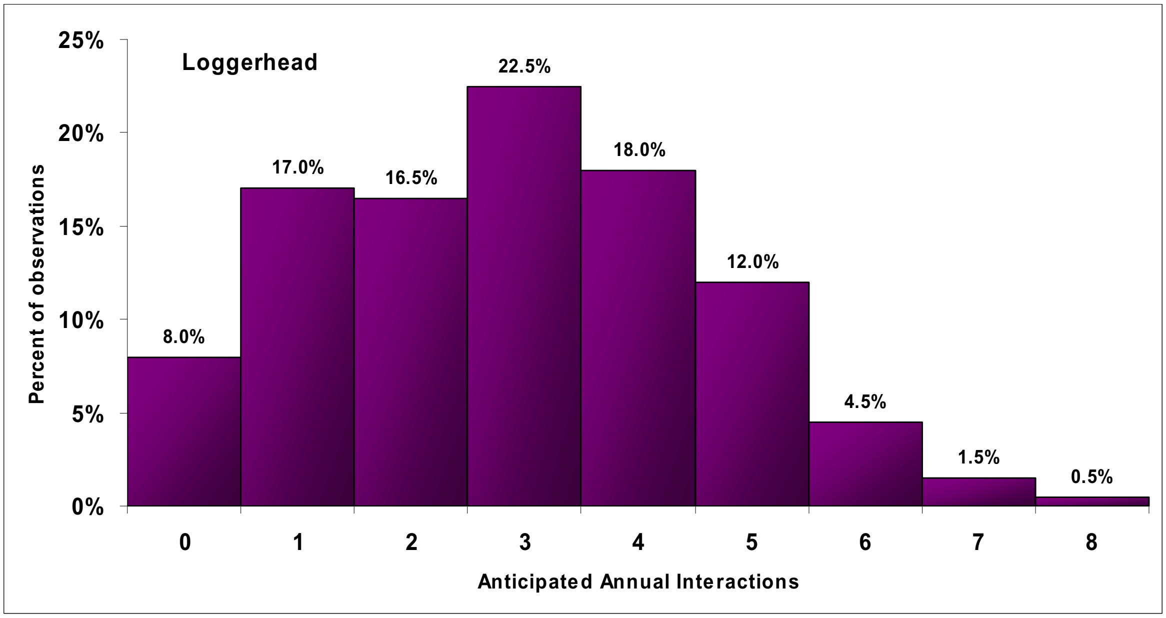

Figure 15. Probability frequency distribution for anticipated annual loggerhead interactions in the deep-set fishery based on n = 200 bootstrap estimates. (Source: Kobayashi 2005).

9.2.2.9 Olive Ridley Sea Turtle

Anticipated Level of Interactions

The olive ridley sea turtle is the most frequently occurring species caught incidental to the deep-set component of the Hawaii-based pelagic longline fishery. With the proposed fishery management regime, about 41 (95% confidence interval = 20- 47) olive ridleys are expected to be incidentally captured by the Hawaii-based deep-set longline fishery each year.

Impacted life stage

Most of the olive ridleys captured incidental to the deep-set longline fishery will be sub-adults or adults. To be conservative, we assume all animals captured are adults.

Sex Ratio

A 50:50 male to female sex ratio is also assumed for the olive ridleys captured incidental to the Hawaii-based pelagic deep set longline fishery.

Nesting Beach Origin

Genetic analyses of olive ridley sea turtles captured previously in the Hawaii-based longline fisheries identified olive ridley turtles from nesting aggregations in the eastern, western, and Indian Pacific Ocean. Of 44 olive ridleys captured by the Hawaii-based longline fishery, 11 (25%) were from the Indian Ocean or western Pacific Ocean and 33 (75%) were from the eastern Pacific (P. Dutton, NMFS, personal communication, August 9, 2005). Based on these data we assume that the olive ridley turtles that are exposed to the Hawaii-based longline fisheries represent the threatened western Pacific population and the endangered eastern Pacific population.

Exposure probabilities

The probability distribution of annual anticipated olive ridley interactions is shown in Figure 16. The probability distribution is based on 200 estimates generated by resampling actual interactions observed in the fishery from 2002 – 2004.

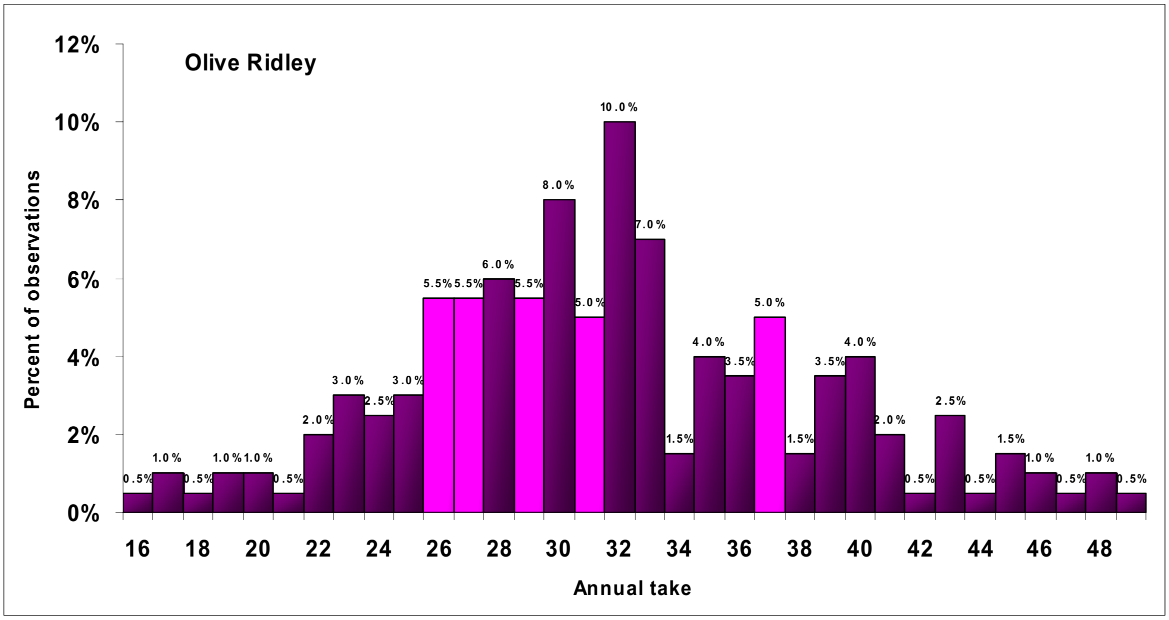

Figure 16.Probability frequency distribution for anticipated annual olive ridley interactions in the deep-set fishery based on n = 200 bootstrap estimates. (Source: Kobayashi 2005).

9.2.2.10 Factors contributing to the likelihood of an interaction with the longline fishery

Gear
Sea turtles may be attracted to the floats used on longline gear. Sea turtles have been observed associating with manmade floating objects significantly more frequently than with natural objects, perhaps related to turtles' affinity for three-dimensional objects. Turtles also show a preference for objects floating horizontally and nearly submerged and are strongly attracted to brightly colored objects (Arenas and Hall 1992). Tuna-style sets generally use larger cylindrical inflatable or rigid spherical buoys and floats, and these also are typically orange in color. Sea turtles may also be attracted to the bait used on longline gear. Four olive ridleys necropsied after being taken dead by Hawaii-based longliners were found with bait in their stomachs (Work 2000).

Environmental conditions
Environmental conditions may also play a large part in whether or not a sea turtle interacts with longline gear. Sea turtles in the open ocean are often found associated with oceanographic discontinuities such as fronts and driftlines, areas often indicating high productivity. In addition, sea turtles also appear to associate with particular sea surface temperatures. As mentioned in more detail later, species such as the loggerheads have been tracked moving along convergent ocean fronts, in waters with sea surface temperatures of 17° C and 20° C (Polovina et al. 2000).

9.2.2.11 Humpback Whales

Humpback whales are present in the Action Area as they migrate to and from and occur in waters surrounding the Hawaiian Islands during the winter months. The deep-set longline fishery generally occurs at locations where humpback whales are uncommon. Thus, interactions between the Hawaii-based deep-set longline fishery and humpback whales are rare and unpredictable events. Over the past 15 years (1990-2004), there have been only three observed interactions between the species and the entire Hawaii-based longline fleet. During this same time period the central north Pacific stock of humpback whales has been steadily increasing in abundance. One interaction per year with adult humpback whales was observed in the deep-set longline fishery in 2001, 2002 and 2004 (Table 31). Two of these interactions occurred outside of the United States EEZ. The third interaction occurred within the U.S. EEZ around Hawaii. According to NMFS' observer characterizations of these events, the whales were or may have become entangled in a main longline. In each instance, efforts were taken to disentangle the whale, and all whales were either released or able to break free from the gear without noticeable impairment the animals' ability to swim or feed. NMFS review also determined that any injuries to the animals as a result of these interactions were not likely to result in mortality.

Observed humpback interactions in the deep-set fishery were not extrapolated to the entire fishery due to the rare and sporadic occurrence of interactions; the fact that humpbacks occur in the action area only in the winter months; and the lack of a uniform occurrence of the species across spatial distribution of the deep-set longline fishery.

Date	EEZ	NMFS' determined Injury severity
Feb 01	Hawaii	Not serious
Oct 02	Outside	Not serious
Feb 04	Outside	Not serious

Table 31. Summary of observed interactions between humpback whales and the Hawaii-based longline fleet from 1994-2004. Seriousness of injuries was assessed under MMPA serious injury guidelines (Angliss and Demaster 1998).

The central north Pacific humpback stock is increasing and it is reasonable to expect that over time there will be more animals present in the action area which may result in an increase in the frequency of interactions with the fishery. However, given the infrequency and rarity of the interactions to date between the fleet and humpbacks, NMFS cannot speculate how the frequency or severity of interactions may change in coming years.

10.0 Response Analysis

As discussed in the Assessment Approach (Section 4.0), once we have identified which listed resources are likely to be exposed to the Hawaii-based pelagic, deep-set longline fishery, we conduct response analyses to identify how listed resources are likely to respond once exposed to the fishery.

10.1 Response of Sea Turtles Given Exposure

The deep-set longline fishery poses direct impacts on sea turtles as they can become entangled in and/or hooked by gear used in the fishery. Incidentally hooked and entangled turtles may die as a result of their interaction with the gear, or they may be released alive with varying degrees of injury, trailing various amounts of gear that remains imbedded in or wrapped around the animal. Fatal interactions result when hooked and/or entangled turtles are unable to surface for air, or when the gear inflicts lethal injury (for example, the turtle is strangled by the line or hooked deeply in the esophagus).

Turtles that do not die from their wounds can suffer impaired swimming or foraging abilities, altered migratory behavior, and altered breeding or reproductive patterns. Although survivability studies have been conducted on sea turtles captured in longline fisheries, such long-term effects are nearly impossible to monitor; therefore a quantitative measure of the effect of longlining on sea turtle populations is very difficult. Even if turtles are not injured or killed after being entangled or hooked, these interactions can be expected to elicit stress-responses in the turtles that can have longer-term physiological or behavioral effects.

The deep-set longline fishery exposes sea turtles to a physical stressor. The adaptive function of the stress response in animals is to accommodate changes in the environment (stressors) by adjustments in behavior and/or changes in physiology. Stressors to which an individual cannot adapt lead to temporary and long-term physiological changes. Fitness is expected to be reduced with increasing frequency of exposure to external stressors (e.g. being captured in the fishery more than once; being exposed to many stressors, such as, fisheries, predators, etc.) and increasing duration and/or intensity of the stressor(s). Such changes may contribute to the development of disease, especially if the organism is simultaneously exposed to pathogenic stimuli (Lutz et al. 2003). Various stressors do not produce the same the same outcomes in all individuals. For example the gender, age, and life stage of the individual as well as environmental conditions can influence how the individual responds to stressors of various duration and intensity (Lutz et al. 2003).

Because sea turtles are long-lived animals, the cumulative effect of various stressors is likely to be great (Lutz et al. 2003). Sea turtles spend discrete portions of their life in a variety of marine habitats and are vulnerable to a greater variety of stressors at multiple life stages compared to less migratory animals. Sea turtles are exposed to natural stressors such as thermal stress (heat stress, cold stunning), seasonal or temperature-related changes in immune function, and the presence of disease, parasites or epiphytes. These natural physiological stressors may be impacted or exaggerated by anthropogenic factors (Lutz et al. 2003). Currently, we do not possess data to estimate the physiological response of sea turtles exposed to the fishery in isolation or in combination with exposure to multiple stressors. We acknowledge that there may be increased risk to individuals exposed to the fishery due to factors described above, yet we were not able to increase the resolution in our risk assessment beyond the post-interaction survival and mortality criteria described below.

10.1.1 Entanglement in Longline Gear

Sea turtles are particularly prone to being entangled in fishing gear because of their body configuration and behavior. Reports of stranded or entangled sea turtles provide evidence that fishing gear can wrap around the neck, flippers, or body, severely restricting swimming and feeding activities and potentially resulting in infection, necrosis, loss of limbs and mortality. Over time, if the sea turtle is entangled, the fishing line will become tighter and more constricting as the sea turtle grows, cutting off blood flow, causing deep gashes, some severe enough to remove an appendage. Sea turtles have also been found trailing gear that has been snagged on the bottom, thus causing them to be anchored in place (Balazs 1985).

Sea turtles have been found entangled in branchlines (gangions), mainlines and float lines. Longline gear is fluid and can move according to oceanographic conditions determined by wind and waves, surface and subsurface currents, etc.; therefore, depending on sea turtle behavior, environmental conditions, and location of the set, turtles could be entangled in longline gear. Entanglement in monofilament line (mainline or gangion) or polypropylene (float line) could result in substantial wounds, including cuts, constriction, or bleeding on any body part. In addition, entanglement could directly or indirectly interfere with mobility, causing impairment in feeding, breeding, or migration. Sea turtles entangled by longline gear are most often entangled around their neck and foreflippers, and, often in the case of leatherback entanglements, turtles have been found snarled in the mainline, floatline, and the branchline (e.g. Hoey 2000).

Of the turtle species, leatherbacks seem to be the most vulnerable to entanglement in fishing gear. This susceptibility may be the result of their body type (large size, long pectoral flippers, and lack of a hard shell), their attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, possibly their method of locomotion, and perhaps to the lightsticks used to attract target species in longline fisheries.

10.1.2 Hooking (Longline Gear)

In addition to being entangled in a longline, sea turtles are also injured and killed by being hooked. Hooking can occur as a result of a variety of scenarios, some of which will depend on foraging strategies and diving and swimming behavior of the various species of sea turtles. For example, necropsied olive ridleys have been found with bait in their stomachs after being hooked; therefore, they most likely were attracted to the bait and attacked the hook. In addition, leatherbacks, loggerheads and olive ridleys have all been found foraging on pyrosomas which are illuminated at night. If lightsticks are used on a shallow set at night to attract the target species, the turtles could mistake the lightsticks for their preferred prey and get hooked externally or internally by a nearby hook. Similarly, a turtle could concurrently be foraging in or migrating through an area where the longline is set and could be hooked at any time during the setting, hauling, or soaking process.

Sea turtles are either hooked externally - generally in the flippers, head, beak, or mouth - or internally, where the animal has attempted to forage on the bait, and the hook is ingested into the gastro-intestinal tract, often a major site of hooking (E. Jacobson, *in* Balazs et al. 1995). Even if the hook is removed, which is often possible with a lightly hooked (i.e. externally hooked) turtle, the hooking interaction is believed to be a significant event. Like most vertebrates, the digestive tract of the sea turtle begins in the mouth, through the esophagus, and then dilates into the stomach. The esophagus is lined by strong conical papillae, which are directed caudally towards the stomach (White 1994). The existence of these papillae, coupled with the fact that the esophagus snakes into an s-shaped bend further towards the tail make it difficult to see hooks, especially when deeply ingested. Not surprisingly, and for those same reasons, a deeply ingested hook is also very difficult to remove from a turtle's mouth without significant injury to the animal. The esophagus is attached fairly firmly to underlying tissue; therefore, when a hook is ingested, the process of movement, either by the turtle's attempt to get free of the hook or by being hauled in by the vessel, can traumatize the internal organs of the turtle, either by piercing the esophagus, stomach, or other organs, or by pulling the organs from their connective tissue. Once the hook is set and pierces an organ, infection may ensue, which may result in the death of the animal.

If a hook does not become lodged or pierce an organ, it can pass through to the colon, or even be expelled through the turtle (E. Jacobson *in* Balazs et al. 1995). In such cases, sea turtles are able to pass hooks through the digestive track with little damage (Work 2000). Of 38 loggerheads deeply hooked by the Spanish Mediterranean longline fleet and subsequently held in captivity, six loggerheads expelled hooks after 53 to 285 days (average 118 days) (Aguilar et al. 1995). If a hook passes through a turtle's digestive tract without getting lodged, the chances are good that less damage has been done. Tissue necrosis that may have developed around the hook may also get passed along through the turtle as a foreign body (E. Jacobson, *in* Balazs et al. 1995).

Whereas entanglement and foul hooking is the primary form of interaction that occurs between leatherback turtles and the longline fishery, internal hooking is much more prevalent in hard-shelled turtles, especially loggerheads. Internal hooking of leatherback turtles occurs only rarely. Participants of the January, 2004 workshop to revise the post-interaction criteria agreed that leatherbacks are more vulnerable to all aspects of a longline interaction (hooking internal or external, entanglement, handling related injuries) because of their friable skin, softer tissue, and bone structures and their increased susceptibility to both entanglement and anoxia. Consequently, participants felt that the risk for most injury categories would be greater for leatherbacks than for hardshell turtles (i.e. loggerhead, green, and olive ridley turtles).

10.1.3 Trailing Gear

Trailing line is line that is left on a turtle after it has been captured and released, particularly line trailing from an ingested hook. Turtles are likely to swallow line trailing from an ingested hook, which may occlude their gastrointestinal tract, preventing or hampering the turtle when it feeds. As a result, trailing line can eventually kill a turtle shortly after the turtle is released or it may take a while for the turtle to die.

Trailing line can also become snagged on a floating or fixed object, further entangling sea turtles or the drag from the float can cause the line to constrict around a turtle's appendages until the line cuts through the appendage. With the loss of a flipper a turtle's mobility is reduced, as is its ability to feed, evade predators, and reproduce. Observers on longliners that have captured (hooked) a turtle are directed to clip the line as close to the hook as possible in order to minimize the amount of trailing gear. This is difficult with larger turtles, such as the leatherback, which often cannot practicably be brought on board the vessel, or in inclement weather, when such action might place the observer or the vessel and its crew at risk. Tools have been developed specifically to remove line from hooked turtles.

10.1.4 Forcible Submergence

Sea turtles can be forcibly submerged by deep-set longline gear. Forcible submergence occurs through a hooking or entanglement event where the turtle is unable to reach the surface to breathe. Due to the depth at which gear is set in the tuna longline fishery, hooked and entangled turtles will not be able to surface. While sea turtle bycatch rates are lower overall in the deep-set longline fishery, mortality rates are higher in the deep-set longline fishery (Boggs 2005) primarily because the turtles drown due to forcible submergence. Such drowning may be either "wet" or "dry." With wet drowning, water enters the lungs, causing damage to the organs and/or causing asphyxiation, leading to death. In the case of dry drowning, a reflex spasm seals the lungs from both air and water. Before death due to drowning occurs, sea turtles may become comatose or unconscious. Studies have shown that sea turtles that are allowed time to stabilize after being forcibly submerged have a higher survival rate. This depends on the physiological condition of the turtle (e.g. overall health, age, size), time of last breath, time of submergence, environmental conditions (e.g. sea surface temperature, wave action, etc.), and the nature of any sustained injuries at the time of submergence (NRC 1990).

The following paragraphs describe non-lethal responses to forcible submergence. Sea turtles forcibly submerged for extended periods of time show marked, even severe, metabolic acidosis as a result of high blood lactate levels. With such increased lactate levels, lactate recovery times are long (even as much as 20 hours), indicating that turtles are probably more susceptible to lethal metabolic acidosis if they experience multiple captures in a short period of time, because they would not have had time to process lactic acid loads (*in* Lutcavage and Lutz 1997). Kemp's ridley turtles that were stressed from capture in an experimental trawl ($\leq$7.3 minute forcible submergence) experienced significant blood acidosis, which originated primarily from non-repiratory (metabolic) sources. Visual observations indicated that the average breathing frequency increased from approximately 1-2 breaths/minute pre-trawl, to 11 breaths/minute post-trawl (a 9 to 10-fold increase). Given the magnitude of the observed imbalance, complete recovery of acid-base homeostasis may have required 7 to 9 hours (Stabenau et al. 1991). Similar results were reported for Kemp's ridleys captured in entanglement nets - turtles showed significant physiological disturbance, and post-capture recovery depended greatly on holding protocol (Hoopes et al. 2000).

Presumably, however, a sea turtle recovering from a forced submergence would most likely remain resting on the surface (given that it had the energy stores to do so), which would reduce the likelihood of being recaptured by a submerged longline. Recapture would also depend on the condition of the turtle and the intensity of fishing pressure in the area. NMFS has no information on the likelihood of recapture of sea turtles by HMS fisheries. However, in the Atlantic Ocean, turtles have been reported as captured more than once by longliners (on subsequent days), as observers reported clean hooks already in the jaw of captured turtles. Such multiple captures were thought to be most likely on three or four trips that had the highest number of interactions (Hoey 1998).

Stabenau and Vietti (2003) studied the physiological effects of multiple forced submergences in loggerhead turtles. The initial submergence produced severe and pronounced metabolic and respiratory acidosis in all turtles. As the number of submergences increased, the acid-base imbalance was substantially reduced; although successive submergences produced significant changes in blood pH, PCO_2, and lactate. Increasing the time interval between successive submergences resulted in greater recovery of blood homeostatis. The authors conclude that as long as sea turtles have an adequate rest interval at the surface between submergences, their survival potential should not change with repetitive submergences.

Respiratory and metabolic stress due to forcible submergence is also correlated with additional factors such as size and activity of the sea turtle (including dive limits), water temperature, and biological and behavioral differences between species and will therefore also affect the survivability. For example, larger sea turtles are capable of longer voluntary dives than small turtles, so juveniles may be more vulnerable to the stress of forced submergence than adults. Gregory et al. (1996) found that corticosterone concentrations of small loggerheads captured were higher than those of large loggerheads captured during the same season. During the warmer months, routine metabolic rates are higher, so the impacts of the stress due to entanglement or hooking may be magnified (e.g. Gregory et al. 1996). In addition, disease factors and hormonal status may also play a role in anoxic survival during forced submergence. Any disease that causes a reduction in the blood oxygen transport capacity could severely reduce a sea turtle's endurance on a longline, and since thyroid hormones appear to have a role in setting metabolic rate, they may also play a role in increasing or reducing the survival rate of an entangled sea turtle (Lutz and Lutcavage 1997). Turtles necropsied following capture (and subsequent death) by longliners in this fishery were found to have pathologic lesions. Two of the seven turtles (both leatherbacks) had lesions severe enough to cause probable organ dysfunction, although whether or not the lesions predisposed these turtles to being hooked could not be determined (Work 2000). As discussed further in the leatherback and loggerhead subsections below, some sea turtle species are better equipped to deal with forced submergence.

Sea turtles also exhibit dynamic endocrine responses to stress. In male vertebrates, androgen and glucocorticoid hormones (corticosterone (CORT) in reptiles) can mediate physiological and behavioral responses to various stimuli that influence both the success and costs of reproduction. Typically, the glucocorticoid hormones increase in response to a stressor in the environment, including interaction with fishing gear. "During reproduction, elevated circulating CORT levels in response to a stressor can inhibit synthesis of testosterone or other hormones mediating reproduction, thus leading to a disruption in the physiology or behavior underlying male reproductive success" (Jessop et al. 2002). A study in Australia examined whether adult male green turtles decreased either CORT or androgen responsiveness to a capture/restraint stressor to maintain reproduction. Researchers found that migrant breeders, which typically had overall poor body condition because they were relying on stored energy to maintain reproduction, had decreased adrenocortical activity in response to a capture/restraint stressor. Smaller males in poor condition exhibited a pronounced and classic endocrine stress response compared to the larger males with good body condition. The authors state: "We speculate that the stress-induced decrease in plasma androgen may function to reduce the temporary expression of reproductive behaviors until the stressor has abated. Decreased androgen levels, particularly during stress, are known to reduce the expression of reproductive behavior in other vertebrates, including reptiles." Small males with poor body condition that are exposed to stressors during reproduction and experience shifting hormonal levels may abandon their breeding behavior (Jessop et al.2002).

Female green turtles have also been studied to evaluate their stress response to capture/restraint. Studies showed that female green turtles during the breeding season exhibited a limited adrenocortical stress response when exposed to ecological stressors and when captured and restrained. Researchers speculate that the apparent adrenocortical modulation could function as a hormonal tactic to maximize maternal investment in reproductive behavior such as breeding and nesting (Jessop et al. 2002).

10.1.5 Survival of Sea Turtles that Interact With Deep-Set Longline Gear

This section describes the response of sea turtles to interactions with the Hawaii-based deep-set longline fishery based on observed interactions from 1994-2004. Observers recorded data on 63 interactions between turtles and the deep-set longline fishery from 1994 – 2004 (Boggs 2005). These data provide insight as to the probable survival and degree of injury to sea turtles following interactions with the deep-set longline fishery.

Of the 63 observed interactions in the deep-set fishery, 45 were confirmed as immediate mortalities and 18 were released alive/injured (Boggs 2005). Table 32 shows the number of each species observed in the deep-set fishery since 1994, the number of fatal interactions observed for each species and the condition of live turtles upon release. The most common interactions in the Hawaii-based deep-set longline fishery are fatal interactions with olive ridley sea turtles. Only 2 of 37 olive ridleys have been released alive since 1994. Of 18 turtles that were released alive, half of them were released with all of the gear removed while 2 were released with hooks remaining in their esophagus.

The 2004 BiOp describes methods used by NMFS to estimate the fraction of turtles likely to survive an interaction with the fishery (NMFS 2004). The methods for estimating post-interaction survival and mortality have been refined and revised over time as more information has become available on sea turtle survival following an interaction with the longline fishery. The 2004 BiOp explains how initially, a constant fraction was applied to all interactions to estimate the rate of survival. In 2001, NMFS began to differentiate between anatomical location of hooking and condition of the turtle when it was released and assigned varying fractions of survival based on these criteria.

NMFS Office of Protected Resources (OPR) convened a workshop on Marine Turtle Longline Post-Interaction Mortality on 15-16 January, 2004, during which seventeen experts in the areas of biology, anatomy/physiology, veterinary medicine, satellite telemetry, and longline gear deployment presented and discussed the more recent data available on the survival and mortality of sea turtles subsequent to being hooked by fishing gear. Based on the information presented and discussed at the workshop and a comprehensive review of all of the information available on the issue, the Office of Protected Resources proposed the criteria in Table 33.

The new criteria divide mouth hooking events into three components to reflect the severity of the injury and to account for the probable improvement in survivorship resulting from removal of gear, where appropriate, for each injury. The three components consist of: (1) hooked in esophagus at or below the heart (insertion point of the hook is not visible when viewed through the open mouth; (2) hooked in cervical esophagus, glottis, jaw joint, soft palate, or adnexa[15] (insertion point of the hook is visible when viewed through the open mouth); and (3) hooked in lower jaw (not adnexa). The 2004 criteria, also, separate external hooking from mouth hooking, eliminate the 'no injury' category, and add a new category for comatose/resuscitated.

The new criteria recognize that in most cases removal of some or all of the gear (except deeply-ingested hooks) is likely to improve the probability of survival. The categories for gear removal

[15] Subordinate part such as tongue, extraembryonic membranes

are: released with hook and with line that is greater than or equal to half the length of the carapace; released with hook and with line that is less than or equal to half the length of the carapace; and released with all gear removed. Turtles that have all or most of the gear removed are expected to have, on average, a higher probability of survival.

Hard-shelled turtles and leatherback have been shown to have disparate rates of post-hooking mortality, with leatherbacks being an estimated 10% more susceptible to post-hooking mortality than hard-shelled turtles. The new criteria take these differences into consideration and assign slightly higher rates of post-interaction mortality for leatherback turtles (Table 33).

10.1.6 Updated Mortality Rate Calculations

Average mortality fractions for deep-set bycatch were estimated using the same source data and methods as in the 2004 BiOp. For this consultation, 17 interactions occurring from December 30, 2003 – December 2004 were added to the database; 13 olive ridleys and 1 green turtle that were dead upon release and 3 leatherback turtles that were released live. Assumed probabilities of post-release mortality were based on guidance provided OPR in April 2005 (Table 33). Mortality criteria included whether the turtle was hooked or entangled, responsive or comatose, the anatomical location of hooking, and the amount of gear left on the turtle at the time of release. Certain hooking locations (e.g. external body parts, the upper and lower jaw) and the removal of most or all of the fishing gear were assumed to result in a lower probability of post-interaction mortality, based on the guidance from OPR.

NMFS' observer data and notes on the condition, handling, and release of sea turtles caught by the Hawaii-based fleet are routinely summarized by the Pacific Islands Fisheries Science Center[16]. These data were compiled and the assumed post-interaction probability of mortality (0.01 to 0.70) for each observed turtle released alive, plus the known probability of mortality (1.0) for each observed dead turtle from all years were summed and averaged to provide an overall mortality rate (fraction of bycatch) for each species (Boggs 2005).

As categorized in Table 32, mortality criteria and assumed probability of post-interaction mortality were assigned to each observed turtle take as indicated by reference to an "interaction category" row number (I to VI, externally hooked to comatose) and a "released with" column number (1 to 3 from left to right) in the table provided by OPR (Table 33).

Reasonable deductions were made in the few cases where the description of a turtle's status was not descriptive enough for classification according to the OPR criteria (Boggs 2005). For example, carapace length and the length of line left remaining on a turtle were not always recorded, but average turtles sizes, and descriptive remarks (such as a line cut "as close to the hook as possible") permitted reasonable assignments to be made. When not stated it was assumed that all gear was removed from turtles brought onto the deck and measured by the observers, unless the insertion of the hook could not be seen through the mouth, in which case observers must not remove the hooks (Boggs 2005). For one leatherback turtle coded as lightly hooked and entangled (LHE) but for which the observer tally sheet indicated only entanglement and no indication of gear being removed, the higher mortality level of "released entangled" (category/row V, released column 2) was assigned (Boggs 2005).

[16] Data are maintained by George Balazs and Denise Parker, PIFSC.

The previous classification (used for the 2004 BiOp) of 3 turtles to category/row III were re-classified. One olive ridley hooked in the beak is now assigned to category/row II. Another olive ridley had a deeply ingested hook (DIH) code, and even though the observer notes said the turtle was hooked in the mouth, the notes also said “the hook was unable to be retrieved”. Since the turtle was decked for measurement, this implies the hook was too deep to be removed and this turtle was reclassified as category/row IV. A similar reclassification occurred for a loggerhead released with a hook still in its throat. In the prior classification, the fact that the end of the hook was visible was misinterpreted. The insertion of the hook, not just the end, must be visible for classification to category/row III. These reclassifications had small effects on the average mortality rates (Table 34).

Species	Total	Number of Turtles Released Alive															Number Observed Dead
		Hooked with or without entanglement											V. Entangled Only		VI. Comatose and resuscitated		
		I. Externally			II. Upper or lower jaw			III. Upper mouth/throat			IV. Deep esophagus						
		Hook & line > .5 cp	Hook & line < .5 cp	All gear removed	Hook & line > .5 cp	Hook & line < .5 cp	All gear removed	Hook & line > .5 cp	Hook & line < .5 cp	All gear removed	Hook & line > .5 cp	Hook & line < .5 cp	Released entangled	Disentangled	Hook & line < .5 cp	All gear removed	
		I-1	I-2	I-3	II-1	II-2	II-3	III-1	III-2	III-3	IV-1	IV-2	V-2	V-3	V-2	V-3	
Green	7			1													6
Leatherback	15	2	4	3									1	2			3
Loggerhead	4									1		1		1			1
Olive Ridley	37						1					1					35
All Species	**63**	**2**	**4**	**4**			**1**			**1**		**2**	**1**	**3**			**45**

Table 32. Numbers and release condition of turtles caught on deep-set tuna-style longline gear by Hawaii-based fleet through December 2004 categorized according to criteria provided by OPR (see Table 1) (Source: Boggs 2005).

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

Table 33. Criteria for assessing marine turtle post-interaction mortality after release from longline gear. Percentages are shown for hardshelled turtles, followed by percentages for leatherbacks (in parentheses).

[1] Subordinate part such as tongue, extraembryonic membranes

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

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

Summary Average Mortality Rates		
Species	**New**	**Old**
Green	0.86	0.84
Leatherback	0.34	0.39
Loggerhead	0.44	0.40
Olive Ridley	0.96	0.94

Table 34. Average sea turtle mortality rates based on observed interactions in the deep-set component of the Hawaii-based longline fishery. New mortality rates are based on the full observer database with a comparison of the mortality rates used in the 2004 BiOp. (Source: Boggs 2005).

Most olive Ridley (35 out of 37) and green turtles (3 out of 4) were dead on retrieval, and most of the turtles released alive were externally hooked (10) or entangled only (4). The majority of leatherbacks (12 out of 15) and loggerheads (3 out of 4) were released alive. The updated average mortality rates over the history of the deep-set sector (Table 34) were very similar to those used for the same sector in the previous BiOp (NMFS 2004). The reclassification of one loggerhead caused a 10% increase in the overall average loggerhead mortality. All leatherbacks were released alive from December 2003 through December 2004, which decreased the overall average mortality by 13% from previous estimates. All olive ridley and green turtles retrieved from December 2003 through December 2004 were dead upon retrieval, resulting in increases in the overall average mortality for olive ridleys by 2.1% and by 2.6% for green turtles (Boggs 2005).

10.1.7 Summary of Sea Turtle Responses to Interactions with the Fisheries

10.1.7.1 Green Sea Turtle

Assuming that patterns observed in the past represent future patterns, the continued management regime for the deep-set Hawaii-based longline fishery is expected to result in about 7 (95% confidence interval = 0-8) interactions with green turtles in the fishery each year. Of the turtles that interact with the deep-set Hawaii-based longline fishery, essentially all 7 are expected to die as a result of the exposure. Four of these turtles are likely green turtles from nesting beaches in Mexico which are listed as endangered and three green turtles likely to be killed in an interaction with longline fishery would have originated from Hawaiian nesting populations which are classified as threatened (Table 35).

10.1.7.2 Leatherback Turtles

Assuming that patterns observed in the past represent future patterns, the continued management regime for the deep-set Hawaii-based longline fishery is expected to result in about 13 (95% confidence interval = 2-16) interactions with leatherback turtles each year. Of the leatherbacks that interact with the deep-set Hawaii-based longline fishery, about a third (.34), or 6 (due to rounding) leatherbacks are expected to die as a result of the exposure. Approximately 5 of these leatherbacks will originate from endangered western Pacific populations while the remaining leatherback turtle likely to be killed in an interaction with longline fishery may originate from endangered eastern Pacific nesting beaches (Table 35).

10.1.7.3 Loggerhead Turtles

Assuming that patterns observed in the past represent future patterns, the continued management regime for the deep-set Hawaii-based longline fishery is expected to result in about 6 (95% confidence interval = 0-7) interactions with loggerhead turtles in the fishery each year. Of the loggerheads that interact with the deep-set Hawaii-based longline fishery, less than half (.44), or 3 (due to rounding) loggerheads are expected to die as a result of the exposure. Based on existing data, all of these loggerheads originate from threatened Japanese loggerhead populations (Table 35).

10.1.7.4 Olive Ridley Sea Turtles

Assuming that patterns observed in the past represent future patterns, the continued management regime for the deep-set Hawaii-based longline fishery will result in about 41 (95% confidence interval = 20-47) interactions with olive ridley sea turtles in the fishery each year. Of the olive ridleys that interact with the deep-set Hawaii-based longline fishery, almost all or 40 olive ridley turtles are expected to die as a result of the exposure. Approximately 30 of these olive ridleys will likely originate from endangered eastern Pacific populations while the remaining 10 olive ridley turtles killed in interactions with longline gear likely originate from threatened western Pacific nesting beaches (Table 35).

Species	Percent originating from each region	Mortality rate for deep-set	Anticipated incidental takes by region	Anticipated incidental mortalities by region	Number of adult female mortalities
Green	57% Eastern Pacific	0.86	4	4	2
	43% Hawaiian Islands		3	3	2
Leatherback	6% Eastern Pacific	0.34	1	1	1
	94% Western Pacific		12	5	3
Olive ridley	75% Eastern Pacific	0.96	31	30	15
	25% Western Pacific		10	10	5
Loggerhead	100% Japan	0.44	6	3	2

Table 35. Anticipated annual incidental takes and subsequent mortalities of marine turtles that interact with the Hawaii deep-set tuna fishery. Genetic data were used to estimate the stock composition of marine turtles incidentally taken by the fishery (2004 BiOp and Peter Dutton, Southwest Fisheries Science Center, personal communication). The probabilities of mortality after an interaction with the deep-set longline fishery were estimated by Boggs (2005). For the purpose of the risk analysis, it was assumed that all incidentally taken turtles are adults and that there is a 50% sex ratio. These assumptions should make the calculations conservative enough to assume that maximum number of adult female mortalities has been estimated. All mortality numbers were rounded up to the next integer. (Source: Snover 2005).

10.2 Responses of humpback whales to Interactions with the Deep-Set Fishery

NMFS' observer data indicate that three humpback whales have been entangled in deep-set pelagic longline gear. Further analyses of these interactions determined that these three events resulted in non-serious injuries; indicating that the animals were hooked in a region other than the head, were released with no or minimal gear attached, and the interactions were not expected to result in mortality.

The effects of trailing fishing gear on large whale species are largely unknown. NMFS sponsored a workshop to discuss methods for differentiating serious and non-serious injury of marine mammals taken in commercial fishing operations. Results of this workshop indicate that some but not all entanglements may result in serious injury or mortality (Angliss and Demaster 1997). Available evidence from entangled north Atlantic right whales indicates that while it is not possible to predict whether an animal will free itself of gear, a high proportion are believed to lose or extricate themselves based on scarring observed among apparently healthy animals. At the workshop, predicting the survivability of individual animals that are entangled was determined to be unreliable. Some whales have been observed to carry gear for over five years. The workgroup was in general agreement that entanglement that impedes locomotion or feeding, and entanglement of young whales, should be considered a serious injury (Angliss and Demaster 1997).

11.0 Risk Analyses

As discussed in the Approach to the Assessment, the final step of our assessment uses results from the exposure and response analyses to ask (1) what is likely to happen to different nesting aggregations given the exposure and responses of individual members of those aggregations and (2) what is likely to happen to the populations or species those nesting aggregations comprise. These analyses form the foundation for the jeopardy determinations, which are designed to determine if we would reasonably expect threatened or endangered species to experience reductions in reproduction, numbers, or distribution that would appreciably reduce the species' likelihood of surviving and recovering in the wild (since the proposed fishery is not likely to adversely affect designated critical habitat, this Opinion did not conduct "destruction and adverse modification analyses).

In the *Status of the Species* and *Environmental Baseline* sections of this Opinion, we discussed the various natural and human-related phenomena that caused the various sea turtle species to become threatened or endangered and continue to keep their populations suppressed. This section of the Opinion examines the physical, chemical, and biotic effects of the deep-set component of the Hawaii-based pelagic longline fishery to determine (a) if those effects can be expected to reduce the reproduction, numbers, or distribution of threatened or endangered species in the action area, (b) determine if any reductions in reproduction, numbers, or distribution would be expected to appreciably reduce the Pacific Ocean population's likelihood of surviving and recovering in the wild, and (c) if appreciable reductions in the Pacific Ocean population's likelihood of surviving and recovering in the wild would cause appreciable reductions in the species (as listed) likelihood of surviving and recovering in the wild.

In this analysis we consider whether effects from the Hawaii-based deep-set longline fishery are likely to reduce appreciably the likelihood of survival and recovery of sea turtle populations in the Pacific Ocean and if so, if those effects also reduce appreciably the likelihood of the species survival and recovery in the wild. Although leatherback sea turtles appear to be faring better in the Atlantic, the species remains at risk in the Atlantic. The assumption that the extirpation of the species in one ocean basin may affect the extinction risk of the entire species is reasonable based on the relationship between local and regional persistence in species (Gotelli 2001). Based on this relationship, the risk of regional extinction is lower than the risk of local extinction; however, as local probabilities change, the probability of regional persistence changes correspondingly. Likewise, if effects from the proposed action are deemed not likely to reduce appreciably, the survival and recovery of Pacific sea turtle populations' in the wild, there would be no logical connection to state that the continued existence of the entire species would be jeopardized by the proposed action.

11.1 Humpback Whale

Humpback whale populations near the Hawaiian Islands appear to be stable and increasing in size. Population assessments indicate that the central North Pacific humpback whale stock has been increasing at a rate ranging between 7 to 10 percent per year (Mobley et al.1999; Mizroch et al. 2004, and NMFS 2005). Recent abundance estimates indicate that the central North Pacific humpback whale stock consists of about 4,000 individuals (Calambokidis et al. 1997; Cerchio, 1998; Mobley et al., 1999; NMFS 2005).

The central north Pacific humpback whale stock winters in the vicinity of the main Hawaiian Islands, generally in shallow water shoreward of the 182-m (600-ft) contour, with cow and calf pairs preferring very shallow water less than 18 m (60-ft). Maximum diving depths for humpback whales is 150 m (492 ft), but most dives are less than 60 m (197 ft). Consistent with this behavior, most humpback prey is found in waters shallower than 300 m (984 ft). These life history characteristics of humpback whales limit the potential exposure of the species to the Hawaii-based deep-set fishery. The Hawaii-based deep-set fishery operates year-round, targets a fishing depth of 167 m, and is prohibited from occurring within 25 miles of the main Hawaiian Islands. About half of the fishing effort in the deep-set fishery occurs entirely outside the U.S. EEZ on the high seas.

Available information indicates that three humpback whale interactions have occurred in the deep-set fishery over the past 15 years. Such interactions are extremely rare events when viewed in relation to the amount of fishing effort that has occurred in the deep-set fishery during this period of time. Humpback whale interactions are likely rare events in this fishery because the fishery occurs largely in areas where humpback whales are unlikely to occur.

Based upon the foregoing, NMFS concludes the deep-set fishery is not likely to reduce appreciably the likelihood of humpback whale survival and recovery in the wild by reducing the reproduction, numbers, or distribution of the species.

11.2 Green Turtles

Assuming that patterns observed in the past represent future patterns, the continued management regime proposed for the deep-set Hawaii-based longline fishery will result in about 7 (95% confidence interval = 0-8) green turtles expected to be captured by the fisheries each year. Of the turtles that interact with the deep-set Hawaii-based longline fishery, all 7 are expected to die as a result of the exposure. Four of these turtles are likely endangered green turtles from nesting beaches in Mexico and three green sea turtles likely to be killed in an interaction with longline gear would have originated in the Hawaiian nesting beaches (Table 35).

Out of fourteen green turtles caught by the deep-set component of the Hawaii-based longline fishery, genetic analyses concluded that eight (57%) represented nesting aggregations from the eastern Pacific (Mexico), and 6 green turtles (43%) represented the Hawaiian nesting aggregations (P. Dutton, NMFS, personal communication, August 9, 2005).

Life history information collected by observers suggests that the Hawaii-based longline fisheries are likely to capture sub-adult and adult green turtles (straight carapace lengths ranged from 28.5 cm to 73.5 cm with an average of 51.5 cm). To be conservative, we assume that all individuals interacting with the fishery are adults.

A 50:50 male to female sex ratio is also assumed for the green turtles captured incidental to the Hawaii-based pelagic deep set longline fishery. This is approach is considered to be conservative with respect to the number of adult females anticipated to be exposed to impacts from the fishery.

Historically, the longline fishery has been more likely to hook green turtles externally than to entangle them or hook them internally. The tendency to be hooked externally may be due to their diet preferences: because green turtles primarily feed on benthic, marine algae, they may be less likely to be attracted to the older baited hooks used in the longline fishery. As a result they may be less likely to swallow baited hooks, which would reduce their likelihood of being hooked internally. Further, because of their diet and foraging strategy (green turtles usually forage in water less than 10 meters deep), green turtle interactions with the deep-set fishery are rare.

Several authors have demonstrated that long-lived species that have evolved low, adult mortality rates and delayed maturity cannot sustain high adult or juvenile mortalities without increasing risk to extinction. For example, Crouse (1999) discussed the importance of high adult and juvenile survival in long-lived species with delayed maturity; after examining the population ecology of a large number of these species (including leatherback and loggerhead sea turtles, and several species of sharks, rockfish, groundfish, albatross, and whales), she concluded that seemingly small numbers of deaths in these species, particularly of adults and juveniles, could have catastrophic effects on the health of population of these long-lived species. Crouse (1999) and Caswell (2001) demonstrated that changes in the survival of adult and sub-adult stages of loggerhead turtles can have significant, short-term effects on the status and trend of these turtle populations. Heppell et al. (1999) reached similar conclusions based on demographic evaluations of several species of sea turtles and sharks. Congdon et al. (1999) and Congdon and Dunham (1984) reached the same conclusions after conducting demographic simulations of several species of long-lived freshwater turtles and sea turtles. Caswell et al. (1999) concluded that the loss of small numbers of adult females would be sufficient to critically endanger the western Atlantic population of northern right whales (*Eubalaena glacialis*), which is another long-lived species with delayed maturity.

Because of the similarities between these life history patterns and those of green turtles (they are long-lived, have high adult survival rates, and delayed maturity), we assume that changes in the survival of adult and sub-adult stages of green turtles would have significant, short-term effects on the status and trend of these turtle populations. Because of their life history pattern, the long lives and high, adult survival rates of sea turtles would mask changes in the survival rates of non-adult age classes. Nevertheless, we do not believe these mortalities (the annual loss of about 7 adult or sub- adult green turtles) would be expected to appreciably reduce the threatened or endangered green turtle's likelihood of surviving and recovering in the wild. The number of green turtles likely to be adversely affected through both lethal and non-lethal interactions with the fishery relative to the abundance and trends of the subpopulations from which these turtles likely originate, is not expected to have a measurable impact on the survival or recovery of the impacted subpopulations. We discuss the status and trend of the two aggregations separately, and then summarize our conclusions for both.

11.2.1 Eastern Pacific Green Turtle Population

As discussed in the *Status of the Species* section of this opinion, the primary green turtle nesting grounds in the eastern Pacific are located in Michoacán, Mexico, and the Galapagos Islands, Ecuador (NMFS and USFWS 1998a). The nesting aggregation at the two main nesting beaches in Michoacán, (Colola — which represents about 70% of the total green turtle nesting in Michoacán — and Maruata; Delgado and Alverado 1999), decreased from 5,585 females in 1982 to 940 in 1984. From the 1960s to the 1990s the number of turtles nesting nightly at Colola, dropped by 90% with only 800-1000 females nesting per year (Eckert 1993). That number appears to have continued to decline in the late 90's. During the 1998-99 season, an estimated 600 green turtles nested at Colola.

In 1990 the Mexican government provided female, green turtles and their eggs with long-term protection from poaching and other activities. During the 1998-99 season, only about 5% of the nests were poached at Colola, although about 50% of the nests at Maruata were poached because political infighting made it difficult to protect the turtles on this beach (Delgado and Alvarado 1999). Nevertheless, despite the long-term protections, the nesting aggregation continues to decline, and investigators believe that human activities (including incidental take in various coastal fisheries as well as illegal directed take at forage areas) continue to prevent the aggregations from recovering (P. Dutton, NMFS, personal communication, 1999; Nichols 2002).

There are few historical records of abundance of green turtles from the Galapagos. An annual average of 1,400 nesting females was estimated for the period 1976- 1982 in the Galapagos Islands (NMFS and USFWS 1998a). In 2002, 2,756 nesting females green turtles were tagged in the Galapagos, which was the highest number tagged since 1975 (Zarate et al. 2003).

Clearly, the additional loss of approximately 4 adult or sub-adult, green turtles from these nesting aggregations each year would reduce the number of animals in the sub-population. If we assume that half of the adult or sub-adult turtles that are killed during interactions with the fishery are female, this reduction in numbers would also reduce the number of adult turtles that reproduce each year.

The risk to the Colola Beach, Mexico green turtle nesting population due to removal of the of adult females expected to be killed by incidental interactions with the deep-set Hawaii-based longline fishery was assessed using the population growth rate parameters described in section 7.3.2 (Snover 2005). Based on the 2-yr running sum, a low estimate of the number of adult females in this nesting aggregation as of 2002 was 3,260. Colola represents approximately 70% of the nesting in Michoacan; within the eastern Pacific there is additional nesting in the Galapagos Islands and Ecuador (Delgado and Alvarado 1999, NMFS and USFWS 1998). If we consider only Michoacan nesting, a conservative estimate of the total number of adult females is 4,238. From Table 35, a maximum of 4 adult female green turtles from the eastern Pacific can be expected to be killed through interaction with the Hawaii deep-set longline fleet. If all of these turtles come from Michoacan, the resulting mortality rate is 0.001. This value was added to and subtracted from the r_A estimated for Colola Beach to compare changes in the extinction parameters under the scenario with mortality resulting from the deep-set longline fishery and the scenario without the additional mortalities from the deep-set fishery (Snover 2005). Neither the addition nor subtraction of this amount of additional mortality had an impact on the persistence estimates for this nesting beach (Table 36). At the number of significant figures considered here (2), there was no change in the probability of quasi- or ultimate extinction except for the probability of quasi-extinction in 100 yr, when the value ranged from 0.13 to 0.15 (Table 36 and Figure 17).

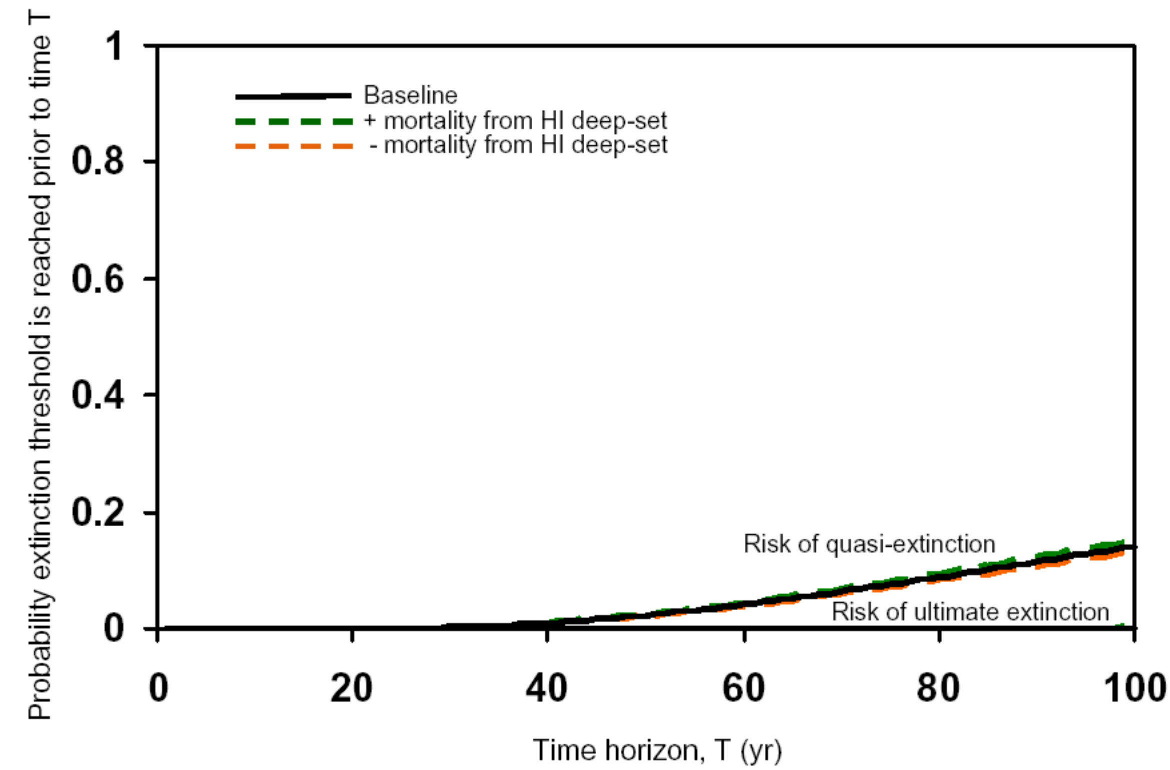

Figure 17. Cumulative distribution plot of extinction probabilities for green turtles nesting at Colola Beach, Michoacan, Mexico. Dashed green line indicates extinction probabilities when mortality from the Hawaiian deep-set lonline fishery is added to current population trends. Dashed orange line indicates extinction probabilities when mortalities from the Hawaiian deep-set longline fishery are removed. Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female. Note that extinction probabilities do not get much above 0 for ultimate extinction. (Figure Source: Snover 2005).

Demographic Parameter		Estimate		
Log growth rate (μ)		-0.01 [-0.16, 0.14]		
Variance in mean log growth rate (σ^2)		0.06 [0.02, 0.32]		
Finite rate of change in population size (λ_A)		1.02 [0.87, 1.35]		
Instantaneous rate of change in population size (r_A)		0.02 [-0.14, 0.30]		
Risk of quasi-extinction			+ HI	- HI
Probability of quasi-extinction ever occurring		1 [0.03, 1]	1 [0.03, 1]	1 [0.03, 1]
Median time to quasi-extinction (yr)		>100	>100	>100
Probability of quasi-extinction in:	25 yr	0 [0, 0.46]	0 [0, 0.47]	0 [0, 0.44]
	50 yr	0.02 [0, 1]	0.02 [0, 1]	0.02 [0, 0.99]
	100 yr	0.14 [0, 1]	0.15 [0, 1]	0.13 [0, 1]
Risk of ultimate extinction				
Probability of extinction ever occurring		1 [0, 1]	1 [0, 1]	1 [0, 1]
Median time to extinction (yr)		>100	>100	>100
Probability of extinction in:	25 yr	0 [0, 0]	0 [0, 0]	0 [0, 0]
	50 yr	0 [0, 0.46]	0 [0, 0.43]	0 [0, 0.45]
	100 yr	0 [0, 1]	0 [0, 1]	0 [0, 1]

Table 36. Results of the Dennis-Holmes Model for green turtles from Colola Beach, Michoacan, Mexico. Unless otherwise noted, values are reported as means with the lower and upper 95% confidence intervals in brackets. Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female. For the risk analysis of incidental takes from the Hawaii deep-set tuna fishery, the estimated mortality from this fishery was considered in two ways. First it was considered as additional mortality and added to the baseline (+HI); second was a consideration of what impact the removal mortalities associated with this fishery would have on population viability and the mortality was subtracted from the baseline (-HI). (Source: Snover 2005).

11.2.2 Hawaiian Green Turtle Population

The green turtles in Hawaii are genetically-distinct and geographically isolated from other green turtle populations. Ninety percent of the nesting and breeding activity of the Hawaiian green turtle occurs at French Frigate Shoals, where 200-700 females were estimated to nest annually (NMFS and USFWS 1998a). The incidence of diseases such as fibropapilloma, and spirochidiasis, which are major causes of strandings of green turtles suggests that future declines in this population could reverse or eliminate the increases of recent decades (Murakawa et al. 2000). Nevertheless, since Hawaiian green turtles were first protected in the early 1970s, ending years of exploitation, the nesting population of Hawaiian green turtles has shown a definite increase (Balazs 1996, Chaloupka and Balazs 2004). For example, the number of green turtles nesting at an index study site at East Island has tripled since systematic monitoring began in 1973 (NMFS and USFWS 1998a). Balazs and Chaloupka (2004) conclude that the Hawaiian green turtle stock is well on the way to recovery following 25 years of protection of turtles and their nesting and foraging habitats.

Annual mortality of 3 green turtles due to interactions with the longline fishery would reduce the abundance of this nesting aggregation. If we assume that some of the adult turtles that are killed in interactions with the Hawaii-based longline fisheries are females, the fishery may reduce the reproduction of this nesting aggregation.

11.2.3 Synthesis

Almost all of the green turtles that interact with the Hawaii-based longline fisheries are probably members of the eastern Pacific and Hawaiian nesting aggregations. If we assume that half of the adult turtles that are killed in interactions with the Hawaii-based longline fisheries are females, the fishery would also reduce the reproduction of these nesting aggregations, although, the consequences of losing a female turtle on the dynamics of a turtle's population will vary depending on whether the adult female dies before or after she lays her eggs (if the turtle dies before laying her eggs, the potential effect on the population would be larger).

In the *Environmental Baseline* section of this Opinion, we noted that green turtles are captured, injured, or killed in numerous Pacific fisheries including the Hawaii-based shallow-set longline fishery; State of Hawaii authorized fisheries; Japanese longline fisheries in the western Pacific Ocean and South China Seas; longline fisheries off the Federated States of Micronesia; commercial and artisanal swordfish fisheries off Chile, Columbia, Ecuador, and Peru; purse seine fisheries for tuna in the eastern tropical Pacific Ocean, and California/Oregon drift gillnet fisheries. Because of limited available data, we cannot accurately estimate the number of green turtles captured, injured, or killed through interactions with these fisheries. However, an estimated 85 green turtles were estimated to have died between 1993 and 1997 in interactions with the tuna purse seine fishery in the eastern tropical Pacific Ocean; approximately 7,800 green turtles are estimated to die annually in fisheries and direct harvest off of Baja, California; and before 1992, the North Pacific driftnet fisheries for squid, tuna, and billfish captured an estimated 378 green turtles each year, killing about 93 of them each year. Little data on the life stage or sex of captured animals are available; however, we expect that both incidental and intentional takes affect the larger turtle life stages, sub-adults and adults. Given the population ecology of sea turtles in general, and green turtles in particular, these mortalities would be expected to reduce the numbers of these green turtles.

Although the mortalities associated with the Hawaii-based deep-set longline fishery would reduce the numbers and may reduce the reproduction of both the eastern Pacific and Hawaiian nesting aggregations, the "jeopardy" standard requires us to consider those effects on a species' survival and recovery in the wild. Specifically, the "jeopardy" standard requires us to determine that reductions in a species' reproduction, numbers, or distribution would be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild. We identify reductions in a species' likelihood of surviving and recovering in the wild by quantitatively or qualitatively analyzing the probable effect of changes in a reproduction, numbers, and distribution based on our understanding of relationships between vital rates (for example, age- or stage-specific rates of survival or fecundity), variance in those rates over time and among different populations, a species' rates of increase (lambda), and a species' probability of quasi-extinction or persistence over time.

Historically, the Hawaii-based pelagic longline fishery (shallow and deep-set combined) interacted with an average of 40 green turtles each year; with an estimated 23 mortalities as a result of these interactions (McCracken 2000). Most of those interactions and mortalities were associated with the shallow-set component of the Hawaii-based pelagic longline fishery, which has now been modified to reduce the number of sea turtles that are likely to be hooked or captured by the fisheries and to reduce the harm resulting from those interactions.[17]

The deep-set fishery is likely to result in the mortality of approximately 7 green turtles each year. Of these turtles, *c.* 4 are likely to be adult or sub-adult green turtles from the eastern Pacific nesting aggregations and *c.* 3 are likely to be from the Hawaiian nesting aggregations. The Dennis-Holmes population growth parameters used to assess the potential risks these mortalities might pose to the different nesting aggregations could not detect the effect of these mortalities on the extinction risk of either the endangered or threatened green sea turtles (Snover 2005). These values provide an indication of the general trend observed for the monitored component of the population and provide an indication of population viability given current population status and observed trends. While the general trends observed in adult females on the nesting beach may be representative of overall population trends, in terms of increasing, decreasing, or stable; specific values for λ and r calculated from nesting beach censuses are not likely to represent the population as a whole (Snover 2005). The wide confidence intervals about most of the estimated parameters are also highlighted to demonstrate the amount of uncertainty in the projections of a population's extinction risk in the long term (e.g. 50 – 100 years) given a short time series of observations.

[17] As discussed previously, green turtles on the Pacific coast of Mexico are listed separately as endangered species, rather than the threatened status assigned to the remainder of their global populations. Under normal circumstances, we would analyze the effects of the proposed fisheries on the endangered populations separately from their threatened counterparts; however, using the information available, we cannot distinguish the effects of the fisheries on the different populations (because our data on interactions between the fisheries and these turtles cannot distinguish between the endangered turtles and the threatened turtles of these turtles). As a precautionary approach, our analyses group the endangered and threatened populations and treat them both as endangered.

To approach the assessment qualitatively, we need to ask if the deaths associated with the proposed fishery are likely to be exceeded by the number of younger turtles recruiting into the adult of sub-adult population. Although most populations are designed to withstand some level of mortality without increases in their risk of extinction, threatened and endangered species will often be incapable of recovering from even small numbers of deaths. Further, most populations fluctuate over time, if a population is experiencing an increasing trend in a longer cycle, it is more likely to be able to withstand mortalities than if the population is experiencing a decreasing trend. The important consideration is whether the population appears to have a growth rate that would allow it to recover from small numbers of deaths.

The Hawaii nesting aggregation of green turtles has been increasing for several years and has the demographic characteristics of a population that is recovering from historic declines. Similarly, our assessment of female green turtles that nest at Colola Beach suggest that this nesting population is stable, on average, despite a lower confidence interval suggesting that the population may, in fact, be declining. Increases in nesting females in 2000 and 2001 provide cause for optimism, though current nesting abundance remains below historical levels observed in the 1960s (Alvarado-Diaz and Trejo 2003; Alvarado-Diaz, personal communication, October, 2003).

The number of lethal and non-lethal green turtle interactions expected to occur in the deep-set longline fishery are so minor that effects from the deep-set fishery would be masked by background variance, even considering the effects of the other sources of mortality that were discussed in the *Environmental Baseline*. The effects of mortalities associated with the deep-set longline fishery are undetectable on the survival rates of adult and sub-adult green sea turtles from the eastern tropical Pacific Ocean or Hawaiian (assuming that we had the data necessary to reliably estimate survival rates) given the small number of such interactions. Because of the size of green turtle populations relative to the small number of individual green turtles expected to be captured and killed in the proposed fishery and in view of stable and increasing trends in Hawaiian green turtle populations, the mortalities associated with the deep-set longline fishery are not expected to appreciably reduce the species' likelihood of surviving and recovering in the wild.

In the consultation process, the applicant submitted an independent analysis of the effects of fishing related mortality on the Hawaiian green turtle population.[18] The analysis, based on a Bayesian state-space surplus production model, relied on historical harvest records and a relative abundance index (usually a nesting abundance time series) to model the effect of fishing related mortality on the long-term viability of the Hawaiian stock of green turtles. The analysis incorporated a higher fishing related mortality for the stock than anticipated in the exposure analysis of this Opinion to demonstrate that the anticipated losses of individuals to the Hawaiian green turtle stock are expected to have no impact on stock viability. The analysis concludes that it is not possible to distinguish between the expected baseline population trajectory and the population trajectory expected when 1 tonne of green turtles (equivalent to 23 green turtles) are removed from the population. The analysis indicates that this level of loss, which is greater than that expected in the fishery, does not result in any detectable impact on long-term stock survival

[18] Source: Memorandum from Dr. Milani Chaloupka, Ecological Modelling Services P/L, Queensland, St. Lucia, Australia to James M. Lynch, Stoel Rives LLP, Seattle, Washington, dated September 2, 2005.

or recovery. Though NMFS did not rely solely on this analysis to reach the conclusion that the fishing related mortality expected to occur incidental to the Hawaii-based pelagic, deep-set longline fishery would have no detectable impact on the long-term population trajectory for the Hawaiian green turtle stock, the conclusions from this analysis are consistent with NMFS' conclusions regarding no detectable effects.

11.3 Leatherback Turtles

11.4 Western Pacific Leatherback Turtle Stocks

Assuming that patterns observed in the past represent future patterns, the continued management regime for the deep-set Hawaii-based longline fishery will result in about 13 (95% confidence interval = 2-16) leatherback interactions each year. Of the leatherbacks that interact with the deep-set longline fishery, about a third (.34), or 6 (due to rounding) leatherbacks are expected to die as a result of the exposure. Approximately 5 of these leatherbacks will originate from endangered western Pacific populations while the remaining leatherback turtle killed in an interaction with longline gear will likely originate from endangered eastern Pacific nesting beaches (Table 35).

Based on the limited genetic sampling from the action area, about 94% of the leatherback turtles sampled (17 out of 18 genetic samples) originated from western Pacific nesting beaches (P. Dutton et al. 2000; P. Dutton, NMFS, personal communication, August 9, 2005). Individuals from western Pacific nesting beaches originate from Indonesia (e.g. Jamursba-Medi or War-Mon), Papua New Guinea (e.g. Kamiali), Malaysia (e.g. Terrenganu), the Solomon Islands, or Fiji, although satellite tracks from leatherback turtles tagged in Papua New Guinea suggest that these turtles tend to migrate south instead of north, which would take them away from the action area. 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 most likely.

The remaining 6% (approximately 1 leatherback) of leatherback interactions in the fishery would likely represent turtles from the eastern Pacific Ocean. These turtles may originate from nesting aggregations along the coast of Mexico, Costa Rica, or Panama, although turtles from these nesting aggregations may only migrate into the action area when oceanic phenomena like El Nino events deter 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. 1996). Eckert (1997) suggests that these turtles migrate toward the coast of South America where upwelling water masses provide an abundance of prey. Although these data suggest that the Hawaii-based pelagic, deep-set longline fishery is more likely to interact with leatherback turtles from Indonesia, over a period of several years, we would expect these fisheries may interact with turtles from the other, smaller nesting aggregations.

Published estimates of the abundance of nesting female leatherbacks in the Pacific Ocean have established that leatherback populations have collapsed or have been declining at all major

Pacific basin nesting beaches over the past two decades (Spotila et al. 1996; NMFS and USFWS 1998b; Sarti et al. 2000; Spotila et al. 2000). Leatherback turtles disappeared from India before 1930, have been virtually extinct in Sri Lanka since 1994, and appear to be approaching extinction in Malaysia (Spotila et al. 2000). Leatherback turtle nesting aggregations throughout the eastern and western Pacific Ocean have been reduced to a fraction of their former abundance by the combined effects of human activities that have reduced the number of nesting females and reduced the reproductive success of females that manage to nest (for example, egg poaching). At current rates of decline, leatherback turtles in the Pacific basin are a critically endangered species with a low probability of surviving and recovering in the wild (see section 7.0, *Species Status and Trends*).

Leatherback turtles are long-lived, have high adult survival rates, and delayed maturity (however, leatherbacks mature at an earlier age than most hard-shell turtles); as a result, we assume that changes in the survival of adult and sub-adult stages of leatherback turtles can have significant, short-term effects on the status and trend of these turtle populations. Because of their life history pattern, long lives and high adult survival rates of sea turtles could mask changes in the survival rates of non-adult age classes. Nevertheless, the annual loss of about 6 adult or sub-adult leatherback turtles would not be expected to appreciably reduce the leatherback sea turtle's likelihood of surviving and recovering in the wild. This conclusion is based on the number of leatherback turtles that are likely to be killed during interactions with the fishery relative to the size of the subpopulation to which those turtles probably belong and the changed conditions of the *Environmental Baseline*.

As discussed previously, almost all of the leatherback turtles that interact with the Hawaii-based longline fisheries are probably members of the western Pacific nesting aggregation, which consists of nesting aggregations located in Indonesia, Papua New Guinea, the Solomon Islands, and Vanuatu. In the *Environmental Baseline* section of this Opinion, we established that in the western Pacific Ocean and South China Seas, leatherback turtles are captured, injured, or killed in numerous fisheries including Japanese longline fisheries. Leatherback turtles in the western Pacific are also threatened by poaching of eggs, killing of nesting females, human encroachment on nesting beaches, incidental capture in fishing gear, beach erosion, and egg predation by animals. As a result of these threats, the nesting assemblage Terrenganu - which was one of the most significant nesting sites in the western Pacific Ocean - has declined severely from an estimated 3,103 females in 1968 to 2 nesting females in 1994 (Chan and Liew 1996). With only one to two nesting females per year nesting at this beach, this population is essentially functionally extinct. Nesting assemblages of leatherback turtles along the coasts of the Solomon Islands, which supported important nesting assemblages historically, are also reported to be declining (D. Broderick, personal communication, *in* Dutton et al. 1999). In Fiji, Thailand, and Australia, leatherback turtles have only been known to nest in low densities and scattered aggregations.

The leatherback turtles nesting on the beaches in the State of Papua represent one of the largest remaining nesting aggregations for this species in the Pacific Ocean. The nesting aggregation appears to be relatively large and has fluctuated between 400 and 1,000 individuals throughout most of the 1990s and early 2000s. Our analyses indicate that the population is stable or slightly increasing. That this nesting population is stable means that increases in adult mortality or decreases in recruitment into the adult population (as from poor hatchling production) can cause the nest numbers to decline and the extinction risks to rapidly change. Additional sites have been identified in the western Pacific and the number of nesting females was updated based on the identification of these new sites (Dutton et al. in press). Dutton et al. (in press) estimate nesting female leatherback abundance in the western Pacific to be 5,000 which updates Spotila et al.'s (2000) estimate of 1,800 nesting females in the western Pacific region. While the total estimate has been updated with the identification of these previously undocumented nesting sites, we have no information on the trends of these newly discovered populations nor do we understand their relation to other populations in the region.

The deep-set fishery is likely to result in the mortality of approximately 4 to 5 western Pacific adult leatherback turtles each year which would reduce the abundance of regional nesting aggregations. If we assume that at least 3 adult turtles that are killed in interactions with the deep-set Hawaii-based longline fishery are females, then the fishery would reduce the reproduction of this nesting aggregation, although, the consequences of losing a female turtle on the dynamics of the turtle's population will vary depending on whether the adult female dies before or after she lays her eggs.

The risk to Jamursba-Medi, Papua, Indonesia leatherback nesting population due to removal of three adult females expected to be killed by incidental interactions with the deep-set Hawaii-based longline fishery was assessed using the population growth rate parameters described in section 7.3.3 (Snover 2005). If the Hawaii deep-set longline fleet kills 3 adult females per year (Table 35), the total mortality from this source for the western Pacific is 0.001. This level of mortality had very little impact on extinction risks and time to extinction for the nesting aggregation at Jamursba-Medi (Table 37, Figure 18). Probability of quasi-extinction in 50 and 100 yr ranged from 0.07 to 0.08 and from 0.25 to 0.27, respectively (Table 37). At the number of significant figures considered here (2), there was no change in the probability of ultimate extinction except for the 100 yr time frame, when the values ranged from 0.00 to 0.01 (Table 37).

If we assume that, in most years, all of these turtles migrate into the action area from Indonesia or Papua New Guinea, then the higher mortality estimate would represent much less than 1% of the number of nesting females. If we assume that, in all or some years, leatherback turtles from Papua New Guinea, the Solomon Islands, or Vanuatu may also be captured and killed by the fishery, then the risks to the Indonesian nesting aggregation would be smaller.

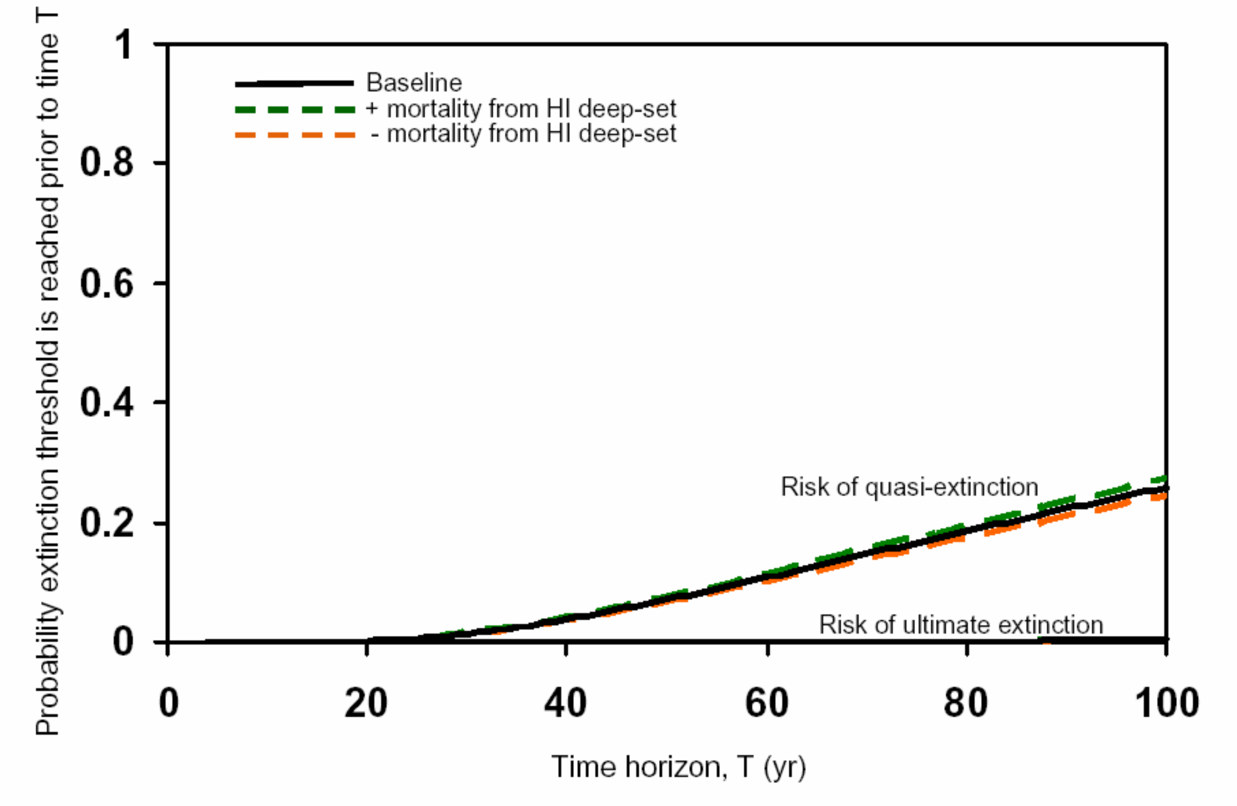

Figure 18. Cumulative distribution plot of extinction probabilities for leatherback turtles nesting at Jamursba-Medi, Indonesia. Dashed green line indicates extinction probabilities when mortality from the Hawaiian deep-set longline fishery is added to current population trends. Dashed orange line indicates extinction probabilities when mortalities from the Hawaiian deep-set longline fishery are removed. Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female. Note that extinction probabilities do not get much above 0 for ultimate extinction. (Figure Source: Snover 2005).

Demographic Parameter		Estimate (baseline)		
Log growth rate (μ)		-0.01 [-0.31, 0.29]		
Variance in mean log growth rate (σ^2)		0.05 [0.02, 1.01]		
Finite rate of change in population size (λ_A)		1.01 [0.74, 2.21]		
Instantaneous rate of change in population size (r_A)		0.02 [-0.30, 0.79]	Risk Assessment	
Risk of quasi-extinction			+ HI	- HI
Probability of quasi-extinction ever occurring		1 [0.15, 1]	1 [0.15, 1]	1 [0.15, 1]
Median time to quasi-extinction (yr)		>100	>100	>100
Probability of quasi-extinction in:	25 yr	0.01 [0, 0.970]	0.01 [0,1]	0.01 [0, 1]
	50 yr	0.07 [0, 1]	0.08 [0,1]	0.07 [0, 1]
	100 yr	0.26 [0, 1]	0.27 [0, 1]	0.25 [0, 1]
Risk of ultimate extinction				
Probability of extinction ever occurring		1 [0.02, 1]	1 [0.02, 1]	1 [0.02, 1]
Median time to extinction (yr)		>100	>100	>100
Probability of extinction in:	25 yr	0 [0, 0.14]	0 [0, 0.02]	0 [0, 0.13]
	50 yr	0 [0, 1]	0 [0, 0.98]	0 [0, 1]
	100 yr	0.01 [0, 1]	0.01 [0, 1]	0.00 [0, 1]

Table 37.Results of the Dennis-Holmes Model for leatherback turtles from Jamursba-Medi, Papua. Unless otherwise noted, values are reported as means with the lower and upper 95% confidence intervals in brackets. Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female. For the risk analysis of incidental takes from the Hawaii deep-set tuna fishery, the estimated mortality from this fishery was considered in two ways. First it was considered as additional mortality and added to the baseline (+HI); second was a consideration of what impact the removal mortalities associated with this fishery would have on population viability and the mortality was subtracted from the baseline (-HI). (Source: Snover 2005).

To approach the assessment qualitatively, we asked if the deaths associated with the proposed deep-set longline fishery is likely to be exceeded by the number of younger turtles recruiting into the adult of sub-adult population. Although most populations are designed to withstand some level of mortality without increases in their risk of extinction, threatened and endangered species will often be incapable of recovering from even small numbers of deaths. Further, most populations fluctuate over time, if a population is experiencing an increasing trend in a longer cycle, it is more likely to be able to withstand mortalities than if the population is experiencing a decreasing trend. The important consideration is whether the population appears to have a growth rate that would allow it to recover from small numbers of deaths.

If the leatherback turtles originating in the western Pacific are a random mix of individuals from Indonesia or Papua New Guinea, we would expect their combined populations, given their size, to be able to withstand the small mortality levels associated with the deep-set longline fishery without measurable affect on the population's extinction risks. If the leatherback turtles killed in the fishery were exclusively from Indonesia, the effect of these mortalities would be small and might appear to be trivial, but those mortalities might have longer-term consequences for this population because of accumulating effects. If the leatherback turtles killed in the fishery were exclusively from Papua New Guinea, the effect of these mortalities would be small, but those mortalities are less likely to be trivial for this nesting aggregation in any particular year or over several years. Although stronger cohorts in this nesting aggregation might be able to withstand these mortalities, these mortalities would be more significant to weaker cohorts and could cause those cohorts to decline. It is highly unlikely that the leatherback turtles killed in the fishery would originate exclusively or primarily from the Malaysian nesting aggregation. If an interaction were to occur in the fishery, that nesting aggregation would continue to approach ultimate extinction; however, with only 1 to 2 females nesting per year, the probability of an interaction with one of these few remaining animals is highly unlikely.

11.4.1 Eastern Pacific Leatherback Turtle Stocks

Nesting populations of leatherback turtles in the eastern Pacific Ocean are declining along the Pacific coast of Mexico and Costa Rica. According to reports from the late 1970s and early 1980s, three beaches located on the Pacific coast of Mexico support as many as half of all leatherback turtle nests. Since the early 1980s, the eastern Pacific Mexican population of adult female leatherback turtles has declined to slightly more than 200 during 1998-99 and 1999-2000 (Sarti et al. 2000). Spotila et al. (2000) reported the decline of the leatherback turtle population at Playa Grande, Costa Rica, which had been the fourth largest nesting aggregation in the world. Between 1988 and 1999, the nesting colony declined from 1,367 to 117 female leatherback turtles. Based on their models, Spotila et al. (2000) estimated that the colony could fall to less than 50 females by 2003-2004. Although these predictions have not proved true, our assessment suggests that this population has a high risk of extinction (declining to 1 or 0 females) in the one human generation (about 25 years) if its trajectory does not change.

The risk to the Playa Grande, Costa Rica leatherback nesting population due to removal of the adult females expected to be killed by incidental interactions with the deep-set Hawaii-based longline fishery was assessed using the population growth rate parameters described in section

7.3.3 (Snover 2005). As evidenced by the trends in the nesting beach census data, there is a high probability of quasi- and ultimate extinction of this population of leatherbacks, consistent with Spotila et al. (2000). The mean and upper 95% CI are consistent with near certainty that the population will reach quasi-extinction thresholds within the next 20-25 yr and over the next 50-100 yr, the degree of certainty of quasi-extinction increases (Table 38). There is a high probability of ultimate extinction over a 50-100 yr time period as well (Table 38).

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. The 2 yr running sum estimated 124 total adult females as of 2002 for the Playa Grande population and a similar analyses of Mexican nesting beaches indicates 1,100 adult females as of 2001 (2004 BiOp). Thus, an updated value of 1,224 total adult females in the eastern Pacific was used to estimate the Dennis-Holmes extinction parameters (Snover 2005). Table 35 indicates that as many as 1 adult female from this region could be killed in the Hawaii deep-set longline, which results in a mortality rate of 0.001 for the eastern Pacific. The addition and subtraction of this level of mortality from the results for Playa Grande have very little impact on probability of extinction and time to extinction (Table 38; Figure 19). With the number of significant figures considered here (2), there was no change in the mean probabilities of quasi- or ultimate extinction (Table 38). Median times to quasi- and ultimate extinction ranged from 8.99 to 9.05 yr and 35.55 to 35.79 yr, respectively (Table 38) (Snover 2005).

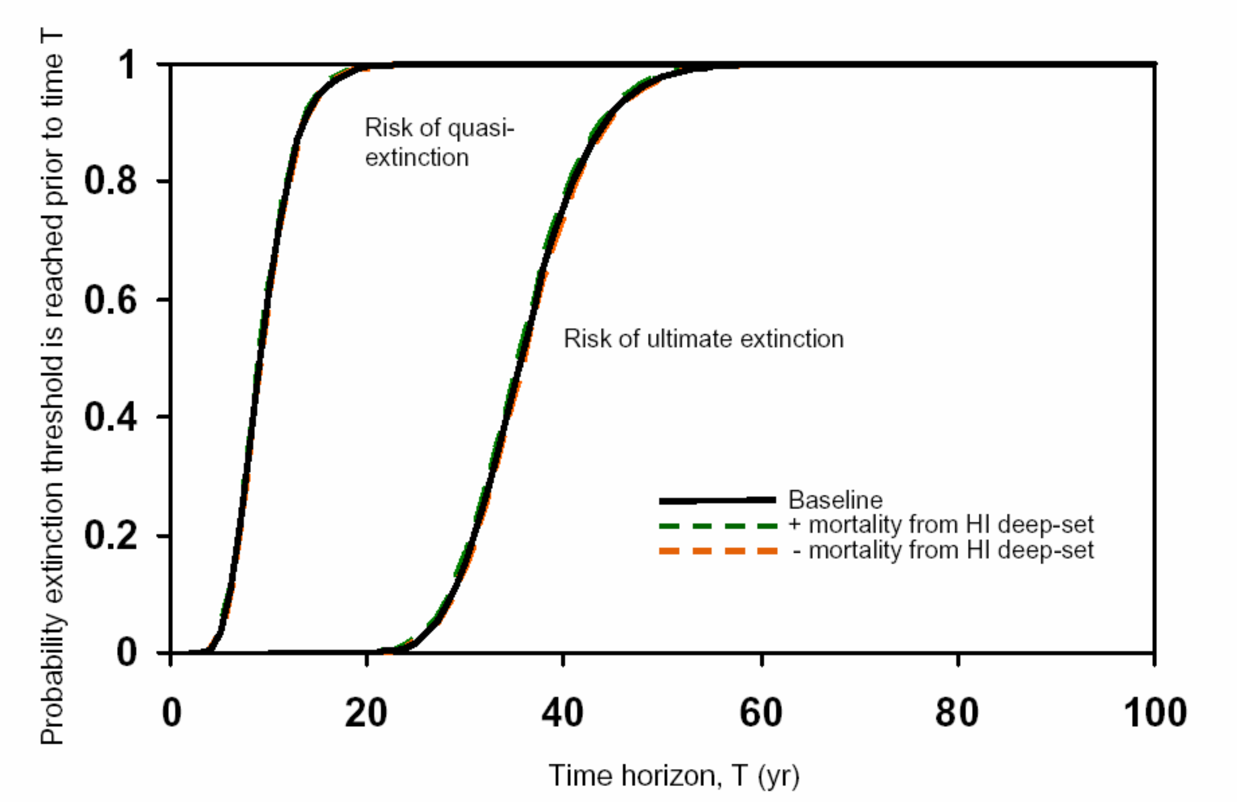

Figure 19. Cumulative distribution plot of extinction probabilities for leatherback turtles nesting at Playa Grande, Costa Rica. Dashed green line indicates extinction probabilities when mortality from the Hawaiian deep-set lonline fishery is added to current population trends. Dashed orange line indicates extinction probabilities when mortalities from the Hawaiian deep-set longline fishery are removed. Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female. (Figure Source: Snover 2005).

Demographic Parameter		Estimate (baseline)	Risk Assessment	
Log growth rate (μ)		-0.15 [-0.33, 0.03]		
Variance in mean log growth rate (σ^2)		0.02 [0.01, 0.67]		
Finite rate of change in population size (λ_A)		0.87 [0.73, 1.43]		
Instantaneous rate of change in population size (r_A)		-0.14 [-0.32, 0.36]		
Risk of quasi-extinction			+HI	-HI
Probability of quasi-extinction ever occurring		1 [0.90, 1]	1 [0.90, 1]	1 [0.90, 1]
Median time to quasi-extinction (yr)		8.99	8.93	9.05
Probability of quasi-extinction in:	25 yr	1 [0.22, 1]	1 [0.37, 1]	1 [0.28, 1]
	50 yr	1 [0.61, 1]	1 [0.78, 1]	1 [0.69, 1]
	100 yr	1 [0.91, 1]	1 [0.95, 1]	1 [0.95, 1]
Risk of ultimate extinction				
Probability of extinction ever occurring		1 [0.67, 1]	1 [0.680, 1]	1 [0.66, 1]
Median time to extinction (yr)		35.55	35.31	35.79
Probability of extinction in:	25 yr	0.02 [0, 0.95]	0.02 [0, 0.95]	0.02 [0, 0.99]
	50 yr	0.98 [0, 1]	0.98 [0, 1]	0.98 [0, 1]
	100 yr	1 [0.04, 1]	1 [0.03, 1]	1 [0.03, 1]

Table 38. Results of the Dennis-Holmes Model for leatherback turtles from Playa Grande, Costa Rica. Unless otherwise noted, values are reported as means with the lower and upper 95% confidence intervals in brackets. Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female. For the risk analysis of incidental takes from the Hawaii deep-set tuna fishery, the estimated mortality from this fishery was considered in two ways. First it was considered as additional mortality and added to the baseline (+HI); second was a consideration of what impact the removal mortalities associated with this fishery would have on population viability and the mortality was subtracted from the baseline (-HI) (Source: Snover 2005).

Several published studies have demonstrated that the death of "small" numbers of individuals can substantially-increase a species' risk of extinction. For example, Walters (1992) chronicled how the incremental loss of small numbers of individuals contributed to the extinction of the endangered dusky seaside sparrow (*Ammodramus maritimus nigrescens*). Spotila et al. (1996, 2000) used population models to demonstrate that leatherback sea turtles in the eastern tropical Pacific could not withstand low levels of adult mortalities. Fujiwara and Caswell (2001) used population models to demonstrate that preventing just two adult, female North Atlantic right whales (*Eubalaena glacialis*) would be sufficient to change the declining trend of this endangered species. Wiegand et al. (1998) used population models to demonstrate that annual anthropogenic mortalities ranging between 0 and 10 individuals per year over a 15-year interval increased the extinction risk of endangered brown bears (*Ursus arctos*) in Spain. Studies of species like the endangered Sonoran pronghorn antelope (*Antillocarpa americana sonoriensis*), Iberian lynx (*Lynx pardinus*), Mediterranean monk seal (*Monachus monachus*), Florida panther (*Felis concolor coryi*), Hawaiian crow (*Corvus hawaiiensis*), California condor (*Gymnogyps californicus*), Puerto Rican parrot (*Amazona vittata*), among others, have also demonstrated that small mortalities — a handful of individuals — would increase these species' risk of extinction.

At the same time, almost every species has evolved to withstand the loss of some of their numbers, even when they are experiencing declines; otherwise any species that experienced any decline would begin a decline to extinction with any additional death within its population. Species and populations persist because, above certain population levels, the relationship between the species' risk of extinction and the death of individual plants or animals is generally greater than one (or several) to one. That is, the death of each individual usually does not result in a corresponding increase in the species' risk of extinction. Species like the North Atlantic right whale and others identified in the previous paragraph are endangered because they have declined to a point where we can draw a direct relationship between the loss of individual adults and increases in the species' risk of final extinction.

Other species are endangered because they appear likely to decline to the condition of these species in the foreseeable future. For these species, the consequences of the death of small numbers of individuals in different populations will usually depend on which populations those individuals represent and the population's size, growth rates over time (which reflect differences in the numbers of individuals that die in the population compared with the number that are born into the population over the same time interval), birth rates, gender ratios, age structure, and how these rates vary with time. These characteristics of populations will determine the relationship between the loss of individuals and the population's or species' extinction risk.

In the past, the entire (shallow and deep-set) Hawaii-based pelagic longline fishery interacted with an average of 112 (95% confidence interval 75-157) leatherback turtles and caused the death of 24 to 49 of these turtles each year. The current management regime for the deep-set fishery is expected to result in the death of about 5 adult or sub-adult leatherback turtles from the western Pacific nesting aggregations and 1 from the eastern Pacific population.

Given the size of leatherback sea turtle populations in the western Pacific region, particularly the nesting aggregations in Indonesia and Papua-New Guinea these leatherback turtles probably represent and the growth rates of this population, the death of about 5 or 6 adult or sub-adult sea turtles are not expected to measurably increase this population's extinction risk. Given the size of leatherback sea turtles populations in the eastern tropical Pacific, despite the declining trend in this region, the death of 1 adult or sub-adult sea turtle is not expected to measurably increase this population's extinction risk.

We also expect the variance in the survival and fecundity rates of the western Pacific leatherback sea turtle populations to make it more difficult to detect increases in the population's extinction risks from this small number of deaths. Chaloupka and Limpus (2002) reported survival rates for adult green turtles in the southern Great Barrier reef region of Australia averaged 0.875 percent (with 95% confidence interval 0.84-0.91). Doak et al (1994) and Wisdom et al (2000) reported that the vital rates of adult and sub-adult desert tortoises (*Gopherus agassizii*) varied by about 8 to 15 percent. Woolfenden and Fitzpatrick (1984) reported that the estimated annual survival rates of adult Florida scrub jays (a threatened species) varied by about 11 percent (mean of 0.820 ±0.091). If the variance in the vital rates of leatherback turtles in the Pacific Ocean are roughly the same order of magnitude as those of green turtles from the southern Great Barrier Reef, the effect of the remaining mortalities associated with the current fishery on the survival rates of adult and sub-adult leatherback turtles in the western Pacific would not be detectable (assuming that we had the data necessary to reliably estimate survival rates).

In this risk assessment, we must determine whether the effects from the deep-set longline fishery on leatherback turtles, considering the status of the species and when added to the environmental baseline, reasonably would be expected to reduce *appreciably* the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of leatherback turtles. Webster's dictionary defines 'appreciable' as measurable; detectable or noticeable. Therefore, we must determine if the effects of the deep-set longline fishery, when added to the environmental baseline, have a measurable and/or detectable effect on the leatherback population. We consider the likelihood of survival in terms of the probability of the species survival without becoming extinct and with sufficient resilience to recover. As stated above, the effects of the deep-set component of the Hawaii based longline fishery on the leatherback population, when added to the environmental baseline, are not detectable and thus could not be reasonably expected to result in an appreciable reduction in either the likelihood of the continued survival or potential for recovery of leatherback turtles in the wild.

Because of the size of leatherback turtle populations in the eastern and western Pacific, relative to the small number of individual leatherback sea turtles that are expected to be captured and killed in the proposed fishery in any particular year, the mortalities associated with the deep-set longline fishery are not expected to appreciably reduce the population's likelihood of surviving and recovering in the wild. Because these mortalities are not likely to reduce the population's likelihood of surviving and recovering in the wild, we do not expect these mortalities to reduce the species' likelihood of surviving and recovering in the wild.

11.5 Loggerhead Turtles

Assuming that patterns observed in the past represent future patterns, the continued management regime proposed for the deep-set Hawaii-based longline fishery will result in the incidental capture of about 6 (95% confidence interval = 0-7) loggerhead turtles each year. Of the loggerheads that interact with the deep-set Hawaii-based longline fishery, less than half (.44), or

3 (due to rounding) loggerheads are expected to die as a result of the exposure. All of these loggerheads likely originate from threatened Japanese loggerhead populations (Table 35). Most of these loggerhead turtles would be oceanic juveniles originating from nesting beaches in southern Japan. Oceanic juveniles from the two nesting beaches on Yakushima Island have a low risk of being killed in an interaction with the deep-set longline gear in any particular year, though the risk of being killed in interactions with the fishery increases over several years.

Historically, most of the loggerhead turtles that interacted with the Hawaii-based longline fishery were either hooked internally or externally. Loggerheads in the north Pacific are opportunistic feeders that target items floating at or near the surface, and if high densities of prey are present, they will actively forage at depth (Parker et al. in press). Although loggerhead turtles have been reported to dive to depths of 128 meters, they spend most of their time (90%) at the surface or at depths less than 40 meters; therefore, loggerheads were more likely to interact with shallow-sets than deep-sets, which generally target depths greater than 100 meters.

The deep-set component of the Hawaii-based pelagic longline fishery is expected to result in the mortality of about 3 pelagic juvenile loggerhead turtles each year which would reduce the numbers of individuals in the species. Assuming that some of the loggerhead turtles captured and killed in the fishery would be females, we would also conclude that these deaths would reduce the number of female loggerhead turtles that recruit into the adult, breeding population, with future effects on the species' reproduction.

Within the Pacific Ocean, loggerhead sea turtles are represented by a northwestern Pacific nesting aggregation (located in Japan) and a smaller southwestern nesting aggregation that occurs in Australia (Great Barrier Reef and Queensland), New Caledonia, New Zealand, Indonesia, and Papua New Guinea. Based on available information, the Japanese nesting aggregation is significantly larger than the southwest Pacific nesting aggregation. Data from 1995 estimated the Japanese nesting aggregation at 1,000 female loggerhead turtles (Bolten et al. 1996; Sea Turtle Association of Japan 2002). Recent data reflect a continuing decline (N. Kamezaki, Sea Turtle Association of Japan, personal communication, August, 2001). We have no recent, quantitative estimates of the size of the nesting aggregation in the southwest Pacific, but currently, approximately 300 females nest annually in Queensland, mainly on offshore islands (Capricorn-Bunker Islands, Sandy Cape, Swains Head; Dobbs 2001).

In the *Environmental Baseline* section of this Opinion, we established that loggerhead turtles are captured, injured, or killed in numerous Pacific fisheries including the Hawaii-based shallow-set longline fishery; Japanese longline fisheries in the western Pacific Ocean and South China Seas; direct harvest and commercial fisheries off Baja California, Mexico, commercial and artisanal swordfish fisheries off Chile, Columbia, Ecuador, and Peru; purse seine fisheries for tuna in the eastern tropical Pacific Ocean, and California/Oregon drift gillnet fisheries. In addition, the abundance of loggerhead turtles on nesting aggregations throughout the Pacific basin has declined dramatically over the past 10 to 20 years. Loggerhead turtle aggregations in the western Pacific Ocean have been reduced to a fraction of their former abundance by the combined effects of human activities that have reduced the number of nesting females and reduced the reproductive success of females that manage to nest (for example, egg poaching). Despite limited quantitative data on the effects of these fisheries and other natural and anthropogenic phenomena on the Japanese nesting population, the effects of the mortalities associated with the Hawaii-based deep-set longline fishery added to the current status and trend of the Japanese loggerhead population may slightly increase the Japanese loggerhead population's rate of decline.

Although the mortalities associated with the Hawaii-based deep-set longline fishery would clearly reduce the numbers and may reduce the reproduction of the Japanese nesting aggregations, the "jeopardy" standard requires us to consider those effects on a species' survival and recovery in the wild. Specifically, the "jeopardy" standard requires us to determine that reductions in a species' reproduction, numbers, or distribution would be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild. As we discussed in the previous turtle narratives, we generally identify reductions in a listed species' likelihood of surviving and recovering in the wild by quantitatively or qualitatively analyzing the probable effect of changes in a reproduction, numbers, and distribution based on our understanding of relationships between vital rates (for example, age- or stage-specific rates of survival or fecundity), variance in those rates over time and among different populations, a species' rates of increase (lambda), and a species' probability of quasi-extinction or persistence over time.

Historically, the Hawaii-based longline fishery interacted with an average of 418 loggerhead turtles each year; it was estimated that as many as 73 of these turtles died as a result of these interactions (McCracken 2000). In this analysis of the deep-set longline fishery we estimate that between about 3 pelagic juvenile loggerhead turtles from the 40 nesting aggregations in southern Japan and perhaps 1 loggerhead turtle from the 2 nesting aggregations on Yakushima Island may be killed in the proposed fishery.

The risk to Japanese loggerhead nesting populations due to removal of the adult females expected to be killed by incidental interactions with the deep-set Hawaii-based longline fishery was assessed using the population growth rate parameters described in section 7.3.4 (Snover 2005). Snover (2005) estimated μ and $\hat{\sigma}^2$ using a sum of the nesting data from 5 of the major nesting sites in Japan, Hiwasa, Omaezaki, Minabe Senri, Inakahama, and Miyazaki (Kamezaki et al. 2003) using data from Kamezaki et al. 2002 from 1986 to 1999. Similar to other species, the confidence intervals around the extinction estimates are very wide and range from 0 to 1. Mean values, however, indicate increasing risks of both quasi- and ultimate extinction over the next 100 years, with a high probability of quasi-extinction within 50 yr (Table 39) (Snover 2005).

To calculate extinction risk, the value of 1,500 adult females was used as Kamezaki et al. (2003) estimates that less than 1,000 females nested in Japan annually from 1998-2000. Lewison et al. (2004) used the value of 1,500 adult females in the Japanese rookery as well. As many as 2 adult females are anticipated to be killed annually in the Hawaii deep-set longline fishery (Table 35), resulting in a mortality rate of 0.001. This level of mortality had very little impact on extinction risk and time to extinction for this nesting population (Table 39, Figure 20). Probabilities of quasi-extinction in 50 and 100 years ranged from 0.45 to 0.47 and from 0.81 to 0.82, respectively (Table 39). Probabilities of ultimate extinction in 100 yr ranged from 0.29 to 0.31 (Table 39).

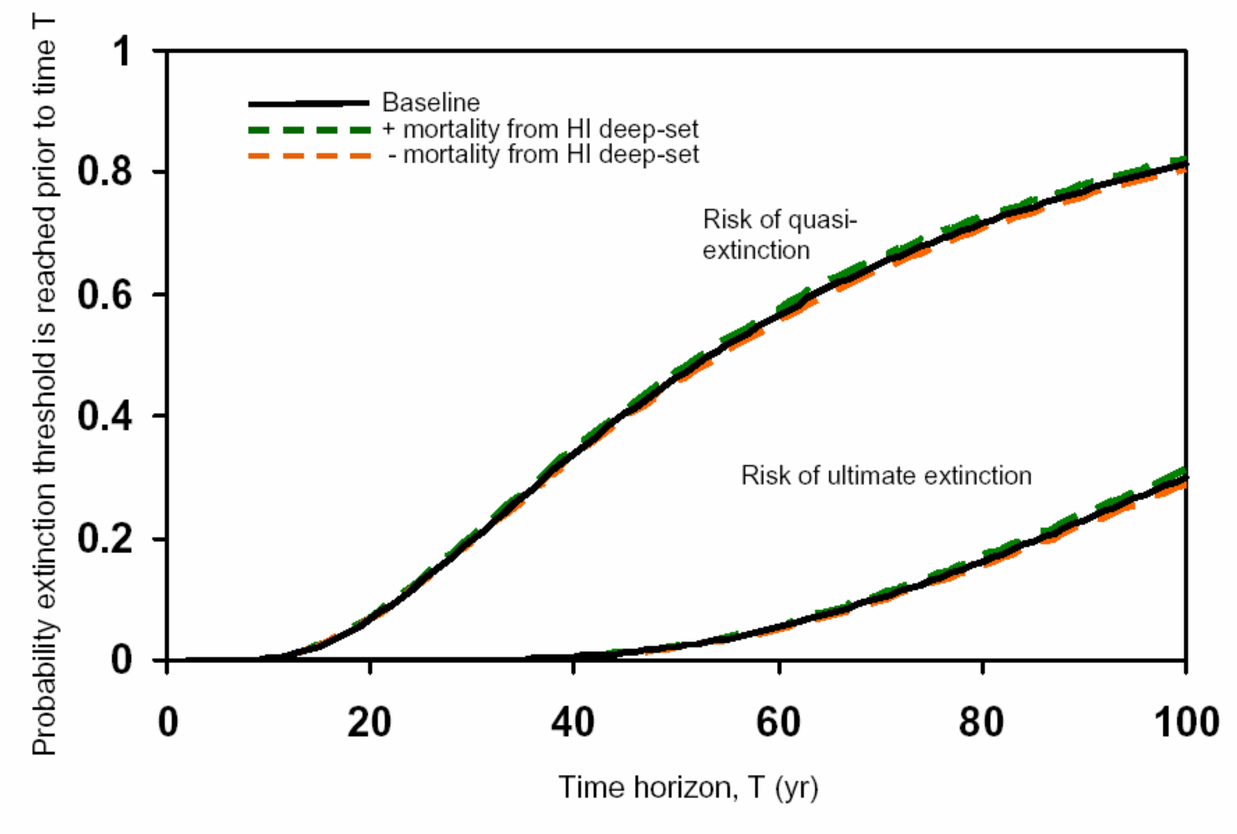

Figure 20. Cumulative distribution plot of extinction probabilities for loggerhead turtles nesting on Japan. Dashed green line indicates extinction probabilities when mortality from the Hawaiian deep-set lonline fishery is added to current population trends. Dashed orange line indicates extinction probabilities when mortalities from the Hawaiian deep-set longline fishery are removed. Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female. (Figure Source: Snover 2005).

Demographic Parameter		Estimate (baseline)	Risk Assessment	
Log growth rate (μ)		-0.05 [-0.44, 0.34]		
Variance in mean log growth rate (σ^2)		0.10 [0.04, 2.34]		
Finite rate of change in population size (λ_A)		1.0 [0.66, 4.51]		
Instantaneous rate of change in population size (r_A)		-0.00 [-0.42, 1.51]		
Risk of quasi-extinction			+ HI	-HI
Probability of quasi-extinction ever occurring		1 [0.38, 1]	1 [0.38, 1]	1 [0.38, 1]
Median time to quasi-extinction (yr)		53.38	52.56	54.24
Probability of quasi-extinction in:	25 yr	0.13 [0, 1]	0.13 [0, 1]	0.13 [0, 1]
	50 yr	0.46 [0, 1]	0.47 [0, 1]	0.45 [0, 1]
	100 yr	0.81 [0, 1]	0.82 [0, 1]	0.81 [0, 1]
Risk of ultimate extinction				
Probability of extinction ever occurring		1 [0.12, 1]	1 [0.12, 1]	1 [0.12, 1]
Median time to extinction (yr)		>100	>100	>100
Probability of extinction in:	25 yr	0 [0, 0.57]	0 [0, 0.58]	0 [0, 0.52]
	50 yr	0.02 [0, 1]	0.02 [0, 1]	0.02 [0, 1]
	100 yr	0.30 [0, 1]	0.31 [0, 1]	0.29 [0, 1]

Table 39. Results of the Dennis-Holmes Model for loggerhead turtles from Japan. Unless otherwise noted, values are reported as means with the lower and upper 95% confidence intervals in brackets. Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female. For the risk analysis of incidental takes from the Hawaii deep-set tuna fishery, the estimated mortality from this fishery was considered in two ways. First it was considered as additional mortality and added to the baseline (+HI); second was a consideration of what impact the removal mortalities associated with this fishery would have on population viability and the mortality was subtracted from the baseline (-HI). (Source: Snover 2005).

To approach the assessment qualitatively, we asked if the deaths associated with the proposed deep-set longline fishery are likely to be exceeded by the number of younger turtles recruiting into the adult of sub-adult population. Although most populations are designed to withstand some level of mortality without increases in their risk of extinction, threatened and endangered species will often be incapable of recovering from even small numbers of deaths. Further, most populations fluctuate over time, if a population is experiencing an increasing trend in a longer cycle, it is more likely to be able to withstand mortalities than if the population is experiencing a decreasing trend.

Balazs and Wetherall (1991) speculated that 2,000 to 3,000 female loggerheads nested annually in all of Japan. Nesting data collected by the Sea Turtle Association of Japan on all of the rookeries, ranged from 2,255 to 2,479 nests from 1998-2000. Considering multiple nesting estimates, Kamezaki et al. (2003) estimates that fewer than 1,000 female loggerheads return to Japanese beaches per nesting season. Two of the most important beaches in Japan, Inakahama Beach and Maehama Beach, located on Yakushima Island in the Nansei Shoto Archipelago, account for approximately 30% of all loggerhead nesting in Japan. Monitoring on Inakahama Beach has taken place since 1985, with about 300 to 400 nesters in 2000.

Given the size of loggerhead sea turtles populations in Japan, we do not expect the death of about 3 oceanic, juvenile loggerhead sea turtles to measurably increase the extinction risk or further reduce the potential for recovery of one or more of the Japanese nesting aggregations despite the declining trend of the loggerhead turtle populations in the Pacific. We also expect the variance in the survival and fecundity rates of the Japanese loggerhead sea turtle populations to make it more difficult to detect increases in the population's extinction risks from the small number of deaths of juvenile turtles.

If the variance in the vital rates of loggerhead turtles in the Pacific Ocean are roughly the same order of magnitude as those of green turtles from the southern Great Barrier Reef, we would not be able to detect the effect of the mortalities associated with the Hawaii-based deep-set longline fishery on the survival rates of adult and sub-adult loggerhead turtles in the Pacific (assuming that we had the data necessary to reliably estimate survival rates).

Because of the size of loggerhead turtle populations in the Pacific, relative to the small number of individual loggerhead sea turtles that are expected to be captured and killed in the proposed fishery in any particular year, we do not expect these mortalities, when added to the environmental baseline, to appreciably reduce the likelihood of loggerhead sea turtle's surviving and recovering in the wild in the Pacific Ocean. Because these mortalities are not likely to reduce the turtles' likelihood of surviving and recovering in the wild in the Pacific Ocean, we do not expect these mortalities to reduce the entire listed species' likelihood of surviving and recovering in the wild.

11.6 Olive Ridley Turtle

Assuming that patterns observed in the past represent future patterns, the continued management regime proposed for the deep-set Hawaii-based longline fishery will result in the incidental capture of about 41 (95% confidence interval = 20-47) olive ridley sea turtles in the fishery each year. Of the olive ridleys that interact with the deep-set Hawaii-based longline fishery, almost all

(39 of 41) olive ridley turtles are expected to die as a result of the exposure. Approximately 31 of these olive ridleys originate from endangered eastern Pacific populations while the remaining 10 olive ridley turtles killed in interactions with longline gear originate from threatened western Pacific nesting beach populations (Table 35).

These mortalities are not likely to appreciably reduce the olive ridley sea turtles' likelihood of surviving and recovering in the wild, because of the status and trend of olive ridley turtle populations in the Pacific basin. Historically, an estimated 10 million olive ridleys inhabited the waters in the eastern Pacific off Mexico (Cliffton et al. 1982 *in* NMFS and USFWS, 1998d). However, human-induced mortality led to declines in this population. Beginning in the 1960s, and lasting over the next 15 years, several million adult olive ridleys were harvested by Mexico for commercial trade with Europe and Japan (NMFS and USFWS 1998d). Although olive ridley meat is palatable, it was not widely sought after; its eggs, however, are considered a delicacy. 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 eastern Pacific, nesting occurs all along the Mexico and Central American coast, with large nesting aggregations occurring at a few select beaches located in Mexico and Costa Rica. The largest known *arribadas* in the eastern Pacific are off the coast of Costa Rica (about 475,000 to 650,000 females estimated nesting annually) and in southern Mexico (about 800,000 or more nests per year at La Escobilla, in Oaxaca; Millán 2000). The greatest single cause of olive ridley egg loss comes from the nesting activity of conspecifics on *arribada* beaches, where nesting turtles destroy eggs by inadvertently digging up previously laid nests or causing them to become contaminated by bacteria and other pathogens from rotting nests nearby.

The nationwide ban on commercial harvest of sea turtles in Mexico, enacted in 1990, appears to have improved the situation for the olive ridley. Surveys of important olive ridley nesting beaches in Mexico indicate increasing numbers of nesting females in recent years (Marquez et al. 1995; Arenas et al. 2000). Annual nesting at the principal beach, Escobilla Beach, Oaxaca, Mexico, averaged 138,000 nests prior to the ban, and since the ban on harvest in 1990, annual nesting has increased to an average of 525,000 nests (Salazar et al. 1998).

Olive ridleys are not as well documented in the western Pacific as in the eastern Pacific, nor do they appear to be recovering as well (with the exception of Orissa, India in recent years). There are a few sightings of olive ridleys from Japan, but no report of egg-laying. Nesting information from Thailand indicates a marked decline in olive ridley numbers primarily due to egg poaching, harvest and subsequent consumption or trade of adults or their parts (i.e. carapace), indirect capture in fishing gear, and loss of nesting beaches through development (Aureggi et al. 1999). Extensive hunting and egg collection, in addition to rapid rural and urban development, have reduced nesting activities in Indonesia as well.

Olive ridley nesting is known to occur on the eastern and western coasts of Malaysia; however, nesting has declined rapidly in the past decade. The highest density of nesting was reported to be in Terrenganu, Malaysia, and at one time yielded 240,000 eggs (2,400 nests, with approximately 100 eggs per nest) (Siow and Moll 1982 *in* Eckert, 1993), while only 187 nests were reported from the area in 1990 (Eckert 1993).

In contrast, olive ridleys are the most common species found along the east coast of India, migrating every winter to nest en-masse at three major rookeries in the state of Orissa, Gahirmatha, Robert Island, and Rushikulya (*in* Pandav and Choudhury 1999). The Gahirmatha rookery, located along the northern coast of Orissa, hosts the largest known nesting concentration of olive ridleys. Unfortunately, uncontrolled mechanized fishing in areas of high sea turtle concentration, primarily illegally operated trawl fisheries, has resulted in large scale mortality of adults during the last two decades. Fishing in coastal waters off Gahirmatha was restricted in 1993 and completely banned in 1997 with the formation of a marine sanctuary around the rookery. Threats to these sea turtles also include artificial illumination and unsuitable beach conditions, including reduction in beach width due to erosion (Pandav and Choudhury 1999). According to Pandav and Choudhury (1999), the number of nesting females at Gahirmatha has declined in recent years, although after three years of low nestings, the 1998-99 season showed an increasing trend, and the 1999-2000 season had the largest recorded number of olive ridleys nesting in 15 years when over 700,000 olive ridleys nested at Nasi islands and Babubali island, on the Gahirmatha coast.

Trends for the primary nesting beach of olive ridleys in the eastern Pacific are very promising and the conservation efforts that have resulted in the dramatic increases are commendable (Marquez et al. 1996). Probabilities of extinction risks indicate negligible risks over the next several decades given that current conservation practices are continued (Table 40). As with all population of marine turtles, these trends can change quickly with changes in conservation efforts.

Demographic Parameter	Estimate (Baseline)
Log growth rate (μ)	0.06 [-0.11, 0.23]
Variance in mean log growth rate (σ^2)	0.11 [0.06, 0.54]
Finite rate of change in population size (λ_A)	1.12 [0.92, 1.64]
Instantaneous rate of change in population size (r_A)	0.12 [-0.08, 0.50]
Risk of quasi-extinction	
Probability of quasi-extinction ever occurring	0 [0, 1]
Median time to quasi-extinction (yr)	NA
Probability of quasi-extinction in: 25 yr	0 [0,0]
50 yr	0 [0, 0.05]
100 yr	0 [0, 0.51]
Risk of ultimate extinction	
Probability of extinction ever occurring	0 [0, 1]
Median time to extinction (yr)	NA
Probability of extinction in: 25 yr	0 [0, 0]
50 yr	0 [0, 0]
100 yr	0 [0, 0.12]

Table 40. Results of the Dennis-Holmes Model for olive ridleys turtles from Escobilla Beach, Oaxaca, Mexico. Unless otherwise noted, values are reported as means with the lower and upper 95% confidence intervals in brackets. Quasi-extinction is defined as 50 adult females and ultimate extinction is defined as 1 adult female. The analysis of risk associated with the deep-set longline was not conducted for this beach as the estimated mortality rate was too low to have an impact on *r* (see text). (Source: Snover 2005).

If 15 adult females are killed annually by the Hawaii deep-set longline fleet, this would result in an estimated overall mortality rate of 1.38×10^{-4} for a current population size of over 94,000 adult females. In terms of the calculations performed here, this number would be considered zero and would not have an impact on the recovery rates estimated for Escobilla Beach (Snover 2005).

Given initial population sizes and increases in the Mexican and Costa Rican populations in recent years, the mortalities associated with the Hawaii-based deep-set longline fishery are not likely to have any measurable effect on the increasing trend of those populations. In the consultation process, the applicant submitted an independent analysis of the effects of fishing related mortality of olive ridley turtles in the deep-set longline fishery on the recovery potential and status of the eastern Pacific olive ridley stock.[19] The analysis, based on a Bayesian state-space surplus production model, relied on historical olive ridley harvest records and a relative abundance index (usually a nesting abundance time series) to model the effect of fishing related mortality on the long-term viability of the eastern Pacific stock of olive ridley turtles. The

[19] Source: Memorandum from Dr. Milani Chaloupka, Ecological Modelling Services P/L, Queensland, St. Lucia, Australia to James M. Lynch, Stoel Rives LLP, Seattle, Washington, dated September 2, 2005.

analysis incorporated a higher fishing related mortality for the stock than anticipated in the exposure analysis of this Opinion to demonstrate that the anticipated losses of individuals to the eastern Pacific olive ridley stock are expected to have no impact on stock viability. The analysis concludes that it is not possible to distinguish between the expected baseline population trajectory and the population trajectory expected when 5 tonnes of olive ridley turtles (equivalent to 132 olive ridley turtles) are removed from the population. The analysis indicates that this level of loss, which is greater than that expected in the fishery, does not result in any detectable impact on long-term stock survival or recovery. Though NMFS did not rely solely on this analysis to reach the conclusion that the fishing related mortality expected to occur incidental to the Hawaii-based pelagic, deep-set longline fishery would have no detectable impact on the long-term population trajectory for eastern Pacific olive ridley turtles, the conclusions from this analysis are consistent with NMFS' conclusions regarding no detectable effects.

Population trends in the western Pacific are more difficult to discern, although it is clear that there are still large populations of olive ridley turtles nesting in India. This population continues to be affected by ongoing factors such as incidental take in fisheries, the harvest of eggs on nesting beaches, and inundation and erosion of beaches. The removal of reproductive adults and pre-reproductive sub-adults from the declining western Pacific population through interactions with the Hawaii-based longline fishery may adversely affect this population's persistence, although it is unknown how much, or to what degree this might impact the population's survival in light of the other factors currently affecting this population.

Nevertheless, the major populations of olive ridley turtles in the Pacific Ocean appear to be increasing, despite some residual, adverse effects of fishery-related mortalities and harvest of adults and eggs. Because of the population size, number of reproductive females, and the rates at which sub-adults are probably recruiting into the adult population, nesting aggregations of this species are deemed to be resilient to the mortalities and reduced reproductive rates associated with the deep-set longline fishery without appreciable reductions in the olive ridley turtle's likelihood of the surviving and recovering in the wild.[20]

12.0 Cumulative Effects

Cumulative effects[21] include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

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[20] Olive ridley turtles on the Pacific coast of Mexico are listed separately as endangered species, rather than the threatened status assigned to the remainder of their global populations. Effects of the proposed fisheries on the endangered populations are generally analyzed separately from their threatened counterparts; however, using the information available, effects of the fisheries cannot be distinguished between the different populations (because our data on interactions between the fisheries and these turtles cannot distinguish between threatened and endangered turtles). As a result, our analyses group the endangered populations and the threatened populations and treat them both as endangered.

[21] "Cumulative effects," as defined for the purposes of the Endangered Species Act in 50 CFR 402.14, should not be confused with the term "cumulative impact" as defined for the purposes of the National Environmental Policy Act of 1969 (42 U.S.C. 4321). "Cumulative effects" under the ESA are limited to the effects of future, non-federal actions in an action area.

12.1 Humpback Whales

As was noted in the Species Status Section, Noise from the Acoustic Thermometry of Ocean Climate (ATOC) program, the U.S. Navy's Low Frequency Active (LFA) sonar program, and other anthropogenic sources (i.e., shipping and whalewatching) in the action area is another concern for the central north Pacific stock. Efforts are underway to evaluate the relative contribution of noise (e.g., experiments with LFA sound sources) to Hawaii's marine environment, although reports summarizing the results of recent research are not available.

Although the scope and magnitude of impacts are poorly understood, humpback whales in the action area may also come into contact with marine debris or contaminants. Entanglement in marine debris can potentially impair an animal's ability to feed, breathe, or swim. Contact with, or ingestion of, contaminants such as petroleum can be toxic to an animal if it is ingested or absorbed. Interactions with either marine debris or contaminants may compromise an animal's immune system or make it more vulnerable to predators. Future actions which result in an increase of marine debris and pollution in the action area may affect survival and fecundity rates of individual whales or potentially the entire stock.

12.2 Sea Turtles

External[22] fisheries described as occurring within the action area (Section 8.0 Environmental Baseline), are expected to continue into the foreseeable future. Conservation efforts are underway to research and export gear technologies to external fisheries with high sea turtle interaction rates. These gear technologies are anticipated to reduce sea turtle bycatch in the future, yet at this time NMFS cannot quantify or predict the foreseeable level of reductions in sea turtle bycatch as a result of these efforts. Thus, impacts from external fisheries described in the Environmental Baseline are expected to occur into the foreseeable future.

Since 1982, NMFS' PIFSC has managed a comprehensive sea turtle stranding program in the Hawaiian Archipelago. Stranding data can provide insights to anthropogenic hazards for sea turtles. The stranding database was analyzed in 2004 to estimate the relative impact of various inshore activities such as recreational fishing (Chaloupka 2004). NMFS relied on results of the stranding analysis to evaluate potential hazards to sea turtles in the action area of the Hawaii-based pelagic, deep-set longline fishery that are likely to continue into the foreseeable future. While the stranding data likely represent inshore impacts, NMFS expects hazards presented here to affect sea turtles in the offshore environment into the foreseeable future as well.

Though not attributable to any one particular state or private action; marine debris and pollution poses a threat to sea turtles in the action area. Necropsy and stranding data demonstrate that sea turtles in the action area become entangled in and ingest marine debris. The sea turtle stranding database contains accounts of sea turtles entangled in cable, a kite string, rope, a parachute anchor, and a sleeping bag. The database also contains accounts of necropsied animals with plastics in their intestines. There's an account of a turtle stuck in a plastic crate and a turtle that was apparently covered in tar (Chaloupka 2004).

[22] "External" means all other fisheries occurring in the action area except for the deep-set component of the Hawaii-based pelagic longline fishery (the proposed action).

Vessel strikes pose a threat to sea turtles in the action area. Of the strandings (alive or dead) in the database in which the cause of stranding could be determined, approximately 5% were attributable to vessel strikes (Chaloupka 2004). Of all the hazards identified in the stranding database, shark attacks and vessel strikes were the hazards most likely to result in mortality. Shark attacks and vessel strikes had a hazard specific mortality rate of approximately 94% (Chaloupka 2004). Thus, while we cannot quantify the number of sea turtles likely to be exposed to vessel strikes in the action area; we acknowledge vessel strikes as a hazard with a high likelihood of mortality for sea turtles occurring in the action area. Additionally, illegal harvest of sea turtles may also occur in the action area (37 turtles in the stranding database had been struck by a spear) through the extent of this illegal activity is unknown.

NMFS expects that the effects of these ongoing activities occurring in the Action Area will be captured in the trend represented by the female nest trend data for the populations affected by the deep-set component of the Hawaii-based longline fishery. NMFS acknowledges that there may be a time lag between the time the animals are impacted and the time those impacts are revealed in the adult female trend data. Moreover, as noted by Chaloupka et al. (in press) monitoring only female nesting activity provides insufficient information for stock assessments because females do not breed every season and no information is provided on the demographic structure of the stock (i.e. other life-stages and males). Estimates of sea turtle abundance, suitable for stock assessment and conservation management planning can be assessed by long term monitoring of recruitment at known foraging areas (Chaloupka et al. in press). However, in the Pacific, foraging ground abundance estimates are only known for three stocks – the southern Great Barrier reef green turtle population, the Australian loggerhead metapopulation, and the Hawaiian green turtle metapopulation. Currently, the female nest trend data are the best available indication of the current status and trend of the populations affected by the Hawaii-longline fishery. As such, NMFS assumes that these cumulative sources of mortality are/will be evident in the female nesting trend data analyzed in the preceding sections.

13.0 Conclusion

After reviewing the available scientific and commercial data, current status of green turtles, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is NMFS' biological opinion that the continued authorization of the deep-set component of the Hawaii-based pelagic longline fishery under the Pelagics FMP, when added to the impacts in the environmental baseline, is not likely to jeopardize the continued existence of humpback whales.

After reviewing the available scientific and commercial data, current status of green turtles, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is NMFS' biological opinion that the continued authorization of the deep-set component of the Hawaii-based pelagic longline fishery under the Pelagics FMP, when added to the impacts in the environmental baseline, is not likely to jeopardize the continued existence of green turtles.

After reviewing the available scientific and commercial data, current status of leatherback turtles, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is NMFS' biological opinion that the continued authorization of the deep-set component of the Hawaii-based pelagic longline fishery under the Pelagics FMP, when added to the impacts in the environmental baseline is not likely to jeopardize the continued existence of leatherback turtles.

After reviewing the available scientific and commercial data, current status of loggerhead turtles, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects it is NMFS' biological opinion that the continued authorization of the deep-set component of the Hawaii-based pelagic longline fishery under the Pelagics FMP, when added to the impacts in the environmental baseline, is not likely to jeopardize the continued existence of loggerhead turtles.

After reviewing the available scientific and commercial data, current status of olive ridley turtles, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is NMFS' biological opinion that the continued authorization of the deep-set component of the Hawaii-based pelagic longline fishery under the Pelagics FMP, when added to the impacts in the environmental baseline, is not likely to jeopardize the continued existence of olive ridley turtles.

14.0 Incidental Take Statement

Section 9 of the ESA and protective regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the reasonable and prudent measures and terms and conditions of the Incidental Take Statement.

The measures described below are nondiscretionary, and must be undertaken by NMFS for the exemption in section 7(o)(2) to apply. NMFS SFD has a continuing duty to regulate the activity covered by this incidental take statement. If NMFS SFD fails to assume and implement the terms and conditions the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, NMFS SFD must monitor the progress of the action and its impact on the species as specified in the incidental take statement. (50 CFR §402.14(I)(3)).

A marine mammal species or population stock which is listed as threatened or endangered under the ESA is, by definition, also considered depleted under the MMPA. The ESA allows takings of threatened and endangered marine mammals only if authorized by section 101(a)(5) of the MMPA. The incidental taking of listed marine mammals must be authorized under section 101(a)(5)(E) of the MMPA, before incidental take of listed marine mammals may be exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA. Therefore, the incidental take of listed marine mammals is not authorized for the proposed action at this time.

14.1 Amount or extent of take

Mortality and hooking and entanglement rates of sea turtles have been calculated based on past observed interaction rates (see section 9.2). As shown in Table 29, the number of each species incidentally captured by the fishery is highly variable from year to year, with some species observed captured every year, and others (e.g. loggerhead and green sea turtles) observed captured only occasionally.

NMFS has developed this incidental take statement to account for the interannual variability observed in the estimated take of sea turtle species incidental to the Hawaii-based pelagic, deep-set longline fishery. The most common form of 'take' in the deep-set longline fishery is the incidental hooking and entanglement of sea turtles incidental to the fishery. All references to 'interactions' in this Opinion refer to animals hook or entangled in the fishery and are thus characterized as 'takes.' As described in section 9.2.2.3, two different methods are required for calculating (a) the anticipated level of interactions analyzed in the biological opinion and (2) the estimated number of interactions occurring incidental to a year of fishing. Section 9.2.2.3 also provides a description of the differences in the uncertainty about these two estimates. As stated in section 9.2.2.3, future anticipated interactions in the fishery may have a higher probability of exceeding a given confidence interval because the intervals pertain to the 'anticipated' and not 'estimated' interactions. Due to the differences in the way in which anticipated interactions are calculated in the biological opinion and the way in which estimated interactions are calculated following a year of fishing to determine if the specified level of incidental take has been exceeded, the degree of influence of one observed capture is disparate between the two estimates. For example, 3 leatherback turtles were observed taken incidental to the 2004 deep-set longline fishery. Due to the sampling scheme of approximately 20% observer coverage, 15 leatherback turtles were estimated to have been taken incidental to the fishery. In other words, 1 observed interaction results in an estimated 5 interactions (with some variability in this value according to sample probability in a particular quarter). When the anticipated interactions are calculated using the pooled/expansion approach across years described in section 9.2.2.1, one observed interaction does not generally have near the influence on the anticipated number of interactions.

The annual number of interactions anticipated to occur incidental to the Hawaii-based deep-set longline fishery in 2005 and beyond is shown in Table 32. As shown in Table 29, the number of estimated interactions is highly variable among years and as described above, the influence of one observed sea turtle interaction translates to an estimate of approximately 5 interactions based on a 20% probability sample. Based on our analysis of past interactions, NMFS is confident that over a period of several years, the mean number of interactions occurring in the fishery will be contained within the anticipated range analyzed in this Opinion. However, due to the factors described above, NMFS expects that in any given year the number of actual interactions may be higher or lower than the values provided in Table 30. Because the estimated interactions (calculated to determine if the ITS has been exceeded) are highly sensitive to an individual observed interaction, relative to the interaction levels anticipated to occur in the fishery, NMFS has determined that specifying a take level over a period of 3 years, which corresponds to the number of years analyzed in this Opinion, will decrease the likelihood of reinitiating consultation on the proposed fishery due to an increase in one observed interaction for a particular species in the fishery in subsequent years. NMFS believes that specifying a take limit over a period of 3 consecutive years is warranted based on demonstrated interannual variability in the rate of interactions and because the best available empirical data have been applied to determine interaction rates. Over a period of 3 consecutive years, the likelihood of the fishery exceeding the specified level of take is extremely low. Whereas, if incidental take levels were specified on an annual basis, the likelihood that the level of interactions occurring in the fishery in a given year could exceed the levels specified in Table 30 is high. However, the best available data, as shown in Table 30, do not indicate that the fishery is likely to interact with the upper anticipated interaction level in each of the 3 consecutive years. NMFS expects interaction levels to hover around the annual levels provided in Table 30 and not to exceed the values in Table 41 over a period corresponding to 3 consecutive fishing years.

NMFS SFD should evaluate take levels following the 2005 fishery based on the sum of the 2003, 2004, and 2005 estimated interactions. This level should be re-evaluated following the 2006 fishery based on the sum of the 2004, 2005, and 2006 estimated interactions and so on. If, during the course of the action, the level of take specified in Table 41 is exceeded, SFD must immediately reinitiate formal consultation pursuant to Criterion 2 of the section 7 regulations (50 CFR 402.16 (a)). The table below specifies two thresholds for incidental take in the fishery, for which exceedence of either would trigger reinitiation of formal consultation. If the ‘number captured’ (interactions not resulting in death to the animal plus interactions resulting in death to the animal) or the ‘number killed’ (interactions resulting in death to the animal) is exceeded, NMFS SFD must request reinitiation of formal consultation.

	Incidental Take	
	Number Captured	Number Killed
Green sea turtles	21	18
Leatherback sea turtles	39	18
Loggerhead sea turtles	18	9
Olive Ridley sea turtles	123	117

Table 41. The number of turtles expected to be captured or killed in the deep-set component of the Hawaii-based pelagic longline fishery over a period of 3 consecutive years.

14.2 Impact of the Take

In the accompanying Opinion, NMFS determined that these levels of anticipated take are not likely to result in jeopardy to the green turtle, leatherback turtle, loggerhead turtle, olive ridley turtle, or humpback whale.

14.3 Reasonable and Prudent Measures

Section 7(b)(4) of the ESA requires that when an agency is found to comply with section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of listed species, NMFS will issue a statement specifying the impact of any incidental taking. It also states that reasonable and prudent measures necessary to minimize impacts, and terms and conditions to implement those measures be provided and must be followed to minimize those impacts. Only incidental taking by the federal agency or applicant that complies with the specified terms and conditions is authorized.

NMFS believes the following reasonable and prudent measures, as implemented by the terms and conditions are necessary and appropriate to minimize the impacts of sea turtles and monitor levels of incidental take. The measures described below are non-discretionary, and must be undertaken by NMFS for the exemption in section 7(o)(2) to apply. If NMFS fails to adhere to the terms and conditions of the incidental take statement, the protective coverage of section 7(o)(2) may lapse.

1. NMFS shall collect data on capture, injury, and mortality of sea turtles in addition to life history information on longline fishing vessels.

2. NMFS shall reinitiate formal consultation under section 7 of the ESA if in a single year, corresponding to a fishing year for the Hawaii-based pelagic deep-set longline fishery, the amount of *either* incidental capture or mortality of sea turtles incidental to the fishery is equal to or greater than 50% of the total take level specified/anticipated for multiple years for any species.

3. NMFS shall require that sea turtles captured alive be released from fishing gear in a manner that minimizes injury and the likelihood of further gear entanglement or entrapment.

4. NMFS shall require that comatose or lethargic sea turtles shall be retained on board, handled, resuscitated, and released according to the established procedures.

5. NMFS shall require sea turtles that are dead when brought on board a vessel or that do not resuscitate be disposed of at sea unless NMFS requests retention of the carcass for sea turtle research.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, NMFS must comply or ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1. The following terms and conditions reasonable and prudent measure No. 1.

    1A. Observer Program: NMFS shall continue the observer program aboard Hawaii-based limited access permit longline vessels to collect data on the incidental take of marine mammals, sea turtles, and other protected species. Observer coverage in the Hawaii-based pelagic, deep-set longline fishery generally shall be maintained at an annual level of at least 20 percent.

    1B. Data Collection: Observers shall collect standardized information regarding the incidental capture, injury, and mortality of sea turtles by species, gear and set information in which each interaction occurred. Observers shall also collect life history information on sea turtles captured by longline fisheries, including species identification; measurements, including direct measure or visual estimates of tail length; condition; skin biopsy samples; and estimated length of gear left on the turtle at release. To the extent practicable, these data should allow NOAA Fisheries Service to assign these interactions into the categories developed through NMFS' most current post-hooking mortality guidelines.

    NMFS' observers shall record the presence or absence of tags on all sea turtles captured by longline fisheries.

    1C. Information Dissemination: Data collected by observers shall be made available on a quarterly basis. "Quarterly Status Reports" shall be sent to the Assistant Regional Directors of Protected Resources and Sustainable Fisheries in NMFS PIR and distributed to NMFS' Sea Turtle Coordinators in Honolulu, Hawaii, Long Beach, California, and Silver Spring, Maryland.

2. The following terms and conditions implement reasonable and prudent measure No. 2.

2A. NMFS' SFD shall monitor and assess incidental take of sea turtles on an annual basis and shall immediately request reinitiation of formal consultation under section 7 of the ESA if the conditions in 2B are met.

2B. If, in a single year, corresponding to a fishing year for the Hawaii-based pelagic, deep-set longline fishery, the amount of incidental capture or mortality of sea turtles in the fishery is equal to or greater than 50% of the take level for any of the species listed in Table 41 (rounded up to the nearest integer) NMFS SFD shall immediately request reinitiation of formal consultation.

3. The following terms and conditions implement reasonable and prudent measure No. 3.

3A. NMFS SFD shall continue to conduct protected species workshops for owners/operators of vessels registered for use with longline fishing permits issued under the Pelagics FMP to facilitate proficiency on mitigation, handling, and release techniques for turtles, as outlined in 50 CFR Part 660. In the protected species workshops NMFS SFD shall continue to educate vessel owners/operators in handling and resuscitation techniques to minimize injury and promote survival of hooked or entangled sea turtles.

3B. NMFS SFD shall include information on sea turtle biology and ways to avoid and minimize sea turtle impacts to promote sea turtle protection and conservation in the protected species workshops for owners/operators of longline vessels registered for use with permits issued under the Pelagics FMP.

3C. Observer training by NMFS shall continue to include sea turtle handling and resuscitation techniques and sea turtle biology information during observer training.

3D. Personnel aboard a vessel registered for use with a longline permit issued under the Pelagics FMP must remove the hook from a turtle, if feasible, as quickly and carefully as possible to avoid injuring or killing the turtle. Each vessel must carry a line clipper. If a hook cannot be removed (e.g., the hook is deeply ingested or the animal is too large to bring aboard), the line clipper must be used to cut the line as close to the hook as practicable and remove as much line as possible prior to releasing the turtle.

3E. Each Hawaii-based longline vessel registered for use with a longline permit under the Pelagics FMP must carry a sea turtle dip net to hoist a sea turtle onto the deck, if practicable, to facilitate the removal of the hook. If the vessel is too small to carry a dipnet, sea turtles must be eased onto the deck by grasping its carapace or flippers, if practicable, to facilitate the removal of the hook. Any sea turtle brought on board must not be dropped on to the deck.

3F. Each longline vessel registered for use with a longline permit issued under the Pelagics FMP must have a wire or bolt cutter aboard the vessel capable of cutting through a hook that may be imbedded externally, including the head/beak area of a turtle.

4. The following term and condition implements reasonable and prudent measure No. 4.

   4A. Operators of vessels registered for use with longline permits issued under the Pelagics FMP shall bring comatose sea turtles aboard, if feasible, and perform resuscitation techniques according to the procedures described at 50 CFR Part 660, Subpart C and 50 CFR 223.206. If an observer is aboard the vessel, the observer shall perform resuscitation techniques on comatose sea turtles.

5. The following term and condition implements reasonable and prudent measure No. 5.

   5A. Dead sea turtles may not be consumed, sold, landed, offloaded, transhipped or kept below deck, but must be returned to the ocean after identification unless NOAA Fisheries Service requests the turtle be kept for further study.

15.0 Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or develop information.

The following conservation recommendations are provided pursuant to section 7(a)(1) of the ESA for developing management policies and regulations, and to encourage multilateral research efforts which would help in reducing adverse impacts to listed species in the Pacific Ocean. Many of these recommendations have been carried over from the 2004 BiOp.

1. NMFS should continue to research modifications to existing gear that (1) reduce the likelihood of interactions between sea turtles and longline fishing gear and (2) reduce the immediate or delayed mortality rates of captured turtles. In particular, NMFS should continue to develop and test circle hooks suitable for use in deep-set longline gear. Any research funded or implemented by NMFS, likely to increase the number of turtles captured or killed in the deep-set fishery beyond the levels considered in this Opinion, must be covered by a research and enhancement permit pursuant to section 10(a)(1)(a) of the ESA. The goal of any research should be to develop a technology or method, through robust experimental designs, that would achieve these goals while remaining economically and technically feasible for fishermen to implement.

2. NMFS should research development or modifications of existing technologies, to detect and alert fishers if sea turtles or marine mammals become entangled in their gear.

3. NMFS should continue efforts to gather international support for the Inter-American Convention for the Protection and Conservation of Sea Turtles.

4. NMFS should support the development of a trans-Pacific international agreement that would include Pacific island and Pacific Rim nations for the protection and conservation of sea turtle populations.

5. NMFS shall make available and disseminate information on sea turtle biology and ways to avoid and minimize sea turtle impacts for promoting sea turtle protection and conservation at appropriate Regional fora (such as the Heads of Fisheries Meetings of the Pacific Community) in the western Pacific region.

6. NMFS should continue and expand on existing efforts to implement measures and management actions that protect sea turtles in their ocean environments and increase hatchling production at nesting beaches in the eastern and western Pacific. NMFS should continue to work with the Council and the relevant non-governmental organizations (such as World Wildlife Fund - Indonesia, Kamiali Integrated Conservation Development Group of Papua New Guinea, the Sea Turtle Association of Japan, and ProPeninsula in Baja, Mexico) to develop and implement long-term conservation programs for sea turtles

in the Pacific that (1) protect the War-mon nesting beach at Jamursba-Medi, Bird's Head Peninsula in the State of Papua, Indonesia; (2) work with villagers in western Papua's Kei Kecil Islands to limit subsistence harvests of leatherback turtles to levels that would be sustainable by the population of leatherback turtles that uses those coastal foraging grounds; (3) work with villages of the Kamiali community in Papua New Guinea to eliminate nest predation of leatherback eggs, relocate leatherback nests from areas that are likely to be lost to beach erosion, and conduct subsistence harvests of leatherback turtle eggs that sustainable by this nesting aggregation of leatherback turtles; (4) conduct mortality reduction workshops with fishermen along the coast of Baja Mexico and place observers on local boats to reduce or eliminate the number of loggerhead turtles captured and killed in these fisheries; (5) conduct programs to relocate loggerhead sea turtle nests in Japan that are likely to be lost to beach erosion and provide shading to nests that experience extreme temperatures.

7. NMFS should continue to provide technical and financial assistance necessary to export advances in knowledge of techniques and gear modifications that reduce interactions with sea turtles and/or dramatically reduce the immediate and/or delayed mortality rates of captured turtles with other nations engaged in similar fishing practices to reduce fishery impacts to sea turtle populations worldwide. As gear technologies and experimental designs are proven effective, NMFS should conduct additional technical assistance workshops to assist other longlining nations in reducing sea turtle bycatch.

16.0 Reinitiation Notice

This concludes formal consultation on the continued authorization of the deep-set component of the Hawaii-based pelagic longline fishery under the Pelagics FMP. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of the incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. If the amount or extent of incidental take identified in the incidental take statement that is enclosed in this biological opinion is exceeded, NMFS SFD should immediately request initiation of formal consultation.

This Opinion has been predicated on several assumptions, which were necessary to overcome gaps in our knowledge. First, the exposure analyses in this biological opinion assumed that different nesting aggregations of green, leatherback, loggerhead and olive ridley sea turtles were likely to be exposed to these fisheries proportional to their representation in genetics data collected in the area fished by the Hawaii-based longline fisheries. If new data reveals that these assumptions are incorrect then this new information is likely to satisfy the second requirement for reinitiating consultation.

Second, the response analyses of this Opinion made assumptions about acute and chronic (post-hooking) mortality rates that were based on the information available from sea turtle experts. If new data, including data collected through the observer program, reveals that those assumptions substantially underestimated the number of sea turtles the would die from acute or chronic exposure to the fisheries, then this new information is likely to satisfy the second requirement for reinitiating consultation.

Lastly, the level of incidental take anticipated in the exposure analysis and specified in the incidental take statement assumes that future interaction rates between sea turtles and the Hawaii-based pelagic, deep-set longline fishery will resemble interaction rates observed in the past. The analysis reveals interannual variability in the number of interactions occurring in the fishery. NMFS assumes that in the future, interaction rates will fluctuate from year to year yet should not exceed the range of interactions anticipated to occur over a period of three consecutive years. If new data reveal that, in a particular year, interaction rates, accounting for interannual variability, have increased beyond those analyzed in this Opinion, this new information would satisfy the second requirement for reinitiating consultation.

17.0 Literature Cited

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