UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

NOV 15 2002

MEMORANDUM FOR: Charles Karnella,
Administrator
Pacific Islands Area Office

FROM: Donald R. Knowles, Don Knowles
Director
Office of Protected Resources

SUBJECT: Biological opinion on the Pelagic Fisheries under the Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region

This transmits the National Marine Fisheries Service's (NMFS) biological opinion (Opinion) on the effects of NMFS' continued authorization of fisheries managed under the Pelagic Fisheries under the Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region Amendment 11 to that Fishery Management Plan, which would establish a limited access program for the domestic longline fishery based in American Samoa in accordance with section 7(a)(2) of the Endangered Species Act of 1973, as amended.

This Opinion concludes that NMFS' prosecution of federal fisheries managed under the the Pelagic Fisheries under the Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region Amendment 11 to that Fishery Management Plan are not likely to jeopardize the continued existence of the endangered northern humpback whale (*Megaptera novaeangliae*), sperm whale (*Balaenoptera physalus*), Hawaiian monk seal (*Monachus schauinslandi*), green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback sea turtle (*Dermochelys coriacea*), and olive ridley sea turtle (*Lepidochelys olivacea*) and the threatened loggerhead sea turtle (*Caretta caretta*). The Opinion includes an incidental take statement.

Regulations at 50 CFR § 402.16 require federal agencies to immediately request reinitiation of formal consultation if 1) the amount or extent of taking specified in the Incidental Take Statement is exceeded; 2) new information reveals effects of the action that may affect listed species or critical habitat in a way not previously considered; 3) the action is modified in a way that causes an effect to listed species that was not previously considered; or, 4) a new species is listed or critical habitat is designated that may be affected by the action.

Exceeding the level of anticipated taking does not, by itself, require the action agencies to stop an ongoing action during reinitiation and completion of consultation. However, our regulations specify that the federal agency must make this ultimate determination, taking into consideration the prohibitions of section 7(a)(2) and 7(d) of the ESA. Further, if after the anticipated level of incidental take has been reached, the continued action results in any additional taking of listed species, the taking may constitute a violation of the prohibitions of section 4(d) and/or 9 of the ESA. As you know, section 7(d) specifies that "after initiation of consultation required under subsection (a)(2), the federal agency and the permit or license applicant shall not make any irreversible or irretrievable commitment of resources with respect to the agency action which has the effect of foreclosing the formulation or implementation of any reasonable and prudent alternative measures which would not violate subsection (a)(2)." Should the incidental take anticipated in this Opinion be exceeded, the Pacific Islands Area Office will need to determine how to proceed.

I look forward to working with you to implement the measures provided in this Opinion and in future consultations. Please feel free to call upon my staff for assistance if needed.

Attachment

cc: Dunnigan, Office of Sustainable Fisheries
McInnis, Lecky, Ruvelas, Southwest Region
Williams, Johnson, Office of Protected Resources
Collins, Lawrence, General Counsel for Fisheries
Feder, General Counsel for Southwest Region

ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
BIOLOGICAL OPINION

Action Agency: National Marine Fisheries Service, Southwest Region, Pacific Islands Area Office

Activity: Authorization of Pelagic Fisheries under the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region.

Consulting Agency: National Marine Fisheries Service, Endangered Species Division

Approved By: ____________

Date issued: 11/15/02

Abstract. To comply with the requirements of the Endangered Species Act of 1973, the National Marine Fisheries Service (NMFS) has prepared a biological opinion on the continuation of various fisheries that are managed under the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region. The biological opinion considers the effects of longline, troll, handline, and pole-and-line pelagic fisheries based in Hawaii, American Samoa, Guam, Pacific Remote Islands Areas, and the Northern Mariana Islands on threatened and endangered species and critical habitat.

Based on previous patterns of interactions between the fisheries and endangered marine mammals, the biological opinion concludes that the proposed fisheries are not likely to adversely affect the following marine mammals or critical habitat that has been designated for them: blue whale, *Balaenoptera musculus*; fin whale, *Balaenoptera physalus,* right whale, *Eubalaena glacialis* and sei whale, *Balaenoptera borealis*. The fisheries are likely to adversely affect Hawaiian monk seal, *Monachus schauinslandi;* humpback whale, *Megaptera novaeangliae*; and sperm whale, *Physeter macrocephalus*. NMFS has based this conclusion on previous patterns of marine mammals that have been captured, injured, or killed through interactions with the gear used in the fisheries.

Based on previous patterns of interactions between the fisheries and threatened and endangered sea turtles, the biological opinion concludes that the proposed fisheries are likely to adversely affect green turtles (*Chelonia mydas*), hawksbill turtles (*Eretmochelys imbricata*), leatherback turtles (*Dermochelys coriacea*), loggerhead turtles (*Caretta caretta*), and olive ridley turtles (*Lepidochelys olivacea*). NMFS has based this conclusion on previous patterns of turtles that have been captured, injured, or killed through interactions with the gear used in the fisheries.

Only limited, quantitative information on the marine mammal and turtle species was available for NMFS' analyses. To conduct its jeopardy analyses for sea turtles in the absence of definitive, quantitative information, NMFS used conceptual models and life stage matrix analysis that considered the information available on the population dynamics of the sea turtle species and the numbers of sea turtles captured, injured, or killed in the U.S. Pacific pelagic fisheries to determine if these injuries or deaths could be expected to reduce a species' reproduction, numbers, or distribution in a way that would be expected to appreciably reduce the species' likelihood of surviving and recovering in the wild. As part of these analyses, NMFS made assumptions about the number of adult, female sea turtles that might be captured,

injured, or killed in the pelagic fisheries. NMFS then considered the probable effects on turtle mortalities in the fisheries on the species' population structure, the status and trends of the various populations, the vital rates, and the relationship between vital rates and the population's status and trend (that is, the population's rates of increase). Specifically, NMFS considered whether mortalities associated with the fisheries are a significant or chronic source of (a) reduced fecundity in the breeding population of these turtles or (b) decreased rates of survival in one or more life history stage of these sea turtles.

Based on these analyses, NMFS concluded that the numbers of monk seals, humpback whales, sperm whales, and green, hawksbill, leatherback, loggerhead, and olive ridley turtles captured, injured, or killed in the proposed fisheries would not reduce the numbers and reproduction of those species in a way that would be expected to appreciably reduce their likelihood of surviving and recovering in the wild. The Opinion also provides an Incidental Take Statement that includes measures to minimize the impact of residual captures and deaths on all the sea turtles and marine mammals.

Table of Contents

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, 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 that may be affected. For the actions described in this document, the action agency is the Office of Sustainable Fisheries of NMFS. The consulting agency is the Endangered Species Division, also of NMFS.

This document represents NMFS' biological opinion (Opinion) based on our review of the Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region, as amended (Pelagics FMP), its implementing regulations, and the proposed Amendment 11 to the Pelagics FMP, and the effects of this action on humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), Hawaiian monk seals (*Monachus schauinslandi*), fin whales (*Balaenoptera physalus*), sei whales (*B. borealis*), right whales (*Eubalaena glacialis*), green turtles (*Chelonia mydas*), hawksbill turtles (*Eretmochelys imbricata*), leatherback turtles (*Dermochelys coriacea*), loggerhead turtles (*Caretta caretta*), and olive ridley turtles (*Lepidochelys olivacea*), in accordance with section 7 of the ESA.

This Opinion is based on information provided in the March 30, 2001 Final Environmental Impact Statement (FEIS) for the Pelagics FMP, the July 1986 Pelagics FMP and subsequent amendments (including the proposed Amendment 11), recovery plans for the humpback whale and Hawaiian monk seal, the most current marine mammal stock assessment reports, sea turtle recovery plans, past and current research and population dynamics modeling efforts, observer and logbook data on fishery effort and protected species interactions within the Hawaii-based longline fishery, and biological opinions for this and other relevant fisheries. A complete administrative record of this consultation is on file at the NMFS Southwest Regional Office, Long Beach, California.

I. CONSULTATION HISTORY

A complete consultation history for previous consultations under the Pelagics FMP can be found in the November 3, 1998, biological opinion on the reinitiated consultation for the Pelagics FMP Hawaii North Central Pacific Longline Fishery (NMFS, 1998a). That opinion found that the proposed action was not likely to jeopardize the continued existence of listed sea turtles or Hawaiian monk seals, and established anticipated incidental take levels for sea turtles captured by the Hawaii-based longline fishery. The opinion also required continuation of the observer program for the fishery and required handling procedures for incidentally captured sea turtles and review of the circumstances surrounding the observed capture of any leatherback turtle.

In a May 18, 2000, memo to the Director of the NMFS Pacific Islands Area Office (PIAO), the Southwest Fisheries Science Center (SWFSC), which is responsible for calculating the estimates of incidental take of sea turtles occurring in the Hawaii-based longline fishery, indicated that the Hawaii-based longline fishery had likely exceeded anticipated mortality take levels for olive ridley turtles (NMFS, 2000b). On June 7, 2000, the Southwest Region reinitiated consultation (NMFS 2000c).

Given the preliminary incidental take estimates prepared by the SWFSC, later finalized in an August, 2000, report (McCracken, 2000), and new information about the status of leatherback and loggerhead turtles in the Pacific Ocean (NMFS, 2000d), NMFS decided to re-analyze the expected effects of the Hawaii-based longline fishery on all affected listed species. NMFS also determined that a comprehensive assessment of all fisheries under the Pelagics FMP was warranted. Previous consultations had focused solely on one fishery under the FMP or on single amendments to the FMP. The intent of this analysis was to provide, in a single document, a comprehensive assessment of the individual and cumulative effects of fisheries under the management of the Pelagics FMP.

The Hawaii-based longline fishery has been the subject of several court-orders and was operating under a restricted fishing regime prescribed by the court to protect listed sea turtles when NMFS completed consultation on the Pelagics FMP on March 29, 2001. In that opinion, NMFS determined that the proposed action was not likely to jeopardize the continued existence of the listed marine mammals or olive ridley sea turtles. NMFS did determine, however, that the fisheries managed under the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region (Pelagic Fisheries) were likely to jeopardize the continued existence of green, leatherback, and loggerhead turtles. The March 29, 2001, opinion included a Reasonable and Prudent Alternative (RPA) designed to avoid the likelihood of jeopardy to these species and an Incidental Take Statement with terms and conditions designed to minimize the impact of any incidental take of all four species of turtles that would occur as a result of implementation of the RPA.

Subsequent to completion of the March 29, 2001, opinion, the Pelagic Fisheries have been operating pursuant to the requirements of the RPA as implemented by regulations. However, on December 12, 2001, NMFS reinitiated consultation on the Pelagic Fisheries to account for new information which could improve NMFS' ability to quantify and evaluate the effects of the Pelagic Fisheries and the reasonable and prudent alternative in the March 29, 2001, opinion on listed sea turtle populations. The new information available consisted of sex- and age-class-structured stochastic simulation models of loggerhead, green, and leatherback sea turtle population dynamics developed subsequent to the completion of the March 29, 2001, opinion, as well as new information on the status, life history, and behavior of several of the affected sea turtle species.

On October 9, 2002, Pacific Islands Area Office requested that the action under consideration in the ongoing consultation be revised to include the operation of the Pelagic Fisheries as described by the FEIS and regulation. In addition, the proposed action was changed to include Amendment 11 proposed by the Western Pacific Fishery Management Council to establish a limited access program for the domestic pelagic longline fishery based in American Samoa.

II. DESCRIPTION OF THE ACTION

NMFS' Pacific Islands Area Office requested consultation on the fisheries managed under the Pelagics FMP as they currently exist (Pelagic Fisheries). Therefore, the management regime, as modified by adoption of the Reasonable and Prudent Alternative in the March 2001 Biological Opinion[1] and described by the preferred alternative of the March 2001 FEIS by NMFS (NMFS 2001c), with subsequent clarifications to the biological opinion and regulatory adjustments to the fisheries conducted under the Pelagics FMP, constitute the action being considered in this Opinion. The Opinion also evaluates the likely impact of a limited access program, proposed by the Western Pacific Fishery Management Council (Council), for the domestic pelagic longline fishery based in American Samoa.

The purpose of fishery management plans, including the Pelagics FMP, has been established by the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 *et seq.*; MSA). The stated purpose of the Pelagics FMP is to maximize the net benefits of the fisheries to the western Pacific region and the nation. Background information on federal fisheries policy and management under the MSA, fishery management plan development process, and Pelagics FMP is described in the March 2001 FEIS (see: Section 1.3, pages 11 - 34).

The current management regime under the Pelagics FMP primarily regulates the domestic pelagic longline fisheries, although certain permitting, reporting, and sea turtle mitigation measures apply to certain non-longline pelagic fisheries in the region, such as the domestic troll, handline, and pole-and-line fisheries. NMFS has no specific regulations, pursuant to the Pelagics FMP, for the domestic tuna purse seine fishery[2] operating in the western Pacific.

The Pelagics FMP, which was implemented in 1987, includes initial estimates of maximum sustainable yields (MSY) for fished stocks and sets optimum yields (OY) for these fisheries in the Exclusive Economic Zone (EEZ).

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[1] Biological Opinion on Authorization of Pelagic Fisheries under the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region, March 29, 2001.

[2] The U.S tuna purse seine fishery is managed under the Treaty on Fisheries Between the Governments of Certain Pacific Island States and the Government of the United States of America (the South Pacific Tuna Treaty). Although they occur in the action area and are subject to management under the MSA, for the most part this fishery is not regulated under the Pelagics FMP (one regulation prohibits large vessels, including U.S tuna purse seiners, from fishing in waters within approximately 50-nm of the islands of American Samoa). This fishery will be subject to separate section 7 consultation on the South Pacific Tuna Treaty and will not be evaluated as part of the effects of this action.

Regulations (final rules) implementing the Pelagics FMP that are in place and constitute the preferred alternative in the March 2001 FEIS (see: Record of Decision, May 9, 2002) provide that:

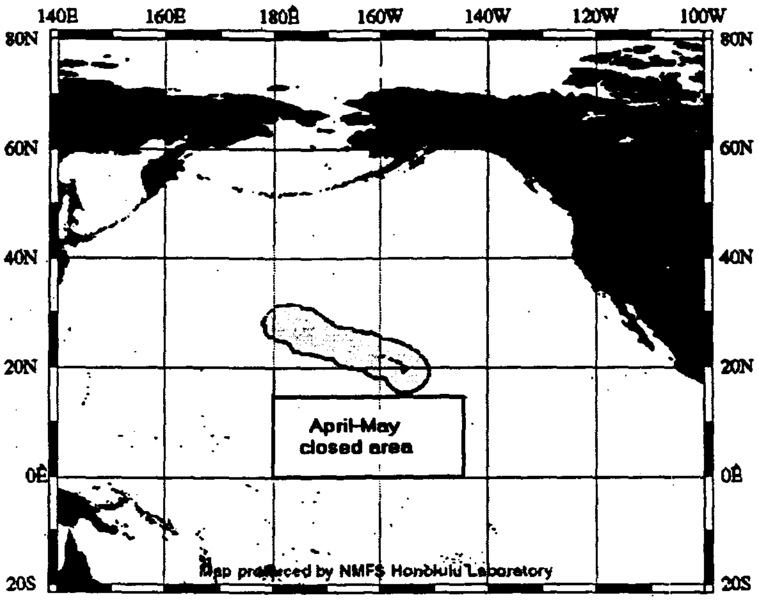
- Fishing for pelagic management unit species (PMUS) in the western Pacific EEZ with drift gillnets is prohibited *(52 FR 5987, March 23, 1987).*
- Fishing vessels that use longline gear to catch PMUS in the EEZ around American Samoa, Guam, CNMI, or the U.S. Pacific remote islands areas (PRIA), such 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).*
- 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).*
- Longline fishing for PMUS is prohibited in closed areas 50 nm around the center points of each of the Northwestern Hawaiian Islands (NWHI), 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 (MHI) 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 modified during the period 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).*
- Longline fishing is also prohibited in an area approximately 50 nm off Guam *(57 FR 7661, March 2, 1992).*
- Hawaii longliners must carry a NMFS observer when directed to do so by NMFS *(58 FR 67699, December 22, 1993).*
- 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).*
- 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).*

- All Hawaii longliners and fishing vessels registered for use with longline general permits, as well as domestic pelagic troll and handline vessels fishing for PMUS in the western Pacific region 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; 67 FR 40232, June 12, 2002).*
- 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).*
- 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).*
- 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 in the NWHI, 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).*
- Hawaii longliners that operate north of 23° N. latitude must: use line setting machines to set longline gear or employ traditional basket-style longline gear to fish for PMUS; 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).* The operator and crew of all Hawaii longliners that accidentally hook or entangle an endangered short-tailed albatross must employ specific handling procedures *(67 FR 34408, May 14, 2002).*
- Operators and owners of Hawaii longliners 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; 67 FR 40232, June 12, 2002).*
- A Hawaii longline limited access permit may be re-registered to a vessel only during the month of October, if its owner had previously de-registered that vessel after March 31, 2001 *(67 FR 40232, June 12, 2002).*
- Hawaii longliners are prohibited from using longline gear to catch PMUS, including engaging in fish transshipping operations supporting longline fishing, from April 1 through May 31 in waters bounded by the equator to 15° N and from 145°W to 180°W *(67 FR 40232, June 12, 2002)*(Figure II-1).
- Hawaii longliners are prohibited from using longline gear to fish for or target swordfish north of the equator. Also, north of the equator, Hawaii longliners must deploy longline gear such that the deepest point of the main longline between any two floats, i.e., the deepest point in each sag of the main line is at a depth greater than 100 m below the sea surface; the length of each float line used to suspend the main longline beneath a float must be longer than 20 m; no fewer than 15 branch lines may be set between any two

floats if the main longline is monofilament set by a line setting machine or no fewer than 10 branch lines between any two floats if the main longline is non-monofilament line set by traditional basket style technique; the possession of light sticks or any other light emitting device, such as glow worms or glow beads, by Hawaii longliners for use as artificial lures to attract and catch swordfish is prohibited *(67 FR 40232, June 12, 2002).*

- Hawaii longliners are prohibited from possessing or landing more than 10 swordfish on any fishing trip *(67 FR 40232, June 12, 2002).*

Figure II-1 **Hawaii-based pelagic longline restricted fishing area** *(67 FR 40232, June 12, 2002)*



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[3] 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.

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

A. Pelagic Fisheries in Hawaii

This section covers pelagic fisheries of Hawaii managed under the Pelagics FMP. These fisheries employ a variety of techniques (longline, troll, handline, and pole-and-line) and operate in areas that range from near shore to beyond the U.S. EEZ. A detailed description of each of these fisheries is provided in the March 2001 FEIS.

1. Hawaii-based Pelagic Longline Fishery

The Hawaii-based longline fishery now operates under management measures, described in the *preferred alternative* of the final EIS completed on March 30, 2001, which were implemented to mitigate adverse impacts on sea turtles (67 FR 40232, June 12, 2002)[4]. The rules were adopted by the Council under the authority of the MSA, approved by the Secretary of Commerce, and implemented by NMFS. They prohibit swordfish-targeted longline fishing, impose a seasonal closure in waters south of Hawaii (from the equator to 15°N and 145°W to 180°) during April and May, ban the possession of light sticks, and limit the possession of 10 swordfish per trip by any Hawaii-based longline vessel. The definition of swordfish-target or shallow-set longline gear is described in the March 2001 FEIS.

The Hawaii-based longline fishery is a limited access fishery, with a total of 164 permits that are transferable (Table II-1). Vessels active in this fishery are limited to 101 feet in length. The area fished ranges as close as 25 miles from Hawaii to thousands of miles from port. These Hawaii-based longline vessels compete with foreign distant water fishing fleets operating on the high seas. In 2001, 101 Hawaii–based longline vessels made 1,034 trips, almost all of which targeted tunas. Swordfish was a major target species of this fishery prior to 2001, but due to conservation measures to protect sea turtles this segment of the Hawaii-based longline fishery was phased out completely by the end of 2001.

The Hawaii-based longline fishery as it operated until March 2001 is described in great detail in the March 2001 FEIS (Section 3.10.3.1, pages 195 to 256). The fishery has changed substantially since the Court first issued an injunction in December 1999, to temporarily close the Hawaii-based longline fishery in certain waters north of the Hawaiian Islands to protect sea turtles. The conduct of the fishery has also have been affected by sea bird mitigation measures when operating north of 23° N latitude (67 FR 34408, May 14, 2002). The Hawaii-based longline fishery now exclusively targets large tunas for *sashimi* (raw fish) and fresh fish that is sold to local retail and wholesale outlets, as well as mainland U.S. and international (Japanese) markets.

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[4] Sea turtle mitigation measures for the Hawaii-based longline fishery were initially promulgated as an emergency interim rule on June 12, 2001 (66 FR 31561).

Table II-1. Summary Information on the Hawaii-based Longline Fishery, 2001. Source: NMFS, unpublished data.

Area Fished	**U.S. EEZs around Hawaii and PRIA; high seas in the central and mid-North Pacific region**
Total Landings	15.6 million pounds
Target Species	Bigeye tuna, Albacore, and Yellowfin tuna
Composition of Landings (Major PMUS)	34% Bigeye tuna 18% Albacore 14% Yellowfin tuna 13% Marlins 3% Swordfish
Season	Year round but highest during the fall and winter
Active Vessels	101
Total Permits	164 (transferable, limited entry)
Total Trips	1,034
Total Ex-vessel Value	$33.0 million

a. *Hawaii-based Longline Tuna-target (Deep-Set) Gear Configuration*

Tuna-target longline fishing is also known as deep-set longline fishing. In general, longline gear consists of a continuous main line that is set on the surface and supported in the water column horizontally by attaching floats[5]. 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 very low (2% of the hooks set in 2001 caught fish). Plastic floats are commonly used though 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 (400m for bigeye tuna[6]). Deep-set longline gear is set in the morning and hauled in the afternoon (Ito and Machado, 2001). The main line is typically 30 to 100 km (18 to 60 nm) long. A minimum of 15, but typically 20 to 30, 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. No lightsticks are attached to the gangions on this type of longline set. A typical deep-set (one day of fishing) consists of 1,200 to 1,900 hooks.

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[5] Under the Pelagics FMP, "longline" gear means a mainline 1 mile or longer in length, suspended in the water column, to which are attached branch (also called dropper or gangion) lines with hooks. When used in the longline closed areas around the Northwestern Hawaiian Islands, the definition is the same except that in those areas a "longline" consists of a mainline of any length (i.e., even mainlines less than 1 mile are prohibited).

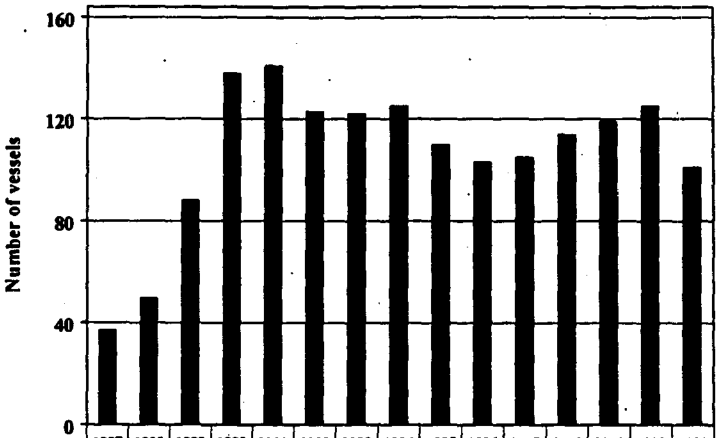
[6] 400 meters is the average deepest depth, ranging from 100 to 400 meters.

b. Vessel Activity

The Hawaii-based longline fishery is the largest commercial fishery in the western Pacific region, with 101 active vessels in 2001, 24 fewer vessels than the previous year. The decrease was attributed to Hawaii-based longline vessels that went to California to fish for swordfish but decided not to return due to the turtle conservation and mitigation measures that prohibited Hawaii-based longline vessels from targeting swordfish. These vessels that transited to California elected to de-register their vessel from their Hawaii longline limited access permit to be able to continue fishing for swordfish. There were approximately 35 vessels that fished out of California in 2001, almost all of which had some history of fishing in the Hawaii-based longline fishery.

The number of active vessels in the Hawaii-based longline fishery increased dramatically in the late 1980's and peaked at 141 vessels in 1991 (Figure II-2). The number of vessels has since ranged from 101-125. The longline fishery operates year-round although vessel activity increases during the fall and is highest during the winter and spring months.

Figure II-2. Number of active Hawaii-based longline vessels, 1987-2001. Source: Ito and Machado 2001, NMFS unpublished data.



	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Vessels	37	50	88	138	141	123	122	125	110	103	105	114	119	125	101

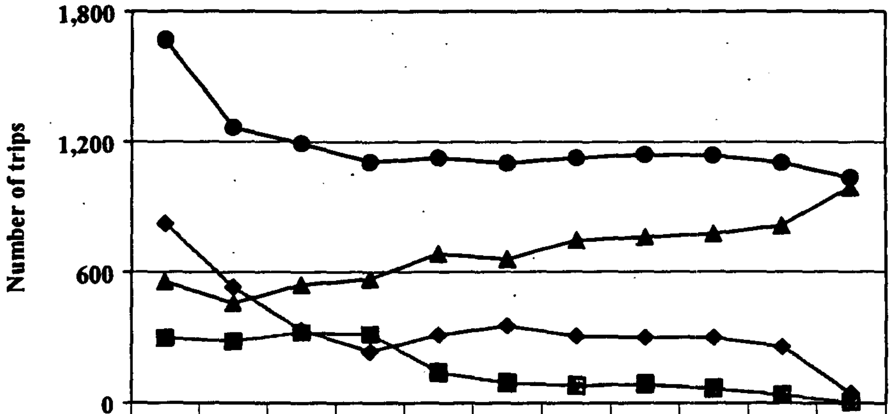
c. Number of trips

Hawaii-based longline vessels made 1,034 trips in 2001; down 69 trips from 2000. Trips were categorized on the basis of target species as tuna-, swordfish-, or mixed- (tuna and swordfish) target. There were 987 tuna-target, 43 mixed-target, and 4 swordfish-target trips made in 2001. Tuna-target trips increased by 173 trips while swordfish-target and mixed-target decreased by 33 and 209 trips, respectively from 2000.

As indicated previously, sea turtle conservation and mitigation measures for the Hawaii-based longline fishery ordered by the Court and promulgated via emergency rulemaking in 2001, prohibited Hawaii-based longline vessels from targeting swordfish while fishing north of the equator and, therefore, required the fishery to target only tuna. When these measures were implemented sudden decreases in swordfish-target as well as mixed-target trips were apparent in the latter part of 2001. These measures became permanent (final) in June 2002 (67 FR 40232, June 12, 2002).

The total number of trips for the Hawaii-based longline fishery has remained relatively stable, however, there was a shift from mixed-target and swordfish-target trips to tuna-target trips from the early 1990's into 2001 (Figure II-3). Swordfish- and mixed-target trips decreased by 99% and 95% of their original levels when compared to their respective trip activity in 1991. In contrast, tuna-target trip activity increased by 78% in that same period.

Figure II-3 Number of trips in the Hawaii-based longline fishery, 1991-2001. Source: Ito and Machado 2001, NMFS unpublished data.



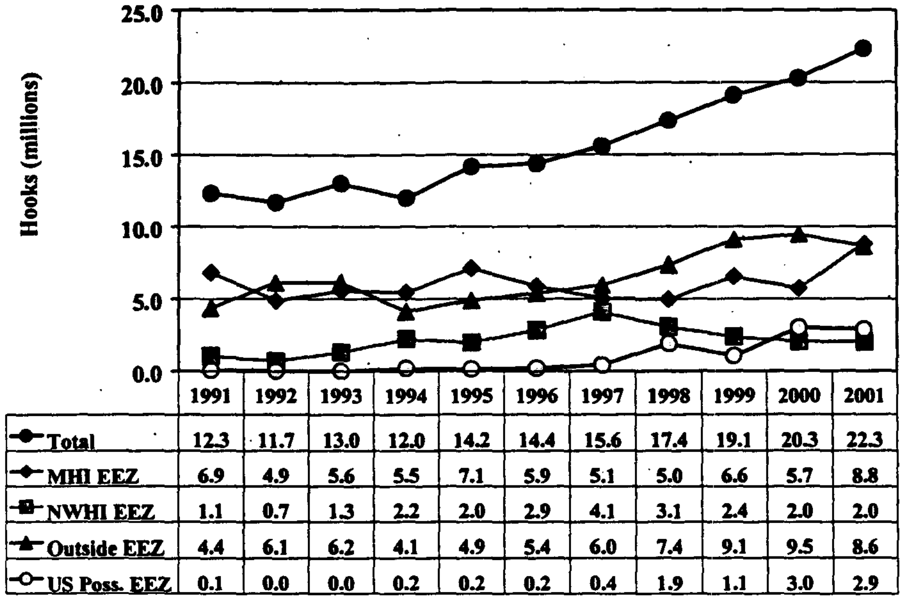
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
● Total	1671	1266	1192	1106	1125	1100	1125	1140	1137	1103	1034
■ Swordfish	292	277	319	310	136	91	78	84	65	37	4
◆ Mixed	823	531	331	228	307	351	302	296	296	252	43
▲ Tuna	556	458	542	568	682	658	745	760	776	814	987

d. *Number of hooks set*

A record 22 million hooks were set in 2001. This increase in number of hooks was due to the shift in effort to tuna which typically results in more than twice as many hooks per day fished than swordfish- or mixed-target trips. Most of the hooks were set in the MHI EEZ(39%) and on the high seas outside the U.S. EEZ (39%). Hooks set in the U.S. possessions accounted for 13%, followed by the Northwestern Hawaiian Islands (NWHI) EEZ(9%). Hooks set in the MHI EEZ increased 54% from 2000 while effort in all the other areas remained about the same.

In general, the total number of hooks set did not change much from 1991-94 but rose 86% thereafter (Figure II-4). Hooks set in the MHI EEZ throughout 1991-2001 varied with no clear trend of increase or decrease. Hooks set outside of the EEZ increased consistently from 1994-2000 with a decline in 2001. Less hooks were set in the NWHI EEZ and EEZ of the U.S. possessions with number of hooks set in NWHI EEZ peaking in 1997 and a increasing trend for hooks set in the EEZ of the U.S. possessions.

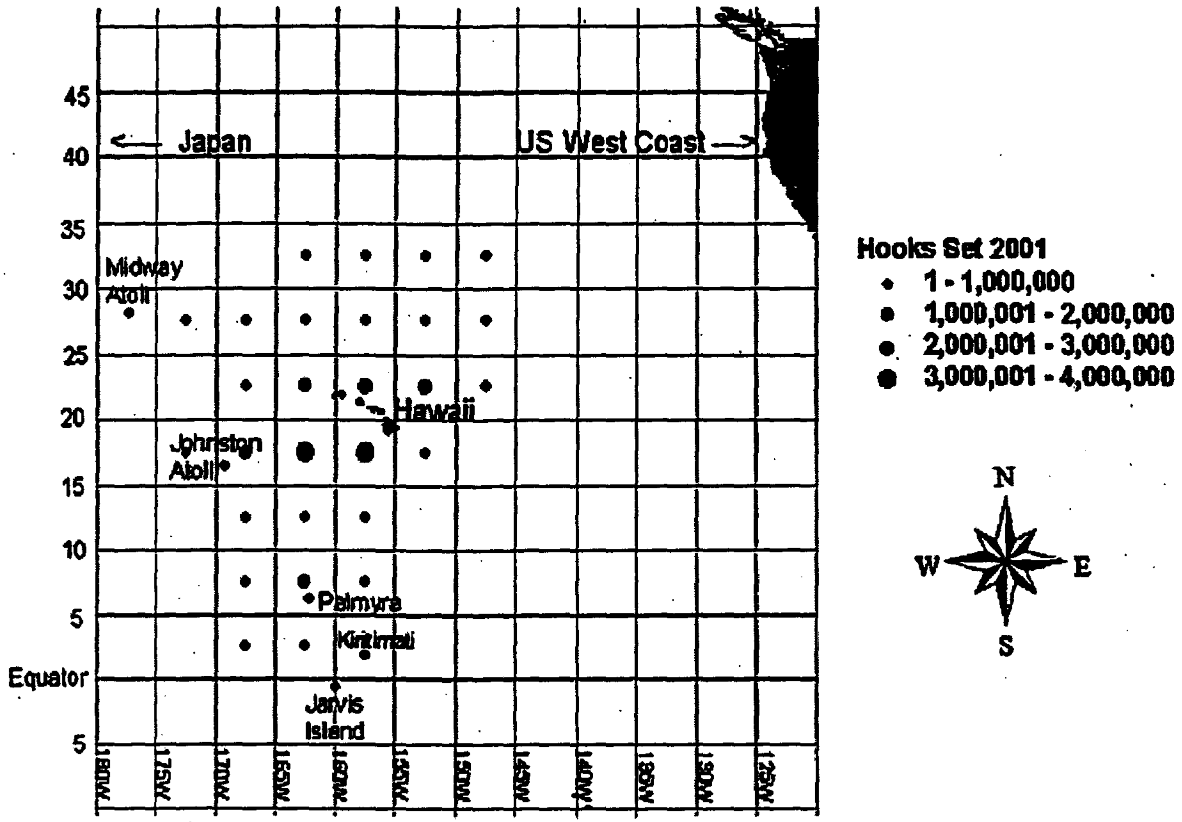
Figure II-4. Number of hooks set by area, 1991 - 2001. Source: Ito and Machado 2001, NMFS unpublished data.



	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
● Total	12.3	11.7	13.0	12.0	14.2	14.4	15.6	17.4	19.1	20.3	22.3
◆ MHI EEZ	6.9	4.9	5.6	5.5	7.1	5.9	5.1	5.0	6.6	5.7	8.8
■ NWHI EEZ	1.1	0.7	1.3	2.2	2.0	2.9	4.1	3.1	2.4	2.0	2.0
▲ Outside EEZ	4.4	6.1	6.2	4.1	4.9	5.4	6.0	7.4	9.1	9.5	8.6
○ US Poss. EEZ	0.1	0.0	0.0	0.2	0.2	0.2	0.4	1.9	1.1	3.0	2.9

The area fished by the Hawai-based longline fishery in 2001 ranged from the equator to 35°N and from 145°W to 175°W (Figure II-5). Effort was highest southwest of the Big Island and east of Johnston Atoll with considerable effort north of the MHI. The effort near Kingman Reef and Palmyra Atoll was slightly higher than the surrounding area.

Figure II-5. Number of hooks set by area, 2001. Source: NMFS unpublished data.



e. Observer Program for the Hawaii-based longline fishery

The NMFS observer program for the Hawaii longline fishery began in 1990, with the voluntary sampling of fishing operations because of unconfirmed reports of interactions between swordfish vessels and protected species, such as Hawaiian monk seals, sea turtles, and sea birds (Dollar 1991). Subsequently, a mandatory NMFS observer program was established in April 1994, to better characterize and understand the effects of the Hawaii-based longline fishery on the incidental take of sea turtle, sea bird, and marine mammal populations. Background information on the observer program and coverage statistics, statistical design and estimates of turtle take based on observer rates are presented in the March 2001 FEIS (Section 3.12.3, pages 432 to 442), which is incorporated in this Opinion by reference.

Initially, observers were placed aboard Hawaii-based longline vessels according to the Statistical Guidelines for a Pilot Observer Program to Estimate Turtle Takes in the Hawaii Longline Fishery (DiNardo, 1993). Using this approach, observer placements were distributed evenly across different strata based on target species and time. During each quarter, a pre-determined number of swordfish, tuna, mixed, or switcher vessels were randomly sampled by observers. Overall observer coverage between 1994 and 1996 was between 4.5 and 5.3% (see Table II-2).

In April 1997, the observer placement strategy changed to reflect the guidelines established in the NOAA Administrative Report, "Recommendations for Scoping the Sea Turtle Observer Program for the Hawaii-Based Longline Fishery," (Skillman et al., 1996). These guidelines recommended that observer coverage should be increased to at least 20% overall to obtain more reliable estimates of sea turtle take. However, because of a lack of funding, the Southwest Region began sampling approximately 5% of the overall fleet effort while focusing on the larger vessels, which were determined to account for 87% of the sea turtle takes. Monitoring a percentage of the small boat sector allowed the potential for detecting large changes in the turtle take rate in that portion of the fishery. The observer data are used to estimate the incidental take of sea turtles, marine mammals, and seabirds and to verify logbook data which are considered reliable for calculating fishing effort and target species, but not for estimating incidental take of sea turtles or other protected species. Observer coverage between 1997 and 1999 was 3.3 to 4.1%.

In August 2000, NMFS modified the observer program sampling design to comply with the terms and conditions of a Court Order. Vessel selections during this time period were based on observer availability and the percent observer coverage goals stipulated by the Court. In late 2000, observer services were contracted out on a permanent basis through a private contractor, Saltwater, Inc. Since January, 2001, 102 observers have been trained. An experienced corps of observers has emerged from this group enabling the NMFS observer program, administered by NMFS-PIAO, to maintain an observer staff ranging from 25 to 40 persons at a given time.

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 slightly above 20% at any given time. The 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.

The sampling design for the program changed 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 NMFS Honolulu Laboratory, was implemented to facilitate data analysis.

Table II-2: Selected Performance Measures for the Hawaiian Longline Observer Program, 1994 to 2002. (NMFS unpublished data)

Year	Number of Trips[1]	Observed Number of Trips[2]	Percent Coverage[3]
1994[4]	1031	55	5.3%
1995[5]	937	42	4.5%
1996	1,062	52	4.9%
1997	1,123	40	3.6%
1998	1,180	48	4.1%
1999	1,136	38	3.3%
2000	1,134	118	10.4%
2001	1,035	233	22.5%
2002[6] (9 months)	801	221	27.6%

[1] Based on dock-side information obtained by NMFS.
[2] Completed number of trips.
[3] Observer coverage based on number of observed trips and dock-side information.
[4] Data from March 1994 to February 1995.
[5] Data from February through December 1995.
[6] Data from January through September 2002.

2. Hawaii-based Troll Fishery

The Hawaii troll fishery is a hook- and-line fishery that typically uses rods and reels as well as hydraulic haulers, outriggers, and other gear to drag lures or baited hooks from moving vessels. Up to six lines rigged with artificial lures or live bait may be trolled when outrigger poles are used to keep gear from tangling. When using live bait, trollers move at slower speeds to permit the bait to swim naturally (WPRFMC 1995). This fishery has three major sectors: commercial troll, charter, and recreational/subsistence. A detailed description of this fishery is presented in the March 2001 FEIS (Section 3.10.3.2, pages 257 to 287).

The Hawaii-based troll fishery operates mainly within the MHI EEZ (Table II-3), usually well within the 50 nautical mile protected species zone closed to longliners. The fishery operates year round but activity is usually highest during the summer months. There were 1,632 active fishermen in the Hawaii-based troll fishery that made 27,285 trips and landed 2.7 millions pounds of fish worth $3.9 million in 2001.

Table II-3: Summary Information on the Hawaii-based Troll Fishery, 2001. Source: Hawaii Division of Aquatic Resources (Preliminary data)

Area Fished	**Predominantly main Hawaiian Island (MHI) EEZ**
Total Landings	2,655,595 pounds
Target Species	Yellowfin tuna Mahimahi Blue marlin Ono Skipjack tuna
Catch Composition	29 percent tuna 28 percent billfish 22 percent mahimahi 20 percent ono
Season	All year but highest during summer months
Active Vessels	1,632 (unique commercial fishing licences)
Total Permits	NA
Total Trips	27,285
Total Ex-vessel Value	$3,907,609

3. Hawaii-based Handline Fishery

The pelagic handline fishery is predominantly a tuna fishery conducted by small boats using relatively simple hook-and-line fishing methods. In Hawaii, three types of handline fishing methods are practiced: nighttime *ika-shibi* (squid-tuna) method, daytime *palu-ahi* (chum-tuna), and seamount fishing and weather buoy method (using both handline and troll methods). The Hawaii-based handline fishery operates within the MHI EEZ.and outside the U.S. EEZ (Table II-4). The fishery operates year round but activity is usually highest during the summer months. The Hawaii-based handline fishery made a total of 3,967 trips in 2001. A detailed description of the Hawaii-based handline fishery is covered in the March 2001 FEIS (Section 3.10.3.3, pages 287 to 305).

Handline gear is set below the surface to catch relatively small quantities of large, deep-swimming tuna that are suitable for *sashimi* markets. The Hawaii handline fishery has nearshore and offshore components. The nearshore fishery targets large yellowfin and bigeye tunas. Nearshore areas have a public sector supported FAD system. The offshore fishery targets juvenile bigeye and yellowfin tuna around seamounts and weather buoys that are 50 to 320 km (35 to 200 nm) from shore (WPRFMC 1995). Some of the larger vessels are able to fish near sea mounts and weather buoys located 100 to 200 nm from shore.

In the nighttime *ika-shibi* fishery, three to four handlines are set, each consisting of a long nylon rope connected to a dacron or polypropylene mainline attached to a monofilament nylon leader. The hook is usually baited with mackerel scad, and is lowered with a lead weight. To attract baitfish and tuna, a low-wattage light bulb is placed in the water, and the surface is chummed with chopped squid and/or chopped anchovies (WPRFMC 1995).

The daytime *palu-ahi* technique adds a weighted, retrievable bag stuffed with chum that is opened at a depth of 120 to 140 meters (400 to 650 ft), releasing the bait to attract tuna to the baited hooks. When a fish is hooked, it is manually hauled in, gaffed and then killed with a bullet or wooden bat.

Table II-4. Summary Information on the Hawaii-based Handline Fishery, 2001. Source: Hawaii Division of Aquatic Resources (Preliminary data)

Area Fished	**MHI EEZ , NWHI EEZ, and seamounts outside the U.S. EEZ**
Total Landings	2,378,968 pounds
Target Species	Yellowfin tuna Bigeye tuna
Catch Composition	55 percent yellowfin tuna 21 percent bigeye tuna 17 percent albacore
Season	Year round
Active Vessels	468
Total Permits	NA
Total Trips	4,816
Total Ex-vessel Value	$3,779,507

4. Hawaii-based Pole-and-Line Fishery

The Hawaii-based pole-and-line fishery is referred to as the *aku* (skipjack tuna) fishery. This fishery uses live-bait as chum to catch skipjack tuna and juvenile yellowfin tuna. A description of the pole-and-line fishery is included in the March 2001 FEIS (Section 3.10.3.4, pages 305 - 312). Hawaii's *aku* fishery began to decline in the mid-1970's prior to closure of the tuna cannery in Honolulu. Skipjack tuna caught by this fishery are now sold to the local fresh fish market.

The Hawaii-based pole-and-line fishery operates primarily within the MHI EEZ (Table II-5). Six pole-and-line vessels actively fished in 2001. These vessels operated year round but their activity was highest during the summer months. The Hawaii-based pole-and-line fishery made a total of 301 trips in 2001. The landings by the pole-and-line fishery was 991 thousand pounds which consisted almost exclusively of skipjack tuna and worth $1.4 million in 2001.

Table II-5: Fishery Information on Hawaii Pole-and-Line Fishery, 2001. Source: Hawaii Division of Aquatic Resources (Preliminary data)

Area Fished	MHI EEZ
Total Landings	990,621 pounds
Target Species	Skipjack tuna
Catch Composition	99.5 percent skipjack tuna
Season	All year
Active Vessels	6
Total Permits	NA
Total Trips	301
Total Ex-vessel Value	$1,365,415

5. Pacific Remote Island Areas (PRIA) Pelagic Troll/Handline Fishery

The PRIA or "U.S. island possessions in the Pacific" are the nine distant-water islands in the central and western Pacific Ocean consisting of Howland Island, Baker Island, Jarvis Island, Wake Island, Kingman Reef, Johnston Atoll, Palmyra Atoll, and Midway Atoll. Midway Atoll, located in the Northwestern Hawaiian Islands, is not part of the State of Hawaii and is treated as one of the PRIA.

A few years ago (1998-1999), there was interest in the potential development of a pelagic troll/handline fishery around Palmyra in the central Pacific. This was spurred by two or three Hawaii-based trollers journeying to Palmyra on fishing expeditions. Also there was indication that a charter troll fishery would expand at Midway Atoll as part of an ecotourism program administered by the U.S. Fish and Wildlife Service (USFWS) (March 2001 FEIS, Section 3.10.3.5, pages 312 - 313). Today, the fishery is dormant; there is no commercial troll/handline fishing activity in EEZ waters around the PRIA in the central Pacific, which is likely due to the lack of an infrastructure at Palmyra Atoll to support a fishery. At Midway Atoll, the U.S. Fish and Wildlife Service is currently engaged in securing a private contractor to reestablish an economically viable ecotourism program. At this time it is unclear if the program will have a troll charter fishing component as part of its program. Nonetheless, current Pelagics FMP management measures include permit and reporting requirements for any U.S. fishing vessel using troll/handline fishing gear to harvest PMUS in waters of the EEZ around the PRIA (67 FR 56500, September 4, 2002). The reporting requirements enable NMFS to monitor the fishery through the collection of catch and effort data , and fishery interactions with protected species.

B. Pelagic Fisheries in American Samoa

The American Samoa-based pelagic fleet includes the generally small twin-hulled *alia* longline vessels, a number of mid-sized and larger monohull longliners, and a relatively small number of vessels used for trolling. In addition, the U.S. distant-water tuna purse seine fleet delivers much of its catch to the canneries in Pago Pago, the capital of American Samoa, and U.S. distant-water albacore trollers occasionally do, as well. Substantial offloading at the canneries is done by foreign purse seine and longline vessels. A detailed description of the pelagic fisheries in American Samoa presented in the March 2001 FEIS (Section 3.10.4, pages 313 - 335). Descriptions of longline and troll fishing can be found above in *Pelagic Fisheries in Hawaii.*

American Samoa's domestic longline and troll fisheries are described further below. Relatively small amounts of pelagic species are also landed from methods not generally used to target pelagic species, including bottomfishing and spearfishing. For example, in 2001 these other methods resulted in about 6,000 pounds of pelagic species landings (WPRFMC 2002c).

1. American Samoa-based Pelagic Longline Fishery

Table II-6 contains a summary of the recent status of the American Samoa-based longline fishery managed under the Pelagics FMP. In 2001, the longline fleet, composed of 62 to 67 active vessels, landed more than 8 million pounds of tunas. In comparison, the Hawaii-based longline fleet landed 15.6 million pounds of fish, primarily tunas. Landings of the longline fleet have been dominated by albacore tuna, which comprised about 88 percent of landings by weight in 2001. The ex-vessel value of longline landings in 2001 was about $8 million.

Table II-6 Summary information on the American Samoa-based Pelagic Longline Fishery, 2001. Source: NMFS unpublished data

Gear:	Longline
Area Fished	Inshore and EEZ
Total Landings	8,206,000 lb
Landings Composition (by weight)	88 % albacore tuna 9 % yellowfin, bigeye, skipjack tuna
Season	All year
Active Vessels	62-67
Total Permits	75 (open access)
Total Sets	4,700-4,800
Total Ex-vessel Value	$ 8,118,000

The number of longline permits was estimated as of March 21, 2002.
Values were estimated as the product of total landings and average prices by species group reported in WPRFMC 2002c.

Small-scale pelagic longlining was introduced into American Samoa in 1995 by fishermen from neighboring independent Samoa (former Western Samoa), where a longline fishery was already established. The longline fleet based on the island of Tutuila, American Samoa, has been, until recently, dominated by twin-hulled boats of aluminum or wood/fiberglass, called *alia*, most of which are about 30 feet long and powered by 40 horsepower outboard engines. These vessels, on which navigation is generally limited to visual methods, typically make only single-day trips, so most of their fishing effort occurs within 25 nautical miles of shore. The longline fishery grew fairly steadily through the late 1990s, but after 2000, it expanded rapidly with the entry of a number of large vessels. The fleet is currently composed of about 40 of the relatively small (< 40 feet) *alia*, about five mid-sized (40-50 feet) monohull vessels, and about 30 large (> 50 feet) monohull vessels (WPRFMC 2002b). These large vessels, which have hydraulically powered reels and electronic navigation equipment and substantially greater gear and storage capacities than the small *alia*, tend to conduct multi-day fishing trips and can range throughout the EEZ (WPRFMC 2002b and WPRFMC 2002c). The rapid influx of the large domestic longliners during just the last two years has resulted in both a dramatic increase in longline fishing effort in the EEZ around American Samoa and a shift in the spatial distribution of longline effort towards waters more distant from shore. The large-vessel closed area that went into effect early in 2002 (67 FR 4369, January 30, 2002), which prohibits vessels longer than 50 feet from fishing for PMUS within approximately 50 nautical miles of the islands of American Samoa, has presumably contributed to the shift.

Figure II-6 shows estimated annual landings by the domestic longline fleet in American Samoa from 1982 through 2001. The development of the *alia* longline fleet is apparent in the increase in annual landings that started in the mid-1990s. The four-fold increase in landings between 2000 and 2001 reflects the near-doubling of the longline fleet size in that one-year period, including the entry of a number of relatively large vessels. In 2001, the longline fishery accounted for more than 99 percent of all pelagic species landings in American Samoa by the locally based fleets.

Figure II-6 Landings in American Samoa's Longline Fishery, 1982-2001. Source: WPRFMC 2002c and NMFS unpublished data.

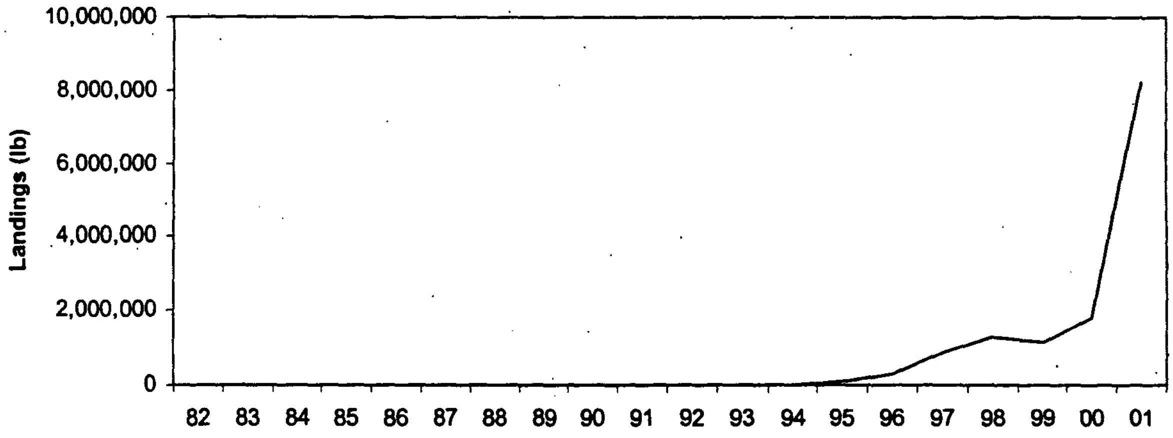
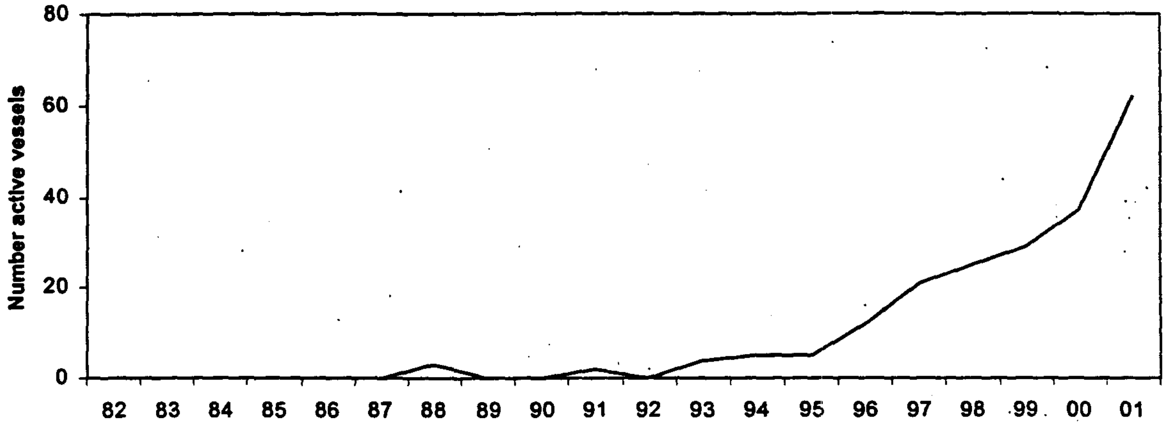


Figure II-7 shows the estimated numbers of boats that were active in American Samoa's longline fishery from 1982 through 2001. The large increase in the number of longline vessels in 2001 was due primarily to the entry of large (> 50 ft) vessels from outside American Samoa. O'Malley and Pooley (in prep.) reported that among recent new entrants in the fishery, three came from Hawaii, six came from the U.S. west coast, three came from the Gulf of Mexico, and four were U.S.-owned longliners that were foreign-built.

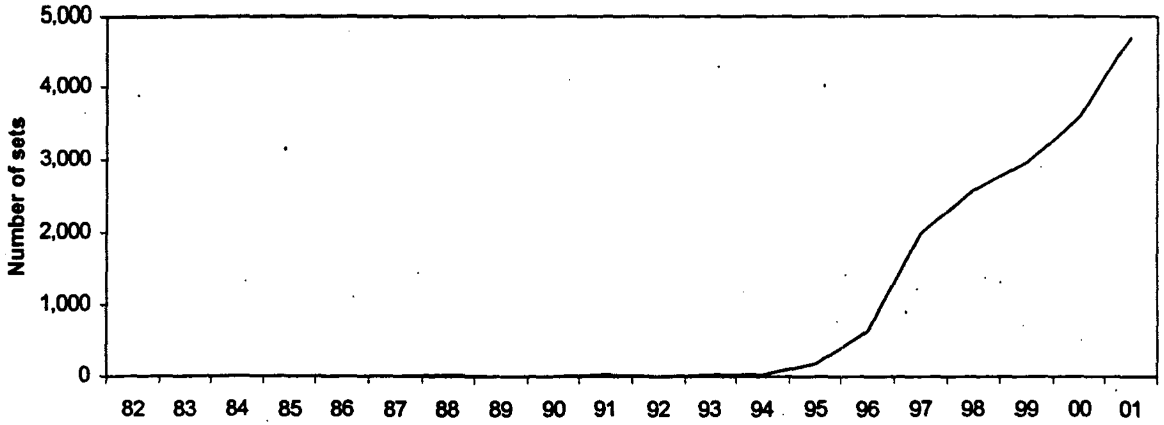
Figure II-7 Participation in American Samoa's Longline Fishery, 1982-2001. Source: WPRFMC 2002c.



Note: Prior to 1997 the estimates were made from the number of longliners interviewed in the creel survey. Starting in 1997 the estimates from the creel survey were supplemented by the numbers of boats that were not interviewed in the creel survey but that submitted longline logs (i.e., the larger vessels, which started entering the fishery soon after the longline logbook program began in 1996). Most longlining that occurred prior to 1995 used a vertical-set method rather than the horizontal method that has been used since 1995.

Figure II-8 shows estimated longline fishing effort by year, expressed in terms of the number of longline sets. The increase in longline effort that started in 1995 reflects both a switchover of some vessels from trolling to longlining and the addition of new vessels to the longline fleet.

Figure II-8 Fishing Effort in American Samoa's Longline Fishery, 1982-2001. Source:

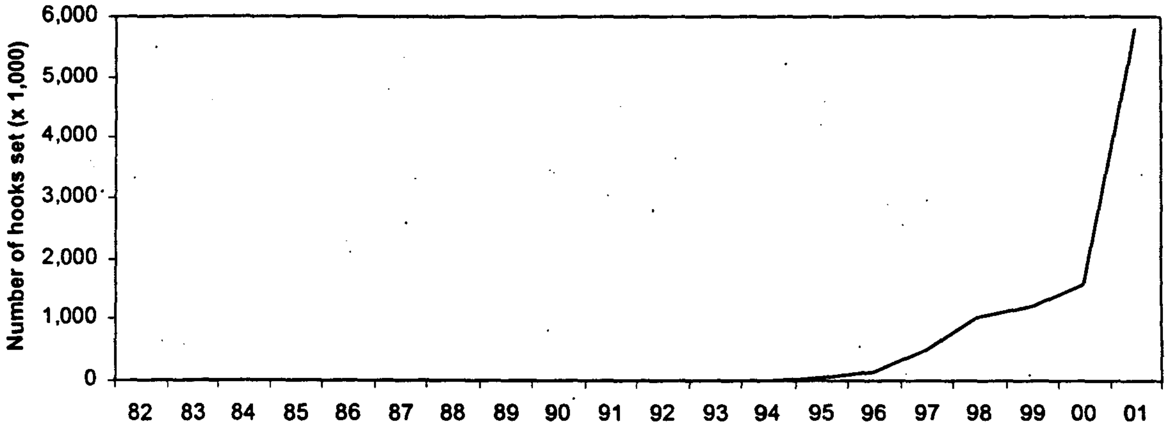


WPRFMC 2002c.

Note: Prior to 1997 the estimates were made from the creel survey. Starting in 1997 the estimates from the creel survey were supplemented by logbook-derived estimates for those vessels known not to be encountered in the creel survey (i.e., the larger vessels, which started entering the fishery soon after the longline logbook program began in 1996).

Figure II-9 shows the estimated number of longline hooks set each year. 2001 saw about 5.8 million hooks set, a four-fold increase from 2000. The concurrent increase in the number of sets made was only 1.5-fold, reflecting the substantial increase in average fishing power per vessel brought about by the entry of comparatively large vessels.

Figure II-9: Hooks set in American Samoa's Longline Fishery, 1982-2001. Source: WPRFMC 2002c.



Note: Prior to 1997 the estimates were made from the creel survey. Starting in 1997 the estimates from the creel survey were supplemented by logbook-derived estimates for those vessels known not to be encountered in the creel survey (i.e., the larger vessels, which started entering the fishery soon after the longline logbook program began in 1996).

A Western Pacific general longline permit or Hawaii longline permit is required to longline in the EEZ around American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, or the PRIA. With the exception of the troll/handline permit requirement for the PRIA (67 FR 56500, September 4, 2002), access by U.S. vessels to the pelagic fishery in these waters is not otherwise restricted. In addition to the permit requirement, longline operators must record certain information about their fishing activity, including catch by set and species, as well as interactions with protected species, in daily logbooks. Pelagics FMP management measures also prohibit large fishing vessels (greater than 50 feet in length), except as exempted, from fishing for PMUS within approximately 50 nm of the islands of American Samoa, including Tutuila, Manua, and Swains Islands, and Rose Atoll. Pelagics FMP sea turtle measures require operators of vessels that fish for pelagic fish with hook-and-line gear to carry line clippers and bolt or wire cutters and to employ specific sea turtle handling and resuscitation methods in the event that sea turtles are accidentally hooked or entangled during fishing operations. In addition, the operators of longline vessels must annually attend a protected species workshop conducted by NMFS.

In response to the unrestricted expansion of the pelagic longline fishery in American Samoa, the Council developed an amendment to the Pelagics FMP (Amendment 11, incorporated by reference in this Opinion), which identifies nine alternatives to control longline effort around American Samoa (WPRFMC 2002b). The preferred alternative adopted by the Council would establish a limited access program in which eligibility to participate in the fishery is limited to owners of vessels that legally harvested PMUS with longline gear in the EEZ around American Samoa on or prior to March 21, 2002. Once the initial permits are issued to eligible participants, the number of available permits would be limited to that number. The limits would be broken down into each of four vessel size classes, although there would be limited opportunities for permit upgrades (by vessel size class) during the first four years of the program.

It has been estimated that a maximum of 138 individuals would likely to be eligible for initial permits, although not all eligible individuals would necessarily obtain a permit (WPRFMC 2002b). This is almost twice the number of currently permitted longline vessels, with most of the difference is in the smallest of the four vessel size classes (≤ 40 ft), as indicated in Table II-7.

Table II-7 Current number of Permitted Longline Vessels and Likely Potential Number of Permits Available under the Preferred Alternative of Proposed Amendment 11. Source: WPRFMC 2002b.

Vessel Size	Current Number of Permits	Potential Number of Permits
≤ 40 ft	40	93
40 - 50 ft	5	9
50 - 70 ft	15	15
> 70 ft	15	21
All	75	138

Note: The current number of permits is as of March 21, 2002.
See WPRFMC (2002b) for the availability of, and schedule for, vessel size upgrade permits.

The wide range of longline vessel types and associated fishing power in the American Samoa-based longline fleet is highlighted in data from two sources. Table II-8 lists some of the typical characteristics of three vessel types used in American Samoa and neighboring Samoa, including the most common *alia* design (28 ft), the less common 40-foot *alia*, and the typical monohull longliner greater than 50 feet in length. Table II-9 shows, for 2001, some of the same characteristics for three vessel types, as measured for the American Samoa fleet from logbook data. The estimates from the logbook data of sets per boat-year and hooks per boat-year are substantially less than the estimates for comparable vessel types given in Table II-8.. One possible explanation for the difference is that some of the vessels monitored in American Samoa in 2001 arrived in 2001 and did not fish the full year.

Table II-8: Profiles of Longline Vessels based in American Samoa and Samoa (formerly Western Samoa). Source: Mulipola 2000, pers. comm. cited in WPRFMC 2000.

Vessel Size and Type	28 ft *Alia*	40 ft *Alia*	50+ ft Monohull
Purchase price (USD)	$25,000	$60,000	$250,000
Miles of mainline set	7-10	20-25	35-50
Sets/trip	1-2	up to 4	6-8
Hooks/set	250-350	500-900	1,200-1,600
Trips/year	100-200 (weather-dependent)	50	40
Hooks/year	30,000-60,000	160,000	400,000

Note: These indicators are based on investigations of the fleets of both American Samoa and Samoa.

Table II-9: Longline fishing effort in American Samoa's longline fishery, by vessel type, 2001. Source: WPRFMC 2002c.

	Alia	Monohull < 50 ft	Monohull > 50 ft
Boats	35	9	26
Sets	1,870	622	2,244
Hooks	602,000	799,000	4,394,000
Average sets/boat	53	69	86
Average hooks/boat	17,000	89,000	169,000

Amendment 11 includes an assessment of the likely effects of the management alternatives. In order to estimate the likely total fleet-wide fishing effort that would occur under the preferred alternative, certain assumptions were made about likely levels of participation and per-vessel fishing effort, by size class. Using the assumptions made in the first three rows of Table II-10, the estimate of total likely effort in the EEZ around American Samoa was about 17 million hooks per year assuming no permit upgrades and about 25 million hooks per year assuming all available permit upgrades are taken. It was estimated that about 85 to 90 percent of total effort would occur beyond 50 nm from shore (WPRFMC 2002b). The estimates were based on the assumption that 75 vessels (the number permitted as of the control date, March 21, 2002) would obtain permits and actually fish. In comparison, the Hawaii-based longline fleet included 101 vessels in 2001 and set a record of 22 million hooks.

Table II-10: Estimates of Likely Fishing Effort in American Samoa's Longline Fishery under Amendment 11. Source: WPRFMC 2002b.

	≤ 40 ft	40 - 50 ft	50 - 70 ft	> 70 ft	Total
Average sets/boat-year	125	175	225	225	
Average hooks/boat-year	43,750	218,750	472,550	472,500	
Boats	40	5	15	15	75
Total sets/year	5,000	900	3,400	3,400	13,000
Total hooks/year	1,750,000	1,094,000	7,087,000	7,087,000	17,000,000

Note: These estimates were based on the assumption that no permits would have been upgraded. The total predicted annual fishing effort assuming all available upgrades taken was about 25 million hooks.

2. American Samoa-based Troll Fishery

Table II-11 contains a summary of the recent status of the American Samoa-based troll fishery managed under the Pelagics FMP. In 2001, the troll fleet, composed of about 18 active vessels, landed about 24,000 pounds of pelagic species, dominated by skipjack and yellowfin tuna, with an ex-vessel value of about $24,000.

Table II-11 Summary information on the American Samoa-based Troll Fishery, 2001. Source: NMFS unpublished data

Gear:	Troll
Area Fished	Inshore and EEZ
Total Landings	24,000 lb
Landings Composition (by weight)	50 % skipjack tuna 20 % yellowfin tuna 9 % pomfret
Season	All year
Active Vessels	18
Total Permits	NA
Total Trips	343
Total Ex-vessel Value	$ 24,000

Values were estimated as the product of total landings and average prices by species group reported in WPRFMC 2002c.

While the longline fishery has grown rapidly during the last few years, the troll fishery has diminished (although not as dramatically as the longline fishery has grown) due to troll fishermen switching to longlining. Figure II-10 shows estimated annual landings by the domestic troll fleet in American Samoa from 1982 through 2001. The development of the longline fleet is apparent in the decreasing trend in troll landings that started in the mid-1990s. In 2001, landings by the troll fishery comprised only about one half of one percent of total pelagic species landings in American Samoa by the locally based fleets.

Figure II-10 Landings in American Samoa's Troll Fishery, 1982-2001. Source: WPRFMC 2002c and NMFS unpublished data.

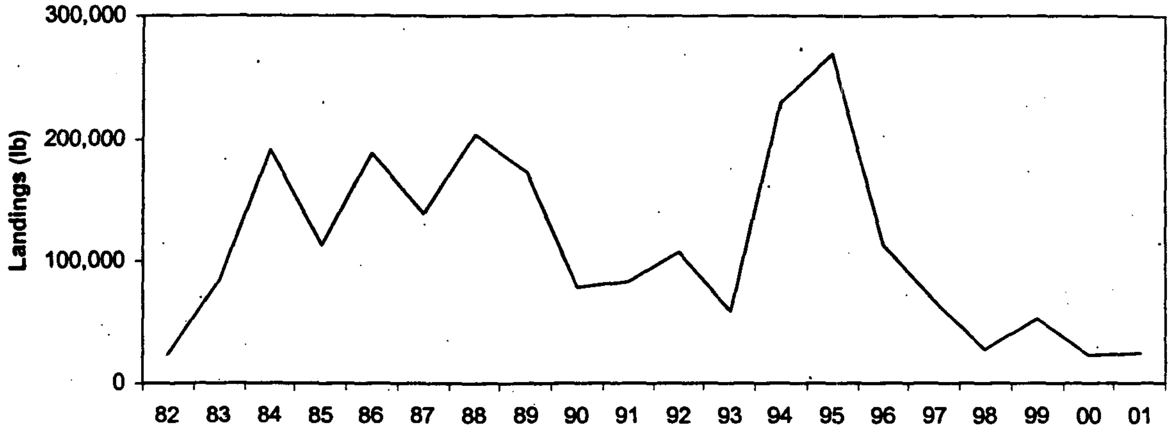


Figure II-11 shows the estimated numbers of boats that were active in American Samoa's troll fishery from 1982 through 2001. The decreasing trend in the size of the fleet after 1995 was due mainly to troll fishermen and boats switching to the developing longline fishery (WPRFMC 2002c).

Figure II-11 Participation in American Samoa's Troll Fishery, 1982-2001. Source: WPRFMC 2002c.

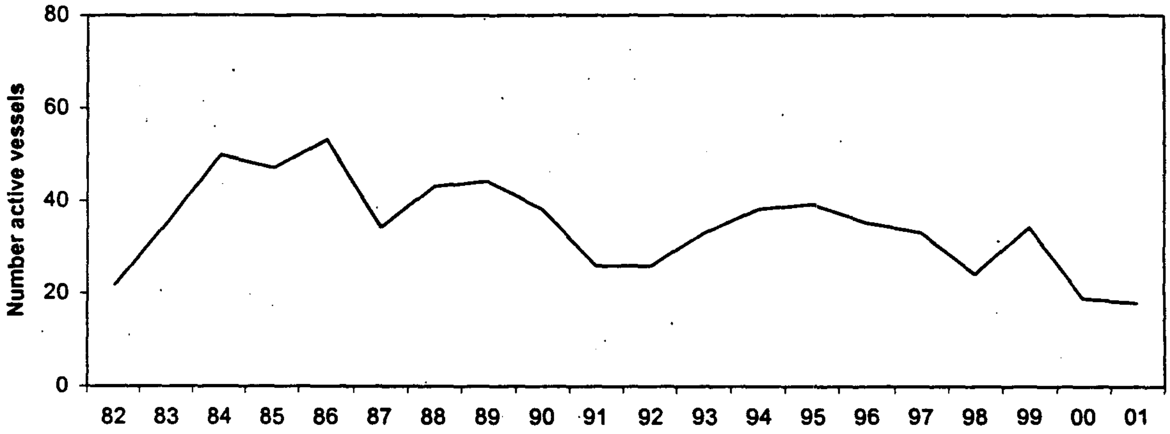
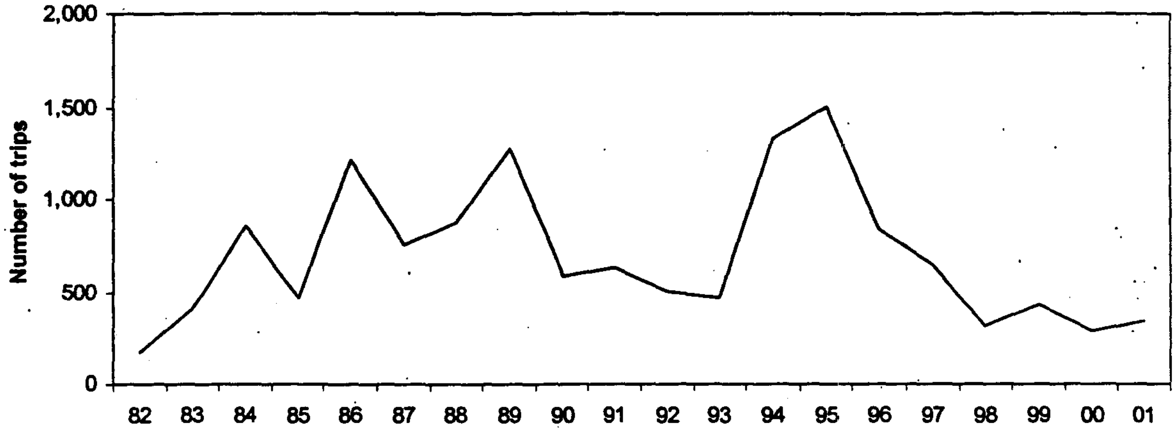


Figure II-12 shows estimated trolling fishing effort from 1982 through 2001, expressed in terms of the number of trips. The decrease in trolling effort that started in 1995 was concurrent with an increase in longline effort and reflects the switchover of some fishermen's effort from trolling to longlining.

Figure II-12 Fishing Effort in American Samoa's Troll Fishery, 1982-2001. Source: WPRFMC 2002c.



C. Pelagic Fisheries in the Territory of Guam

U.S. domestic fishing vessels based in Guam that target PMUS are the distant-water tuna purse seiners, longliners, and smaller recreational trollers. The larger purse seiners fish outside the EEZ around Guam and transship their catch through Guam. The smaller recreational fishing vessels, which are either towed to boat launch sites or berthed in marinas, and domestic longliners fish within the EEZ around Guam or the adjacent EEZ around the Northern Mariana Islands. There is no active domestic longline fishery in Guam at this time. Background information on the pelagic fisheries in Guam is contained in the March 2001 FEIS (Section 3.10.5, pages 335 - 352), which is incorporated in this Opinion by reference.

Guam's domestic pelagic fishery consists mostly of small trolling vessels that are recreational, subsistence and/or commercial (part-time). There is also a small, but significant charter troll fleet that are full-time commercial. Table II-12 profiles the 2001 pelagic fishery. The number of troll fishing vessels active in the Guam pelagic fishery in 2001 declined by 10% from 2000 (Figure II-13) which is mirrored by a similar decrease (9%) in the number of total troll trips (Figure II-14).

Table II-12: Summary Information on the Pelagic Fishery in Guam, 2001. NMFS unpublished data.

Gear	**Troll/Charter**
Area Fished	Inshore and EEZ
Total Landings	760,000 lb
Targets and Catch Composition	44% skipjack tuna 24% mahimahi 16% wahoo 8% yellowfin tuna 4% Pacific Blue marlin
Season	All year
Active Vessels (estim)	375
Total Permits	NA
Total Trips	12,016
Total Ex-vessel (Commercial) Value*	$639,928

*Data (inflation-unadjusted) are available for commercial value, and unavailable for noncommercial values.

Figure II-13: Guam estimated number of trolling boats. Source: WPRFMC 2002c

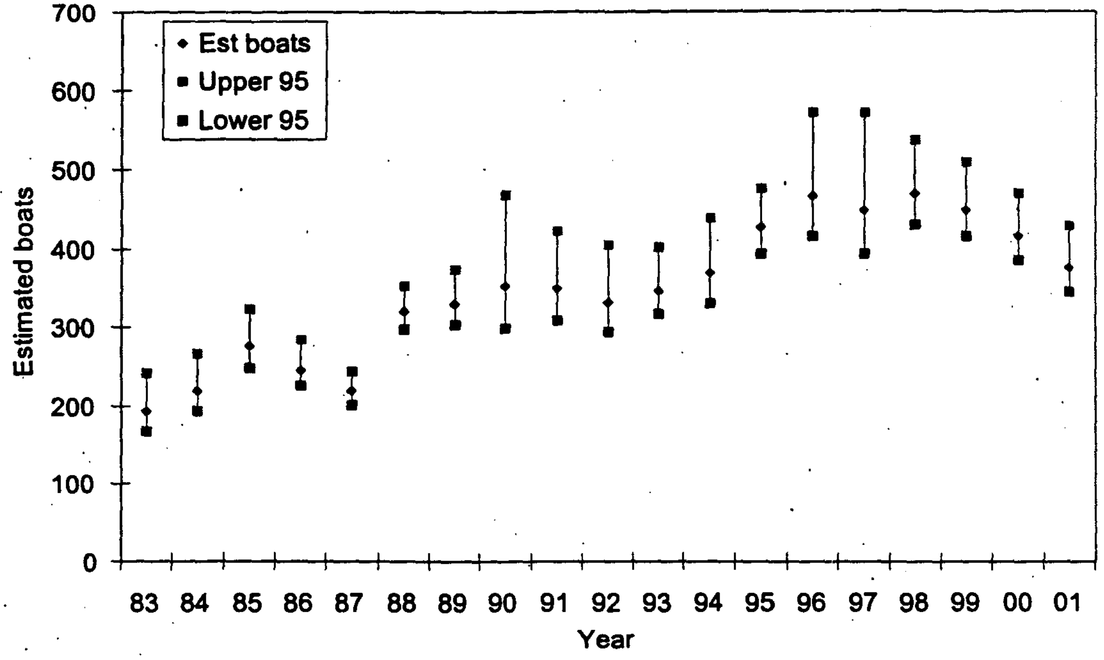
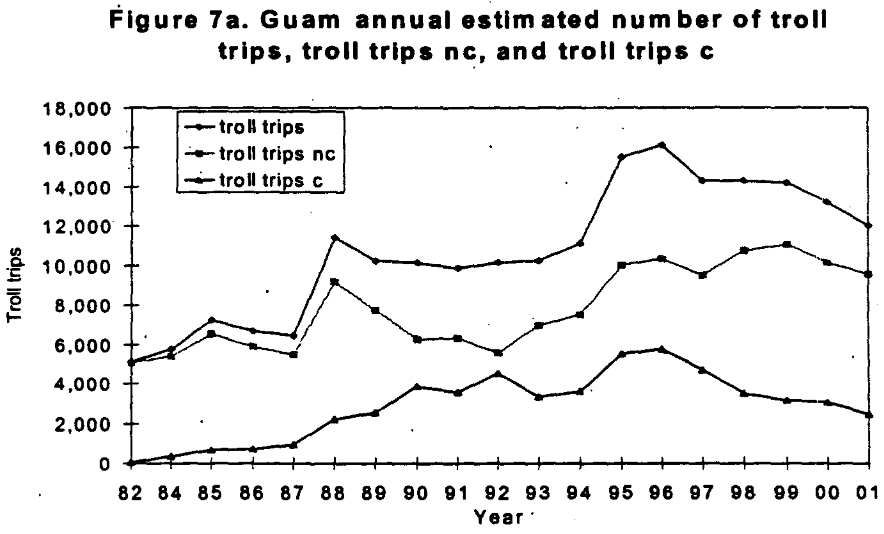


Figure II-14: Guam annual estimated number of troll trips: total, non-charter (nc) and charter (c), 2001. Source: WPRFMC, 2002.c



D. Pelagic Fisheries in the Commonwealth of the Northern Mariana Islands

The CNMI-based pelagic fleet is composed primarily of vessels less than 24 feet in length that are used for trolling and that tend to range no more than about 20 miles from shore (WPRFMC 2002a). The charter component of the fleet includes larger vessels. Most of the fleet is based on Saipan, with smaller numbers of boats on Rota and Tinian. No longlining or purse seining currently occurs in the EEZ around the CNMI. Background information on the pelagic fisheries of the CNMI is presented in the March 2001 FEIS (Section 3.10.6, pages 352 - 362), which is incorporated by reference in this Opinion.

Table II-13 contains a summary of the recent status of the CNMI-based troll fisheries managed under the Pelagics FMP. These estimates of landings, fishing effort, and revenues are derived from records of fish sales only on the island of Saipan, and not all fish sales on Saipan are recorded. It was estimated in WPRFMC (2002c:4-1) that "the commercial purchase database landings include more than 90% of all commercial landings on Saipan."

Table II-13: **Summary Information on the Pelagic Fisheries of the Commonwealth of the Northern Mariana Islands, 2001.** Source: NMFS unpublished data.

	Troll/Charter
Area Fished	Inshore and EEZ
Total Landings	143,000 lb
Landings Composition (by weight)	75 % skipjack tuna 8 % mahimahi 8 % yellowfin tuna
Season	All year
Active Vessels	111
Total Permits	NA
Total Trips	2,200
Total Ex-vessel Value	$286,000

Note: These estimates are only for commercial activity that resulted in fish sales on Saipan.

The estimates of CNMI-based fishing activity that are provided in Table II-12 and throughout this section have not been adjusted to account for the unreported components of the fisheries, so unless otherwise noted, the estimates provided here under-represent total pelagic fishing activity in the CNMI.[7]

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[7] A review of CNMI fisheries production from 1983 through 1993 estimated that the non-commercial portion of the catch (for all fisheries combined) was about 1.5 times greater than the commercial portion (DFW 1994). An analysis of Saipan's seafood markets yielded an estimate of pelagic fish sales for 1995 that was more than twice as great as the estimate derived from the fish sales records (Radtke and Davis 1995).

Figure II-15 shows the numbers of boats that were active in Saipan's commercial pelagic fisheries from 1984 through 2001. Each year's estimate is the number of individuals that were recorded as having sold any pelagic species during the year. WPRFMC (2002c) reported that in 2001, 63 vessels were used for full-time commercial fishing, 58 were classified as part-time commercial fishing vessels, and 142 were identified as subsistence/recreational vessels. Twenty-seven vessels were registered as charter vessels, which typically sell a portion of their catch (WPRFMC 2002c).

Figure II-15: Participation in Saipan's Commercial Pelagic Fisheries, 1984-2001 . Source: WPRFMC 2002c.

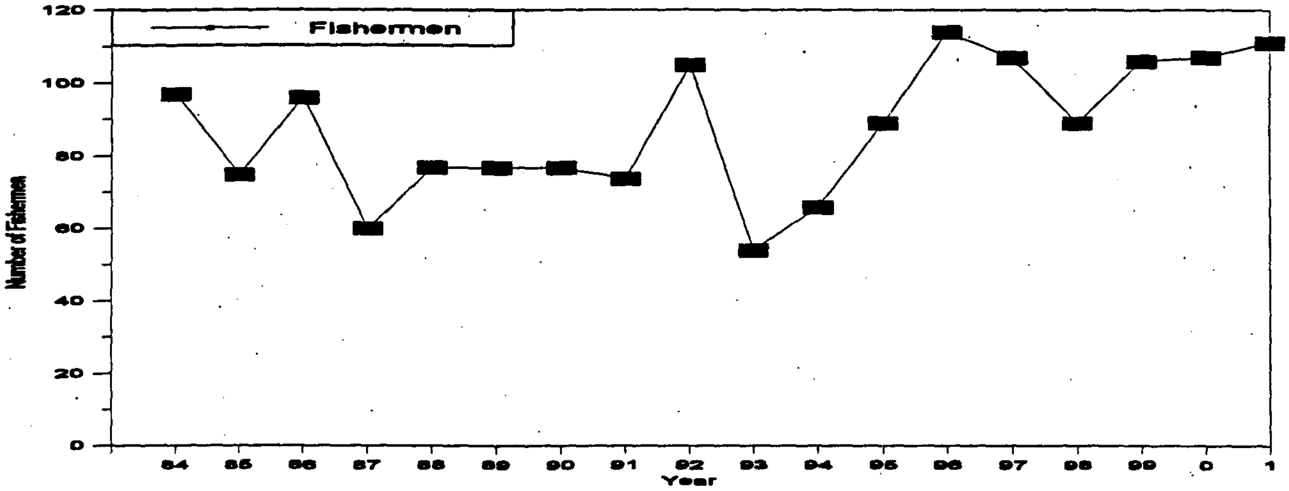
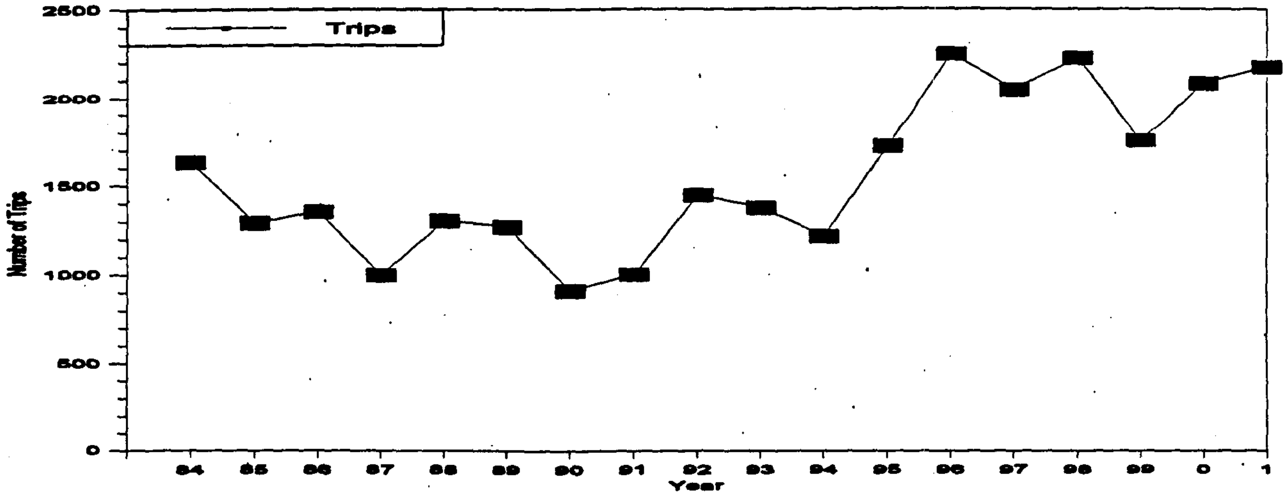


Figure II-16 shows the annual level of trolling effort in the Saipan-based commercial fishery, expressed in terms of the number of commercial fishing trips per year. It can be seen that annual fishing effort from 1995 through 2001 was greater than in any of the preceding 11 years.

Figure II-16 Fishing Effort in Saipan's Commercial Pelagic Fisheries, 1984-2001. Source: WPRFMC 2002c.

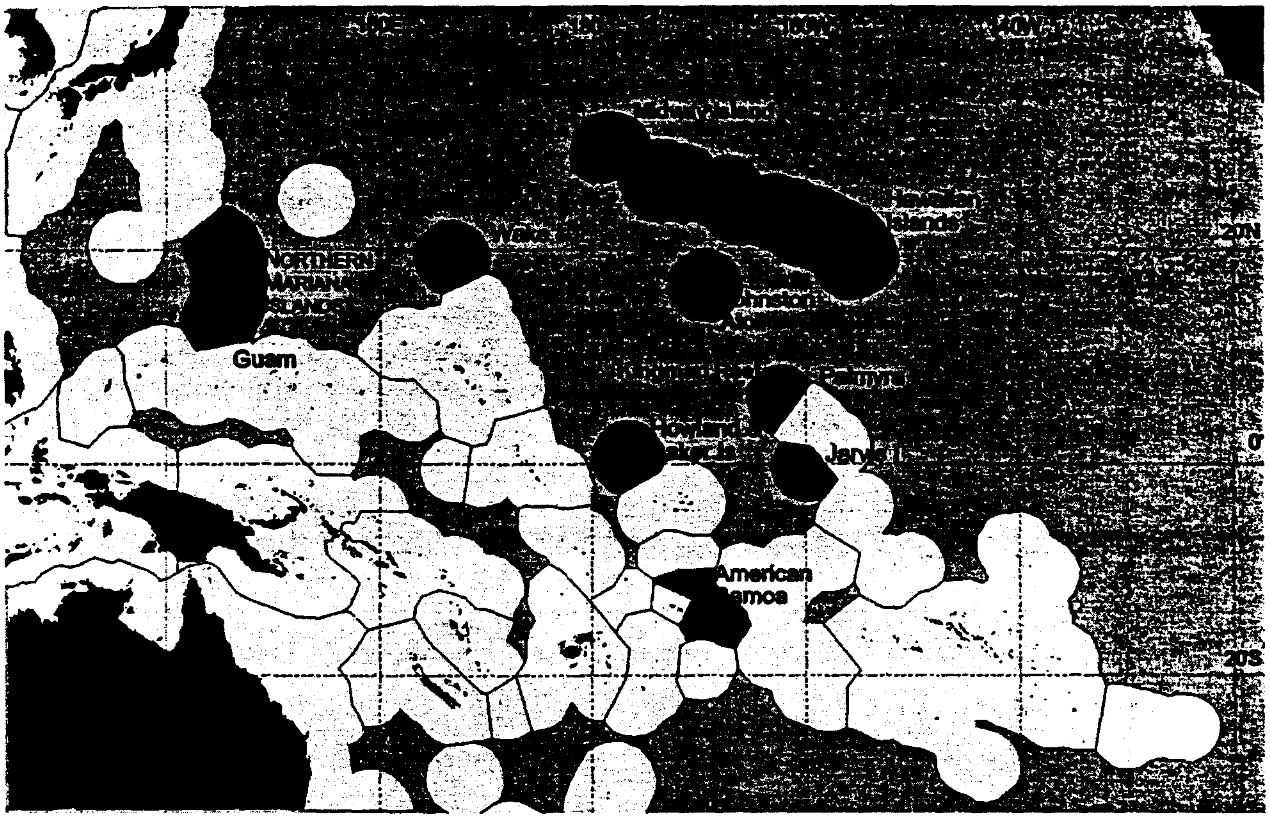


Note: Each year's estimated number of fishing trips was calculated as the number of recorded fish sale transactions that included pelagic species.

E. Description of the Action Area

The action area is all the areas that will be affected directly or indirectly by the Western Pacific Pelagics Fisheries. These fisheries occur throughout the central, western, and northern Pacific Ocean, including inside the EEZ around U.S. islands in the Pacific. These are the islands of American Samoa (Tutuila, Rose Atoll, Swain's Island, and Manua group islands); Commonwealth of the Northern Mariana Islands (Saipan, Rota, Tinian, Farallon de Medinilla, Anatahan, Sarigan, Guguan, Alamagan, Pagan, Agrihan, Asuncion, Farallon de Pajaros); Hawaii (main and Northwestern Hawaiian Islands), Guam, and the largely uninhabited U.S. Pacific remote island areas comprised of Johnston Atoll, Kingman Reef, and Palmyra, Jarvis, Howland, Baker, Midway, and Wake Islands (see Figure II-17). Thus the action area, for purposes of this opinion, is the EEZs around the U.S. Pacific islands and the high sea waters where U.S. fishing vessels that target Pacific pelagic management unit species using longline, troll, and handline gear are managed under the Pelagics FMP.

Figure II-17. Exclusive Economic Zones (EEZs) of the Pacific Islands. Western Pacific Regional Fishery Management Council managed areas are shaded. Source: NMFS, Pacific Islands Area Office.



1. Pelagic Fisheries in Hawaii

a. Hawaii Longline Fishery

The Hawaii longline fishery operates inside and outside the EEZ around the main Hawaiian Islands and Northwestern Hawaiian Islands (NWHI). 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 (see Figure II-18). 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 (see Figure II-19). In addition, during April and May of each year, the area bounded by the equator to 15° N and from 145°W to 180°W is closed to longline fishing by vessels with a Hawaii longline limited entry permit.

Figure II-18. Protected species zone around the Northwestern Hawaiian Islands closed to longline fishing.

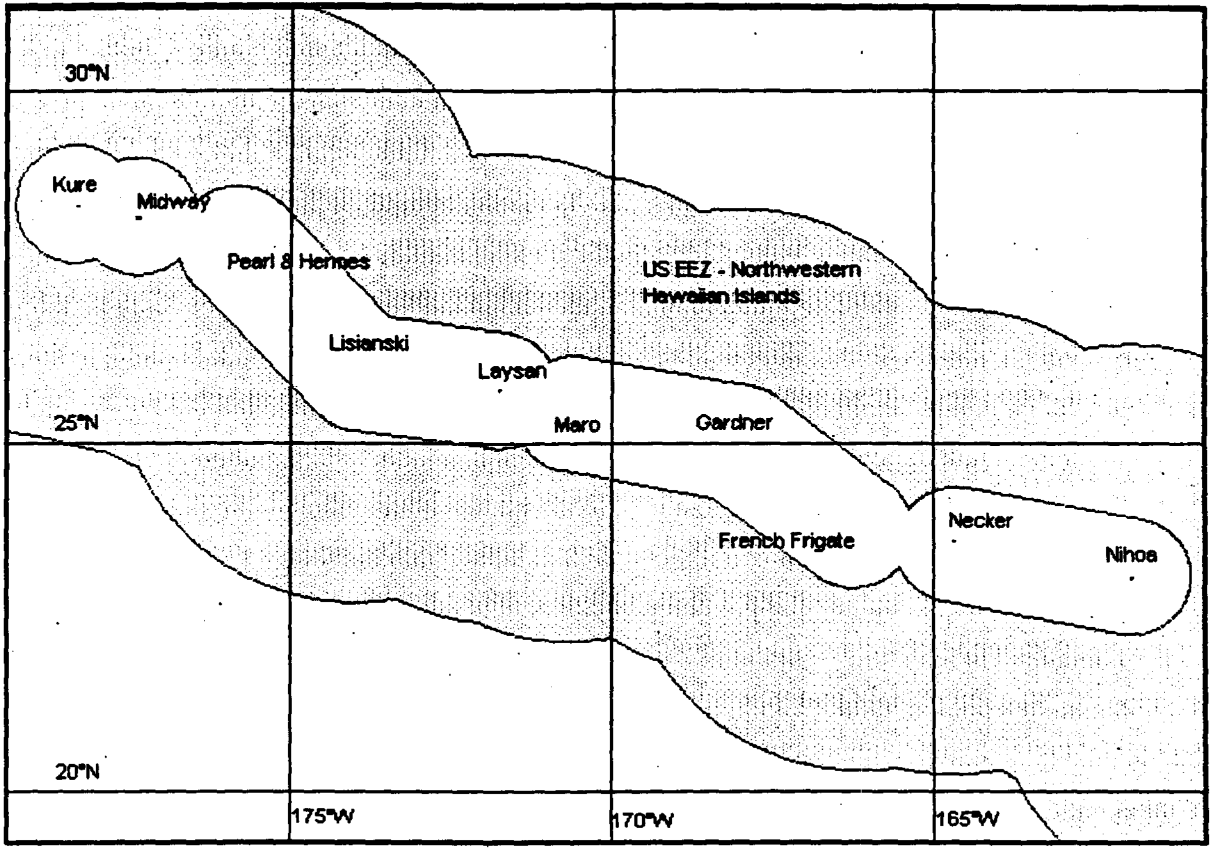
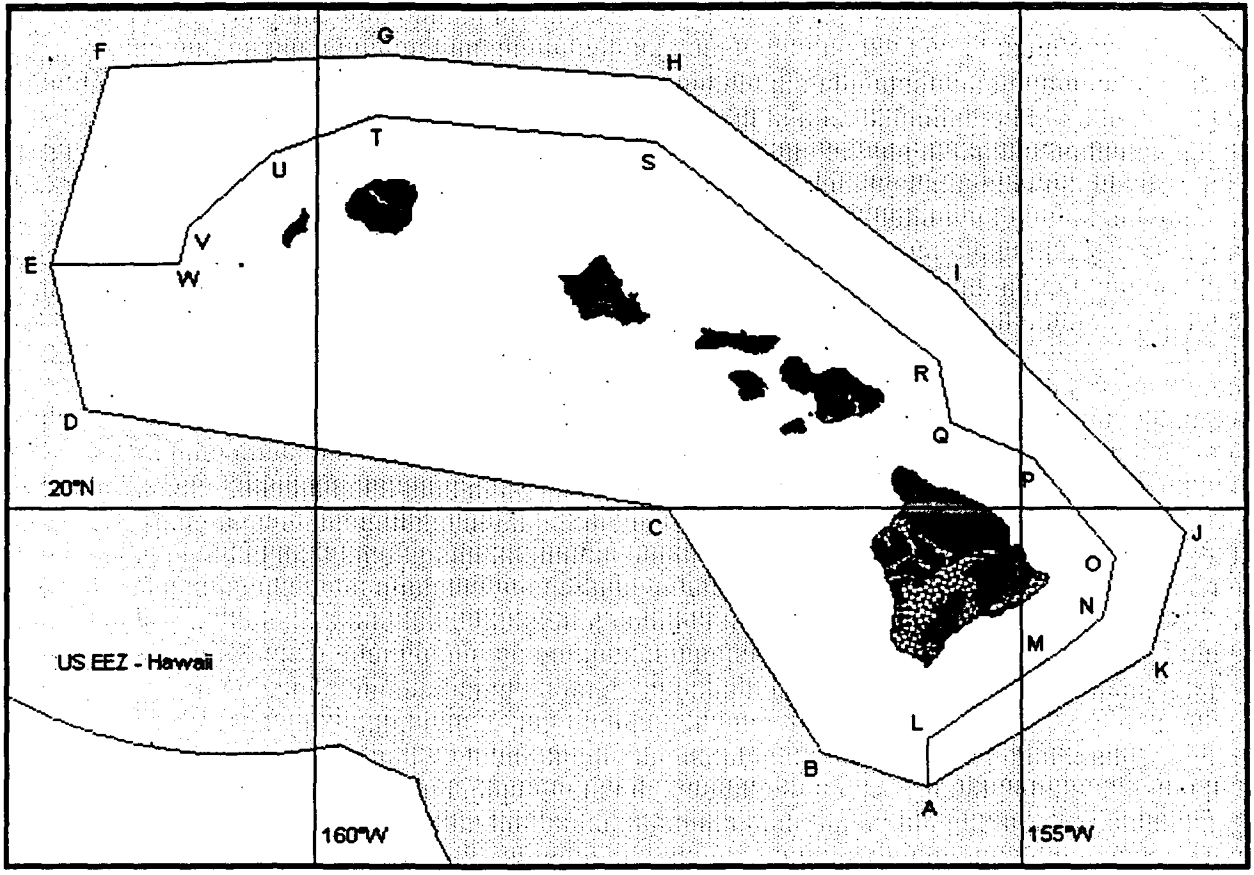
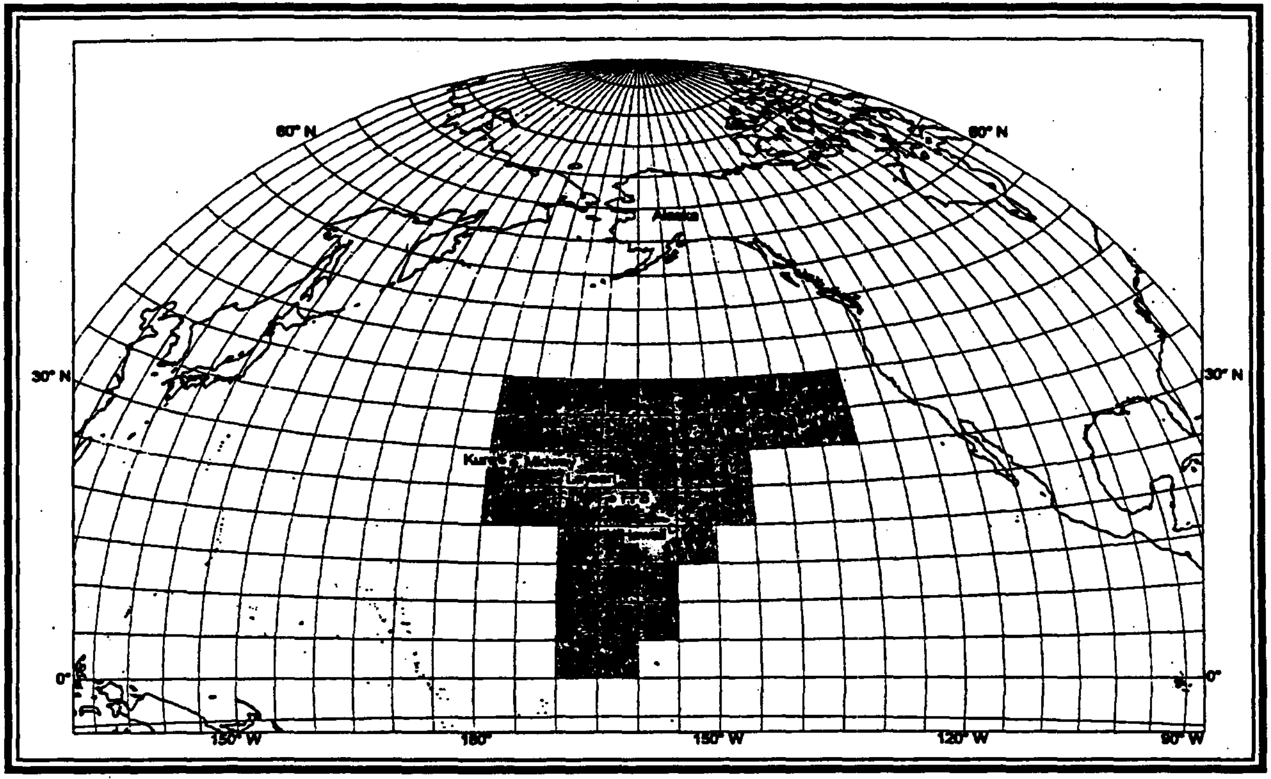


Figure II-19. Closed areas to longline fishing around the main Hawaiian Islands. Distance from shore varies from 25 to 75 nautical miles. Vessels are required to fish further away from shore on the windward side (Northwest) of the islands from February 1 through September 30 each year.



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. Figure II-19 shows the maximum historical boundaries of the Hawaii-based longline fishery using 5 ° increments.

Figure II-20. Historical maximum boundaries of the Hawaii-based longline fishery. Source: NMFS unpublished data.



b. Hawaii-based Troll Fishery

The Hawaii troll fishery, composed of commercial, troll, charter, and recreational/subsistence sectors, generally operates within the EEZ around the main Hawaiian Islands, between 4.9 miles to 53.5 miles offshore. Most of the trips occur within 25 miles from shore (NMFS, 2000). The charter trolling fleet typically operates about 7.5 miles from shore.

c. Hawaii-based Handline Fishery

The offshore handline fisheries occur between 35 to 200 nautical miles from shore, whereas the inshore handline fisheries occur between 5 and 14 miles from shore.

d. Hawaii-based Pole-and-line Fishery

The pole-and-line fishery operates within 25 miles offshore in the EEZ around the main Hawaiian Islands.

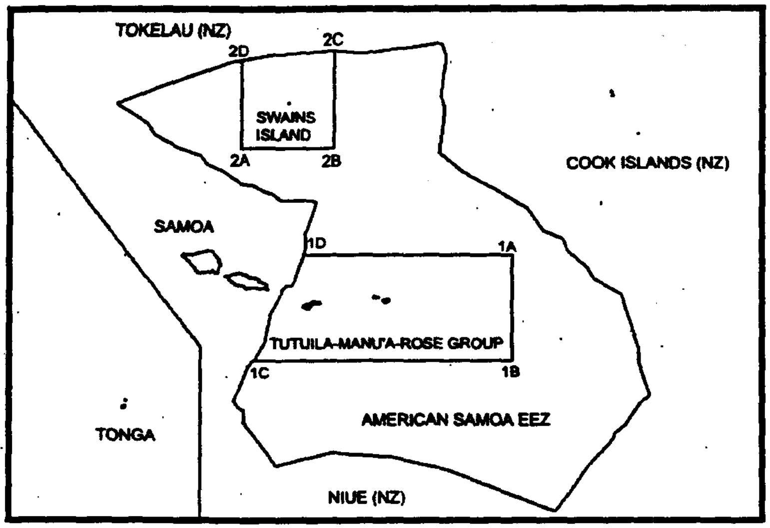
e. Troll/Handline fishery in the U.S. Pacific remote island areas (PRIA)

At present, there is no pelagic troll/handline fishery in the EEZ around the PRIA. It is expected that an active fishery would occur within 25 miles from shore.

2. Pelagic Fisheries in American Samoa

Most of the pelagic hook-and-line fishery based in American Samoa occurs within the EEZ, although vessels greater than 50 feet in length targeting PMUS are prohibited from fishing within approximately 50 nautical miles of the islands of American Samoa, including Tutuila, Manua group and Swains Islands, and Rose Atoll (see Figure II-21). The local, small (<40 ft in length) alia longline fleet and charter trolling vessels typically operate within 50 nm from the islands,

Figure II-21. Areas around American Samoa closed to vessels greater than 50 feet in length.



Coordinates of points:

1A = 13° 30' South, 167° 25' West
1B = 15° 13' South, 167° 25' West
1C = 15° 13' South, approximately 171° 39' West
1D = 13° 30' South, approximately 170° 50' West

2A = 11° 48' South, 171° 50' West
2B = 11° 48' South, 170° 20' West
2C = approximately 10° 13' 11" South, 170° 20' West
2D = approximately 10° 23' 30" South, 171° 50' West

a. American Samoa Longline Fishery

The American Samoa-based pelagic longline fleet, which until recently was comprised exclusively of *alia* less than 30 feet in length, generally fished within 25 nautical miles from shore. The recent entry of numerous large (>50 ft) longline vessels, most of which can range throughout the EEZ, has resulted in not only a dramatic increase in longline fishing effort but also a shift of fishing effort in waters between 50 and 200 nm from shore.

b. American Samoa Troll Fishery

The majority of the American Samoa troll fleet, which is composed of relatively small boats, fishes within 50 nautical miles from shore, although some vessels may fish as far out as 100 nautical miles.

3. Pelagic Fisheries in Guam

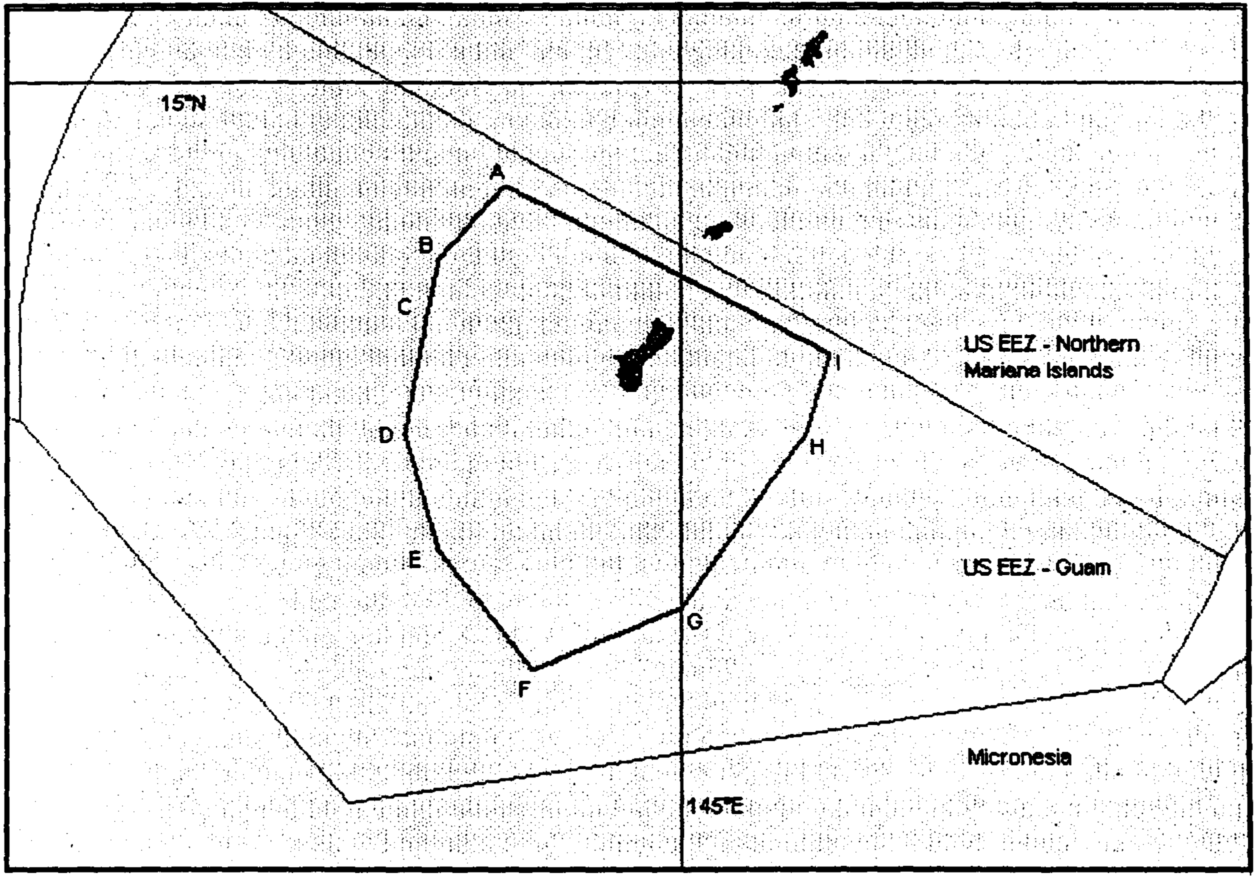
a. Guam-based troll (recreational, commercial, and charter) Fishery

The troll vessels in Guam are small, primarily recreational trolling boats that are either trailered to launch sites or berthed in marinas. The vessels generally fish inshore (within 25 nautical miles of shore) because of their small size. The larger vessels may fish further out within the EEZ.

b. Guam-based Longline Fishery

Figure II-22 depicts the 50-nm area around Guam that is closed to longline fishing. Vessels registered with longline general permits fish outside this closed area. There is no domestic longline fishery off Guam at this time.

Figure II-22. Closed area to longline fishing around the island of Guam.



4. Pelagic Fisheries of Commonwealth of Northern Mariana Islands

a. Commonwealth of Northern Mariana Islands Troll Fishery

The troll fishery occurs primarily between the island of Farallon de Medinilla and the island of Rota to the south. Most of the pelagic troll vessels are based on Saipan. They are small (generally <24 feet) and operate primarily within 20 nautical miles from shore. Larger vessels may fish further offshore within the EEZ. There is no domestic longline fishery in the Commonwealth of the Northern Mariana Islands at this time.

5. Western Pacific Tuna Purse Seine Fishery

The U.S. tuna purse seine fishery is managed under the Treaty on Fisheries Between the Governments of Certain Pacific Island States and the Government of the United States of America (the South Pacific Tuna Treaty). Although the fishery occurs in the action area and subject to management under the Magnuson-Stevens Fishery Conservation and Management Act, for the most part this fishery is not regulated under the Pelagics FMP. [Note: Pelagics FMP regulations prohibit domestic purse seine vessels from fishing within the 50-nm area closure around American Samoa]

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III. STATUS OF AFFECTED SPECIES AND ENVIRONMENTAL BASELINE

The ESA defines a "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. NMFS and United States Fish and Wildlife Service published a joint policy regarding the definition of distinct population segments (61 FR 4722). To be considered a distinct population segment, a population must satisfy two criteria: (1) It must be reproductively isolated from other population units of the same species, and (2) it must represent an important component in the evolutionary legacy of the biological species. The first criterion, reproductive isolation, need not be absolute, but must have been strong enough to permit evolutionarily important differences to occur in different population units. The second criterion is met if the population contributes substantially to the ecological/genetic diversity of the species as a whole.

For the species listed below, most have been listed throughout their known range as either threatened or endangered. In a few cases, green turtles for example, sub-populations of a threatened species have been listed as endangered based on their particular status and extant threats. The following endangered and threatened species occur in the action area and may be affected by the continued regulation of domestic fisheries in the Western Pacific Region under the Pelagics FMP:

Marine Mammals	**Status**
Blue whale (*Balaenoptera musculus*)	Endangered
Fin whale (*Balaenoptera physalus*)	Endangered
Hawaiian monk seal (*Monachus schauinslandi*)	Endangered
Humpback whale (*Megaptera novaeangliae*)	Endangered

Northern right whale (*Eubalaena glacialis*)	Endangered
Sei whale (*Balaenoptera borealis*)	Endangered
Sperm whale (*Physeter macrocephalus*)	Endangered

Sea turtles	**Status**
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

Except for the Hawaiian monk seal, critical habitat for all of the above-listed species in the Pacific Ocean has not been designated or proposed within the action area. 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). Some U.S. fisheries regulated under the Pelagics FMP fish in critical habitat areas of the Hawaiian monk seal (i.e., ocean waters out to 20 fathoms depth), although they do not adversely affect physical features identified as critical habitat. In addition, these fisheries do not target or incidentally catch prey species of the Hawaiian monk seals. Therefore, the proposed action is not likely to adversely affect critical habitat of the Hawaiian monk seal.

Although blue whales, fin whales, northern right whales, and sei whales are found within the action area and could potentially interact with the Pelagic Fisheries, there have been no reported or observed incidental takes of these species in these fisheries. Therefore, the proposed action is not likely to adversely affect blue whales, fin whales, northern right whales, or sei whales, and these species will not be considered further in this Opinion.

Based on observed and reported interactions between the Hawaii-based longline fishery and humpback whales, monk seals, sperm whales, and five species of sea turtles, NMFS has determined that the proposed action is likely to adversely affect humpback whales, monk seals, sperm whales, and green, hawksbill, leatherback, loggerhead, and olive ridley turtles. Therefore, formal consultation is required in order to analyze the effects of the action on these listed species.

The following subsections are synopses of the current state of knowledge on the life history, distribution, and population trends of the marine mammals and sea turtle species adversely affected by the action. These subsections focus primarily on the Pacific Ocean populations of these species as these are the populations directly affected by the proposed action. However, NMFS recognizes that many of these species are listed as global populations (for example, leatherback turtles, loggerhead turtles, and the whales) and the global status and trends of these species are included as well to provide a basis for our final determinations of the effects of the proposed action on the species as listed under the ESA. In addition, the Status of the Species and the Environmental Baseline, typically two separate sections in a Biological Opinion, are combined here because the status of the species in the Pacific Basin and the factors affecting them in the action area are similar to those throughout their range in the Pacific Ocean.

A. Status of Marine Mammals

Most large whales are listed as endangered species under the ESA because their populations were depleted by whalers in the nineteenth and twentieth centuries. Currently, ship strikes and incidental take in commercial fishing operations (domestic and international) are most likely the greatest threat to the recovery of large cetaceans. The monk seal is listed as endangered under the ESA because of its population's large decline. Further decline is likely, due to extremely high juvenile mortality and an inverted age structure that will result in reduced reproductive recruitment in the largest subpopulation (French Frigate Shoals). Under the 1994 amendments to the Marine Mammal Protection Act (MMPA), NMFS was required to produce stock assessment reports (SAR) for all marine mammal stocks that occur in U.S. waters. These reports include information on the status and trends of marine mammals and assessments of all human-caused mortality and serious injury of the listed marine mammal stocks. Information on humpback whales, Hawaiian monk seals, and sperm whales was obtained from both final and draft SARs and is presented below, along with other relevant information (sources identified therein).

1. <u>Humpback Whale</u>

a. Listing status

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

b. Species description and distribution

NMFS recognizes four stocks of humpback whales in the North Pacific basin, based on genetic and photo-identification studies: two Eastern North Pacific stocks, one Central North Pacific stock and one Western Pacific stock (Hill and DeMaster 1998).

Humpback whales typically migrate between tropical/sub-tropical and temperate/polar latitudes. Humpback whales feed on krill and small schooling fish on their summer grounds. The whales occupy tropical areas during winter months when they are breeding and calving, and polar areas during the spring, summer, and fall, when they are feeding, primarily on small schooling fish and krill (Caldwell and Caldwell, 1983). It is believed that minimal feeding occurs in wintering grounds, such as the Hawaiian Islands (Balcomb, 1987; Salden, 1987). Humpback whales summer throughout the central and western portions of the Gulf of Alaska, including Prince William Sound, around Kodiak Island (including Shelikof Strait and the Barren Islands), and along the southern coastline of the Alaska Peninsula. The few sightings of humpback whales in offshore waters of the central Gulf of Alaska are usually attributed to animals migrating into coastal waters (Morris et al. 1983), although use of offshore banks for feeding is also suggested.

The continental shelf of the Aleutian Islands and Alaska Peninsula was once considered the center of the North Pacific humpback whale population (Berzin and Rovnin 1966; Nishiwaki 1966). The northern Bering Sea, Bering Strait, and the southern Chukchi Sea along the Chukchi Peninsula appear to form the northern extreme of the humpback whale's range (Nikulin 1946, Berzin and Rovnin 1966).

Humpback whales occur off all eight Hawaiian Islands, but particularly within the shallow waters of the "four-island" region (Kaho'olawe, Molokai, Lanai, Maui), the northwestern coast of the island of Hawaii (Big Island), and the waters around Niihau, Kauai and Oahu (Wolman and Jurasz, 1977; Herman et al., 1980; Baker and Herman, 1981). The whales are generally found in shallow water shoreward of the 182 m (600-ft) depth contour (Herman and Antinoja, 1977), although Frankel et al. (1989) reported some vocalizing individuals up to 20 km (10.8 nm) off South Kohala on the west coast of the Big Island, over bottom depths of 1400 m (4593 ft). Cow and calf pairs appear to prefer very shallow water less than 18 m deep (10 fm [60 ft]) (Glockner and Venus, 1983). At Kuili off the Big Island, Smultea (1989) found significantly more cow/calf pairs in water less than 55 m (180.5 ft) deep. Cows with calves may select shallow nearshore water, at least partially to minimize encounters with courting adults. Some results suggest that habitat use patterns of nearshore waters by females and calves near Maui may have changed (decreased), potentially due to increasing vessel and other human activities (Salden, 1988; Glockner-Ferrari and Ferrari, 1990).

In the Atlantic Ocean, humpback whales feed in the northwestern Atlantic during the summer months and migrate to calving and mating areas in the Caribbean. Six separate feeding areas are utilized in northern waters after their return; the Gulf of Maine is one of those feeding areas. Humpback whales also use the Mid-Atlantic as a migratory pathway and apparently as a feeding area, at least for juveniles. Since 1989, observations of juvenile humpbacks in that area have been increasing during the winter months, peaking January through March (Swingle et al. 1993). Biologists theorize that non-reproductive animals may be establishing a winter feeding range in the Mid-Atlantic since they are not participating in reproductive behavior in the Caribbean. They feed on a number of species of small schooling fishes, particularly sand lance and Atlantic herring, by targeting fish schools and filtering large amounts of water for the associated prey. Humpback whales have also been observed feeding on krill.

c. Life history information

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

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

Humpback whales exhibit a wide range of foraging behaviors, and feed on a range of prey types including small schooling fishes, euphausiids, and other large zooplankton. Fish prey in the North Pacific include herring, anchovy, capelin, pollock, Atka mackerel, eulachon, sand lance, pollack, Pacific cod, saffron cod, arctic cod, juvenile salmon, and rockfish. In the waters west of the Attu Islands and south of Amchitka Island, Atka mackerel were preferred prey of humpback whales (Nemoto 1957). Invertebrate prey include euphausiids, mysids, amphipods, shrimps, and copepods.

d. Diving and social behavior

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

Clapham (1996) reviewed the social behavior of humpback whales. They form small unstable groups during the breeding season. During the feeding season they form small groups that occasionally aggregate on concentrations of food. Feeding groups are sometimes stable for long periods of times. There is good evidence of some territoriality on feeding grounds (Clapham 1994; 1996), and on wintering ground (Tyack 1981). On the breeding grounds males sing long complex songs directed towards females, other males or both. The breeding season can best be described as a floating lek or male dominance polygyny (Clapham 1996). Intermale competition for proximity to females can be intense as expected by the sex ratio on the breeding grounds which may be as high as 2.4:1.

Humpbacks produce a wide variety of sounds. During the breeding season males sing long, complex songs, with frequencies in the 25-5000 Hz range and intensities as high as 181 dB (Payne, 1970; Winn et al., 1970a; Thompson et al., 1986). Source levels average 155 dB and range from 144 to 174 dB (Thompson et al., 1979). The songs appear to have an effective range of approximately six to 12 mi (10 to 20 km). Animals in mating groups produce a variety of sounds (Tyack, 1981; Tyack and Whitehead, 1983, Silber, 1986). Sounds are produced less frequently on the summer feeding grounds. Feeding groups produce distinctive sounds ranging from 20 Hz to 2 kHz, with median durations of 0.2-0.8 sec and source levels of 175-192 dB (Thompson et al., 1986). These sounds are attractive and appear to rally animals to the feeding activity (D'Vincent et al. 1985; Sharpe and Dill 1997). In summary, humpback whales produce at least three kinds of sounds: (1) complex songs with components ranging from at least 20Hz to 4 kHz with estimated source levels of 144 - 174 dB; these are mostly sung by males on the breeding grounds (Payne, 1970; Winn et al., 1970a; Richardson et al., 1995); (2) social sounds in the breeding areas that extend from 50Hz to more than 10 kHz with most energy below 3kHz (Tyack and Whitehead, 1983, Richardson et al., 1995); (3) feeding area vocalizations that are less frequent, but tend to be 20Hz - 2 kHz with estimated sources levels in excess of 175 dB re 1 uPa-m (Thompson et al., 1986; Richardson et al., 1995). Sounds often associated with possible aggressive behavior by males (Tyack, 1981; Silber, 1986) are quite different from songs, extending from 50 Hz to 10 kHz (or higher), with most energy in components below 3 kHz. These sounds appear to have an effective range of up to 9 km (Tyack and Whitehead, 1983).

e. Population status and trends

An estimated 394 humpback whales constitute the western North Pacific stock (Calambokidis et al. 1997). Waite et al. (1999) identified 127 individual humpback whales in the Kodiak Island region between 1991 and 1994 and estimated there were 651 whales in this region (95% CI:356-1,523). Waite et al. (1999) also estimated that 200 humpback whales regularly feed in Prince William Sound. Subsequently, based on mark-recapture analysis of photo-identification studies, several investigators concluded that the central North Pacific stock consists of at least 4,000 humpback whales (Calambokidis et al., 1997, Ferrero et al., 2000). Other than these estimates of the size of the humpback whale population, the available information is not sufficient to determine population trends. In the BeringSea/Aleutian Islands, the humpback whale population was dramatically reduced by commercial whaling. The humpback whale population is believed to have increased since whaling ceased, although the rate of increase is unknown.

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

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

Cerchio (1998) estimated that about 4,000 animals visit Hawaii annually. Aerial surveys conducted between 1976 and 1990 found a significant increase in sighting rates of humpbacks over that time (Mobley et al., 1999a), consistent with the increase in photographic estimates. Finally, aerial surveys using line-transect methodologies were conducted in 1993, 1995 and 1998. Hawaii population estimates derived from the sighting data show an increase from 2717 (+/- 608) in 1993, to 3284 (+/- 646) in 1995 and 3852 (+/- 777) in 1998 (Mobley et al., 1999b).

New information has become available on the status and trends of the humpback whale population in the North Atlantic. Although current and maximum net productivity rates are unknown at this time, the population is apparently increasing. It has not yet been determined whether this increase is uniform across all six feeding stocks (Waring et al. in prep.). The rate of increase has been estimated at 9.0 percent (CV=0.25) by Katona and Beard (1990), while a 6.5 percent rate was reported for the Gulf of Maine by Barlow and Clapham (1997) using data through 1991. The rate reported by Barlow and Clapham (1997) may roughly approximate the rate of increase for the portion of the population within the action area. The best estimate of abundance for the North Atlantic humpback whale population is 10,600 animals (CV=0.067; Smith et al. 1999), while the minimum population estimate used for NMFS management purposes is 10,019 animals (CV = 0.067; Waring et al., in prep.). The Northeast Fisheries Science Center is considering recommending that NMFS identify the Gulf of Maine feeding stock as the management stock for this population in U.S. waters. A population estimate for the Gulf of Maine portion of the population is not available.

b. Monk Seal

a. Listing status

The Hawaiian monk seal was listed as endangered under the ESA in 1976[8] (41 FR 33922). The species are endemic to the Hawaiian Archipelago and Johnston Atoll, and is one of the most endangered marine mammals in the United States. The Hawaiian monk seal is also the only endangered marine mammal that exists wholly within the jurisdiction of the United States.

b. Species description and distribution

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

c. Life history information

Females reach breeding age at about 5 to 10 years of age, depending on their condition, and give birth about once every year at most. It is estimated that 40 - 80 percent of adult females give birth in a given year (NMFS unpub. data, 2001). After birth, pups take up to 6 weeks to wean. During this time, the mother suckles the pup, rarely leaving it to feed. After weaning, the mother leaves and the pup must forage independently. Newly weaned pups are somewhat more

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[8] In 1976, the Hawaiian monk seal was also designated as a depleted species under the Marine Mammal Protection Act of 1972, and its population status is considered to be below the optimum sustainable population. The Hawaiian monk seal Recovery Team was formed pursuant to the ESA to develop a Hawaiian Monk Seal Recovery Plan. Supported by NMFS, the HMSRT provides a forum in which information regarding species recovery and recovery plan implementation are discussed and recommendations for action are forwarded to NMFS.

gregarious than adults. Pups tend to stay in the reef shallows, entering into more diverse and deeper waters to forage as they age. Male aggression is somewhat common, as males compete for females for breeding purposes. Male aggression has resulted in a number of injuries and deaths to females, juveniles, and pups.

Monk seals feed on a wide variety of teleosts, cephalopods and crustaceans, indicating that they are highly opportunistic feeders (Rice, 1964; MacDonald, 1982; Goodman-Lowe, 1999). Research to identify prey species is currently underway using several methods: collection of potential prey items and blubber samples for fatty acid analysis; Crittercam[9] recording of foraging behavior; correlation of dive depth/location profiles with potential prey species habitat; and analysis of monk seal scat and spew samples for identifiable hard parts of prey. Recent information suggests monk seals may forage in beds of precious corals, which are habitat for known monk seal prey items such as eels (Parrish et al., in press).

d. Diving and foraging behavior

The foraging and dive patterns of monk seals and the availability of prey items to monk seals are important to understand for gear interactions. Various studies have been undertaken to determine the habitat use patterns of monk seals (Schlexer, 1982; DeLong et al., 1984; Abernathy and Siniff, 1998; Stewart, 1998; Parrish et al., 2000). These studies used various technologies, including radio tags, dive depth recorders, Crittercams, and satellite telemetry, to study the foraging behavior of monk seals. The results of these studies vary by location.

DeLong et al. (1984) instrumented seven monk seals at Lisianski Island with radio transmitters and multiple depth of diving recorders and recorded movements for an aggregate of 94 days in which 4,817 dives were recorded. Most dives (59 percent) were in the 10-40 m depth range, and the remainder of dives were to deeper depths. Thirteen dives were recorded to depths of at least 121 m. The outer edge of the reef around Lisianski Island is generally delineated by the 40 m isobath. DeLong et al., (1984) concluded that males during breeding season at Lisianski Island depend entirely upon the food resources on the coral reefs, sandy beach flats and deeper reef slopes around that island.

Schlexer (1982) also recorded diving patterns of monk seals at Lisianski Island. In this study, eight monk seals (five adult males, one juvenile male, one subadult female, and one juvenile female), tracked with radio transmitters and multiple depth of diving recorders, were recorded diving within the 0 - 70 m range. One subadult female and one juvenile female dove in the shallow range of 10 - 40 m, with some dives recorded from 150 - 180 m. None of the adult males dove to depths greater than 70 m.

Stewart (1998) investigated diving patterns of 24 monk seals at Pearl and Hermes Reef using satellite-linked radio transmitters to record dive depth and duration. This study concluded that the monk seals at Pearl and Hermes Reef foraged in relatively shallow waters, and that foraging

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[9] A Crittercam is a self contained video camera that has can be mounted on a monk seal to record its foraging behavior.

activity was different for males and females and among age classes. At Pearl and Hermes Reef, juveniles foraged almost exclusively within the fringing reef, adult males foraged mostly on the inside and outer edge of the fringing reef, and adult females foraged mostly within the center of the atoll and near the atoll's southwestern opening (Stewart, 1998). Adult males generally dove within the 8 - 40 m range, with a secondary mode at 100 - 120 m. Male juveniles generally dove within the 8 - 40 m range. Adult females rarely dove deeper than 40 m, although one female made a number of dives to 60 - 140 m.

Abernathy and Siniff (1998) instrumented adult seals at French Frigate Shoals with satellite-linked time depth recorders. Data showed that instrumented adult male monk seals appeared to utilize the banks to the northwest, with a daytime diving range between 50 and 80 m and a nighttime range between 110 and 190 m. The study also suggested that seals that did not leave the vicinity of French Frigate Shoals rarely dove deeper than 80 m during the day, but made more dives closer to 80 m at night. The study also identified a few seals that were extremely deep divers. These seals' daytime dives reached depths greater than 300 m on a ridge to the east of the atoll. The researchers modeled the home range of individuals and concluded that the average home range was 6,467 km^2 (n=28, SE=3,055 km^2). For example, individuals have been documented traveling between French Frigate Shoals and to Gardner Pinnacles, St. Rogatien Bank, Brooks Bank, and Necker Island. (Abernathy and Siniff, 1998). The conclusion of Abernathy and Siniff (1998) is that monk seals forage on benthic and epibenthic species and on other prey items in the fringing reef complex.

Parrish et al (2002) further investigated subphotic foraging by monk seals, instrumenting 5 males with image-intensifying Crittercams, and using submersibles to explore deep water (300m - 500m) areas in which seals studied by Abernathy and Siniff (1998) had dove. While none of the Crittercams instrumented seals dove deep enough to encounter precious corals, submersible dives to locations and depths in which seals had dove in previous studies revealed beds of gold and pink precious corals, suggesting an overlap between the foraging habitat of some seals and precious corals.

Since 1995, the abundance of shallow water (<20 m) reef fish has been surveyed at French Frigate Shoals and Midway. The data are checked as a potential indicator for changes in abundance of monk seal prey. The surveys are conducted annually by NMFS and are designed to detect changes of 50 percent or greater in fish densities (Laurs, 2000). So far, surveys have not indicated any statistically significant changes in prey abundance at either site (DeMartini, et al., 1999; DeMartini, et al., 1996).

e. Population status and trends

Before human habitation of the Hawaiian Archipelago, the monk seal population may have measured in the tens of thousands as opposed to the hundreds of thousands or millions typical of some pinniped species. When population measurements were first taken in the 1950s, the population was already considered to be in a state of decline. In 1998, minimum population estimate (N_{MIN})[10] for monk seals was 1,436 individuals (based on enumeration of individuals of all age classes at each of the subpopulations in the NWHI, derived estimates based on beach counts for Nihoa and Necker, and estimates for the MHI) (Forney et al., 2001). Taking into account the first year survival rates, NMFS Southwest Fisheries Science Center - Honolulu Laboratory estimated the species population size to be between 1300 to 1400 individuals (Laurs, 2000). Monk seals are found at six main reproductive sites in the NWHI: Kure Atoll, Midway Island, Pearl and Hermes Reef, Lisianski Island, Laysan Island and French Frigate Shoals. Smaller populations also occur on Necker Island, and Nihoa Island. NMFS researchers have also observed monk seals at Gardner Pinnacles and Maro Reef. Monk seals are also found in the MHI, where preliminary aerial surveys counted fewer than 50 individuals. Additional sightings and at least one birth have occurred at Johnston Atoll, excluding eleven adult males that were translocated to Johnston Atoll (9 from Laysan Island[11] and 2 from French Frigate Shoals) over the past 30 years.

Various surveys of the six islands and atolls in the NWHI that support the six main monk seal breeding subpopulations indicate that the NWHI non-pup population (juveniles, sub-adults and adults) declined 60 percent between the years 1958 and 1993 (See Figure III-1). Trends in population are measured by beach counts for each of these subpopulations. Population trends vary within the NWHI. For instance, from 1990 to 1998, the subpopulations at Lisianski Island and Laysan Island have been stable, while the subpopulation at Kure Atoll increased at about 5 percent per year from1983 to 1998. The population at Pearl and Hermes Reef experienced the highest increase of 7 percent per year between 1983 and 1998. Researchers have been able to enumerate the main breeding subpopulations, and in 2000 the number of monk seals identified was 129 at Kure Atoll, 71 at Midway Atoll, 239 at Pearl and Hermes Reef, 204 at Lisianski Island, 315 at Laysan Island, and 342 at French Frigate Shoals (Johanos and Baker, 2002; see also Figure III-2). Population decline over the last decade is attributable to low reproductive recruitment and high juvenile mortality at the largest of the subpopulations at French Frigate Shoals. At this site, the count of animals older than pups is now less than half the count in 1989. Poor survival of pups has resulted in a relative paucity of young seals, so that further decline is expected for this subpopulation as adults die and there are few juveniles to replace them. Survival from weaning to age 1 at French Frigate Shoals has declined to as low as 14 percent in 1997 from about 90 percent in the mid-1980s (Figure III-3) (Laurs, 2000).

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[10] Under the Marine Mammal Protection Act of 1972, Potential Biological Removal (PBR) is defined as the product of the minimum population estimate (N_{MIN}), one-half the maximum theoretical net productivity rate (R_{MAX}), and a recovery factor (F_R): $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. Based on an estimate derived by Wade and Angliss in Barlow et al., 1997 for N_{MIN} (1,436 seals), an estimate of R_{MAX} (0.07) and a default recovery factor (0.1) for this stock, thus, PBR = 1,436 x (0.07 x (0.5)) x 0.1), or PBR = 5.026 or 5 seals (Forney, et al., 2000).

[11] Nine adult male monk seals that had been identified as participating in mobbing behavior were translocated to Johnston Atoll by the NMFS in 1984. This was an attempt to reduce the frequency and/or severity of mobbing incidents involving injury or death of female seals, not to equalize the sex ratio at Laysan Island.

Figure III-1. Historical trend in beach counts (non-pups) of Hawaiian monk seals at the six main reproductive subpopulations. (Source: Laurs, 2000)

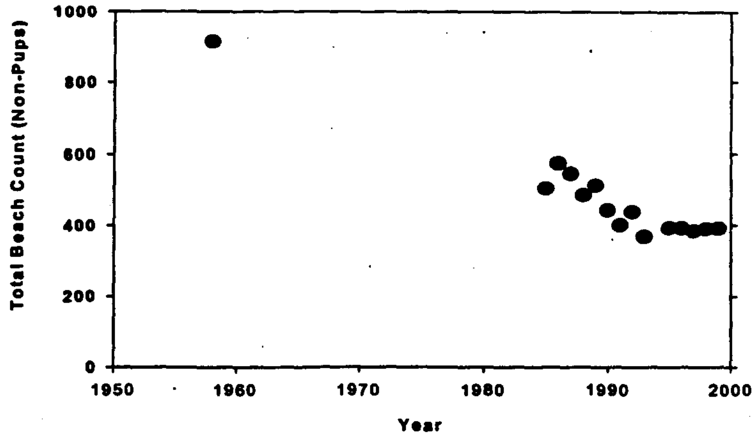


Figure III-2. Recent trends in beach counts (non-pups) of Hawaiian monk seals at each of the six main reproductive subpopulations. (Source: Laurs, 2000)

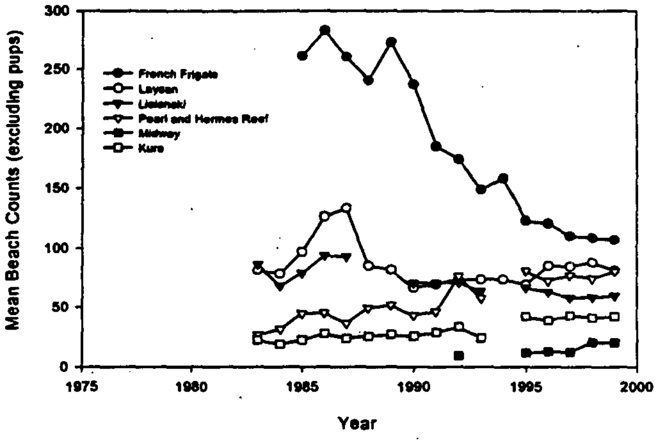


Figure III-3. Survival of Hawaiian monk seals from weaning to age 1 year at the six main reproductive subpopulations. (Source: Laurs, 2000)

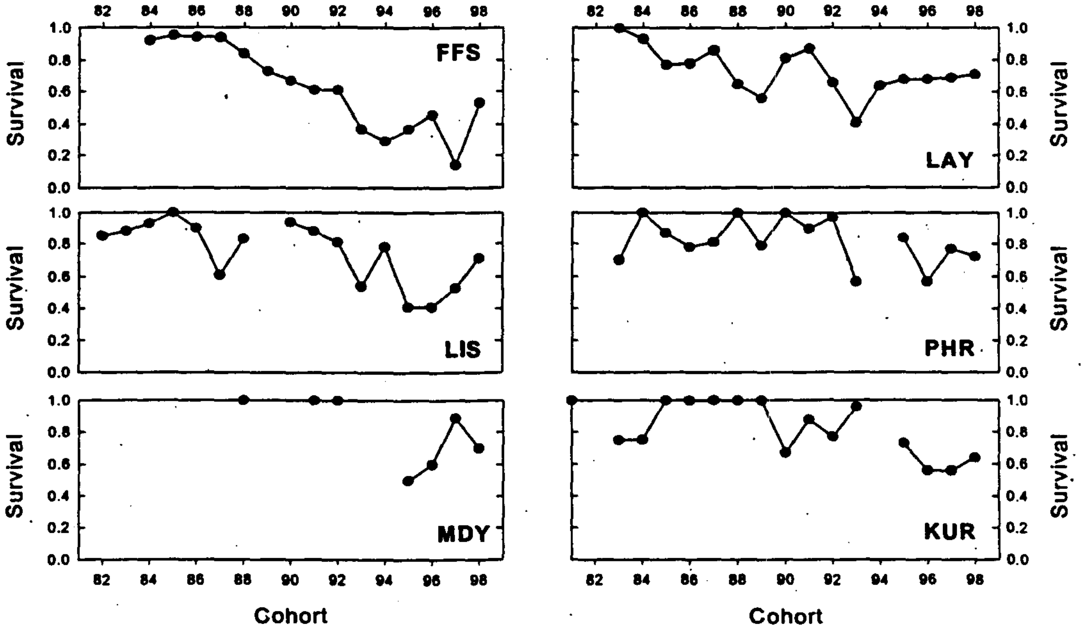
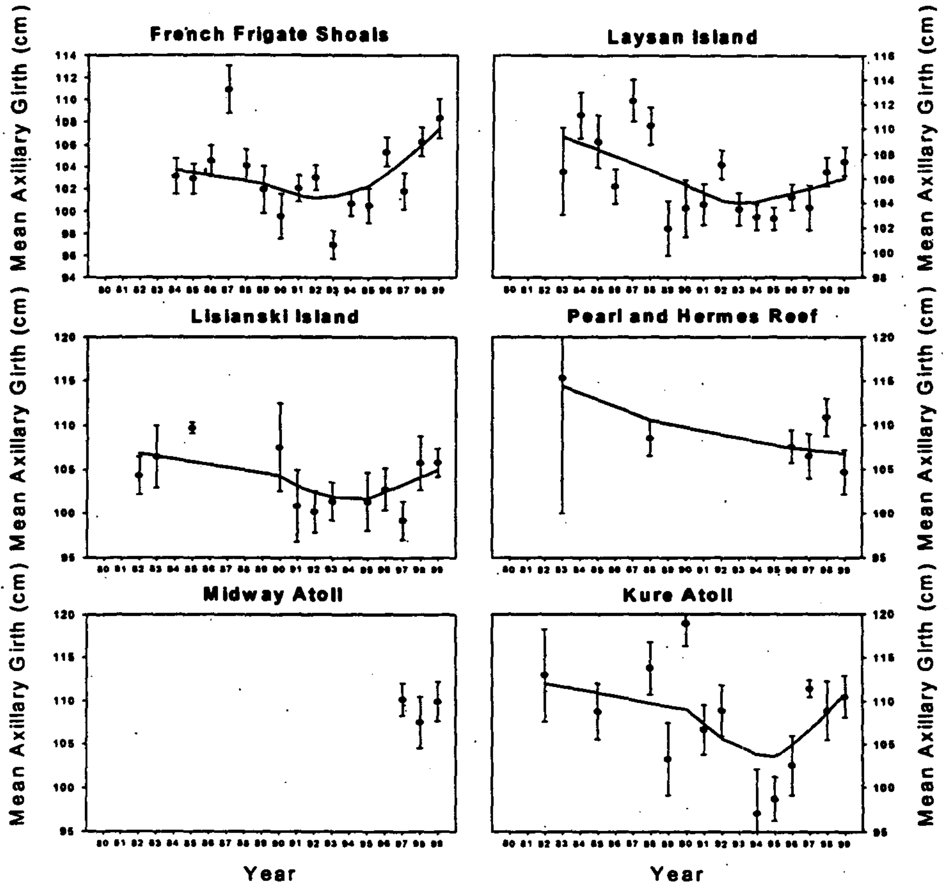


Figure III-4. Trends in Axillary Girth of Hawaiian Monk Seal Pups Measured Within 2 Weeks of Weaning at the Six Main Reproductive Islands. (Source: Laurs, 2000)



3. <u>Sperm Whale</u>

a. Listing status

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

b. Species description and distribution

Sperm whales are distributed in all of the world's oceans. Several authors have recommended three or more stocks of sperm whales in the North Pacific for management purposes (Kasuya 1991, Bannister and Mitchell 1980). However, the IWC's Scientific Committee designated two sperm whale stocks in the North Pacific: a western and eastern stock (Donovan 1991). The line separating these stocks has been debated since their acceptance by the IWC's Scientific Committee. For stock assessment purposes, NMFS recognizes three discrete population "centers" of sperm whales: (1) Alaska, (2) California/Oregon/Washington, and (3) Hawaii. Sperm whales are found throughout the North Pacific and are distributed broadly from tropical and temperate waters to the Bering Sea as far north as Cape Navarin. Mature female and immature sperm whales of both sexes are found in more temperate and tropical waters from the equator to around 45°N throughout the year. These groups of adult females and immature sperm whales are rarely found at latitudes higher than 50°N and 50°S (Reeves and Whitehead 1997). Sexually mature males join these groups throughout the winter. During the summer, mature male sperm whales are thought to move north into the Aleutian Islands, Gulf of Alaska, and the Bering Sea. Sperm whales are rarely found in waters less than 300 m in depth. They are often concentrated around oceanic islands in areas of upwelling, and along the outer continental shelf and mid-ocean waters. Because they inhabit deeper pelagic waters, their distribution does not include the broad continental shelf of the Eastern Bering Sea and these whales generally remain offshore in the eastern Aleutian Islands, Gulf of Alaska, and the Bering Sea.

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

For all stocks, the sperm whale is generally believed to engage in summer migrations, with mature males migrating north to the Gulf of Alaska, Aleutian Islands, and the Bering Sea, or south to the Antarctic. Females, calves and younger males, which usually remain below 40° N latitude in more tropical and temperate waters (Rice, 1989), may be restricted in their migrations by an intolerance to low water temperatures. Mature males return to the warmer waters of the lower latitudes south of 40°E during the winter breeding seasson. Sperm whales may be found singly and in groups as large as fifty or more individuals, with solitary mature breeding males joining groups only during the breeding season (Gosho et al. 1984). During this time, sperm whales in the Pacific Ocean are usually distributed below 40°N Latitude. Historically, sperm whaling grounds in the Pacific were from 20 - 40° N and from 150 - 160° W and were located around the Hawaiian Islands, among other areas (Leatherwood et al., 1988).

Sperm whales have a strong preference for the 3,280-ft (1,000-m) depth contour and seaward. Berzin (1971) reported that they are restricted to waters deeper than 300 m (984 ft), while Watkins (1977) and Reeves and Whitehead (1997) reported that they are usually not found in waters less than 3,281 ft (1,000m) deep. While deep water is their typical habitat, sperm whales have been observed near Long Island, New York, in waters of 41-55 m (135-180 ft) (Scott and Sadove, 1997). When found relatively close to shore, sperm whales are usually associated with sharp increases in bottom depth where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke, 1956). They can dive to depths of at least

2000 m (6562 ft), and may remain submerged for an hour or more (Watkins et al., 1993). Sperm whales feed primarily on buoyant, relatively slow-moving squid (Clark et al., 1993), but may also eat a variety of fish, including salmon (*Oncorhynchus spp.*), rockfish (*Sebastes spp.*), and lingcod (*Ophiodon elongatus*) (Caldwell and Caldwell, 1983).

Sperm whales have been sighted in the Kauai Channel, the Alenuihaha Channel between Maui and the island of Hawaii, and off the island of Hawaii (Lee, 1993; Mobley, et al.1999, Forney et al., 2000). Additionally, the sounds of sperm whales have been recorded throughout the year off Oahu (Thompson and Friedl 1982). Twenty-one sperm whales were sighted during aerial surveys conducted in Hawaiian waters conducted from 1993 through 1998. Sperm whales sighted during the survey tended to be on the outer edge of a 50 - 70 km distance from the Hawaiian Islands, indicating that presence may increase with distance from shore (Mobley, pers. comm. 2000). However, from the results of these surveys, NMFS has calculated a minimum abundance of sperm whales within 46 km of Hawaii to be 43 individuals (Forney et al., 2000). In the past five years, there is only one observed stranding of a sperm whale off Kauai which occurred in 1995 (NMFS, unpublished data).

In the Atlantic Ocean, NMFS' most recent stock assessment report notes that sperm whales are distributed in a distinct seasonal cycle, concentrated east-northeast of Cape Hatteras in winter and shifting northward in spring when whales are found throughout the Mid-Atlantic Bight. Distribution extends further northward to areas north of Georges Bank and the Northeast Channel region in summer and then south of New England in fall, back to the Mid-Atlantic Bight.

In the Mediterranean Sea sperm whales are found from the Alboran Sea to the Levant Basin, mostly over steep slope and deep offshore waters. Sperm whales are rarely sighted in the Sicilian Channel, and are vagrant in the northern Adriatic and Aegean Seas (Notarbartolo di Sciara and Demma, 1997). In the Italian seas sperm whales are more frequently associated with the continental slope off western Liguria, western Sardinia, northern and eastern Sicily, and both coasts of Calabria.

c. *Life history information*

Female sperm whales take about 9 years to become sexually mature (Kasuya 1991, as cited in Perry et al. 1999). Male sperm whales take between 9 and 20 years to become sexually mature, but will require another 10 years to become large enough to successfully compete for breeding rights (Kasuya 1991). Adult females give birth after about 15 months gestation and nurse their calves for 2 –3 years. The calving interval is estimated to be about four to six years (Kasuya 1991). The age distribution of the sperm whale population is unknown, but sperm whales are believed to live at least 60 years (Rice 1978). Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of mortality rate for juveniles and adults are now considered unreliable (IWC 1980, as cited in Perry et al. 1999). Sperm whales are known for their deep foraging dives (in excess of 3 km). They feed primarily on mesopelagic squid, but also consume octopus, other invertebrates, and fish (Tomilin 1967, Tarasevich1968, Berzin 1971). Perez (1990) estimated that their diet in the Bering Sea was 82% cephalopods (mostly squid) and 18% fish. Fish eaten in the North Pacific included salmon, lantern fishes, lancetfish, Pacific cod, pollock, saffron cod, rockfishes, sablefish, Atka mackerel, sculpins, lumpsuckers, lamprey, skates, and rattails (Tomilin 1967, Kawakami 1980, Rice 1986b). Sperm whales taken in the Gulf of Alaska in the 1960s had fed primarily on fish. Daily food consumption rates for sperm whales ranges from 2 - 4% of their total body weight (Lockyer 1976b, Kawakami 1980). Potential sources of natural mortality in sperm whales include killer whales and papilloma virus (Lambertson et al. 1987).

d. Diving and social behavior

Sperm whales are likely the deepest and longest diving mammal. Typical foraging dives last 40 minutes and descend to about 400 meters followed by approximately 8 minutes of resting at the surface (Gordon 1987; Papastavrou et al. 1989). However, dives of over 2 hours and as deep as 3,000 meters have been recorded (Clarke 1976; Watkins et al. 1985). Descent rates recorded from echo-sounders were approximately 1.7 meters/second and nearly vertical (Goold and Jones 1995). There are no data on diurnal differences in dive depths in sperm whales. However, like most diving vertebrates for which there is data (e.g. rorqual whales, fur seals, chinstrap penguins), sperm whales probably make relatively shallow dives at night when deep scattering layer organisms move towards the surface.

The groups of closely related females and their offspring develop dialects specific to the group (Weilgart and Whitehead 1997) and females other than birth mothers will guard young at the surface (Whitehead 1996) and will nurse young calves (Reeves and Whitehead 1997).

Sperm whales produce loud broad-band clicks from about 0.1 to 20 kHz (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995). These have source levels estimated at 171 dB re 1uPa (Levenson 1974). Current evidence suggests that the disproportionately large head of the sperm whale is an adaptation to produce these vocalizations (Norris and Harvey 1972; Cranford 1992; but see Clarke 1979). This suggests that the production of these loud low frequency clicks is extremely important to the survival of individual sperm whales. The function of these vocalizations is relatively well-studied (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995). Long series of monotonous regularly spaced clicks are associated with feeding and are thought to be produced for echolocation. Distinctive, short, patterned series of clicks, called codas, are associated with social behavior and intragroup interactions. They are thought to be for intra-specific communication, perhaps to maintain social cohesion with the group (Weilgart and Whitehead 1993).

The only data on the hearing range of sperm whales are evoked potentials from a stranded neonate (Carder and Ridgway 1990). These data suggest that neonatal sperm whales respond to sounds from 2.5-60 kHz. Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins and Schevill 1975; Watkins et al. 1985). They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995). Sperm whales have moved out of areas after the start of air gun seismic testing (Davis et al. 1995). Seismic air guns produce loud, broadband, impulsive noise (source levels are on the order of 250 dB) with "shots" every 15 seconds, 240 shots per hour, 24 hours per day during active tests.

e. Population status and trends

Current estimates for population abundance, status, and trends for the Alaska stock of sperm whales are not available (Hill and DeMaster 1999). Approximately 258,000 sperm whales in the North Pacific were harvested by commercial whalers between 1947 and 1987 (Hill and DeMaster 1999). In particular, the Bering Sea population of sperm whales (consisting mostly of males) was severely depleted (Perry et al. 1999). Catches in the North Pacific continued to climb until 1968, when 16,357 sperm whales were harvested. Catches declined after 1968 through limits imposed by the IWC.

The best abundance estimate that is currently available for the western North Atlantic sperm whale population is 2,698 (CV=0.67) animals, and the minimum population estimate used for NMFS management purposes is 1,617 (CV=0.67) (Waring et al. in prep.). Due to insufficient data, no information is available on population trends at this time for the western North Atlantic sperm whale stock. No information is available either on Mediterranean sperm whale population size or on the population relationship between sperm whales in the Mediterranean and the North Atlantic. However, the frequent observation of neonates in the Mediterranean and the scarcity of sightings from the Gibraltar area (Bayed and Beaubrun, 1987) points to the possibility that sperm whales in the Mediterranean, like fin whales, may form a resident, reproductively isolated population.

- **Status of Listed Sea Turtles**

For the purposes of this consultation, this Opinion focuses on the effects of the Pelagics FMP fisheries on sea turtle populations in the Pacific Ocean as distinct from their, as listed, global distribution. This approach is allowable based on interagency policy on the recognition of distinct vertebrate populations (Federal Register 61: 4722-4725). To address specific criteria outlined in that policy, sea turtle populations in the Pacific Ocean are geographically discrete from their populations in the Atlantic Ocean and Indian Ocean, for example, with limited genetic exchange (see NMFS and USFWS 1998a). The loss of sea turtle populations in the Pacific Ocean would result in a significant gap in the distribution of each turtle species, which makes these populations biologically significant. Finally, the loss of these sea turtle populations in the Pacific Ocean would dramatically reduce the distribution and abundance of these species and would, by itself, appreciably reduce the entire species' likelihood of surviving and recovering in the wild. However, despite primarily focusing on the Pacific Ocean populations, NMFS must make its final determination of the effect of the Pelagics FMP fisheries on the species as they are listed, or their global populations. To that end, the following discussions include information on the global status and trends of the sea turtles as well as more detailed information on the Pacific Ocean populations. In addition, green turtles and 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. 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 result, our analyses group the endangered populations and the threatened populations and treat them both as endangered to make certain that we afford the endangered turtles the additional protection warranted by their classification.

Populations persist as individuals survive from eggs to adults that successfully reproduce. Populations increase as birth rates consistently exceed death rates; death rates that consistently exceed birth rates cause decreases in population abundance and may result in the population's eventual extirpation (Mangel and Tier, 1994). As summarized in the *Global Status* and *Factors Affecting Sea Turtles in the Pacific Ocean* sections below, natural and anthropogenic (human-caused) activities affect the abundance and survival rates of each life stage. Turtles that survive to transition to the next life stage must survive the rigors of that stage and subsequent stages before they can reach sexual maturity and breed. In general, most anthropogenic activities have negatively affected each life stage, resulting in the observed declines in abundance of most sea turtle populations.

All populations of sea turtles adversely affected by the Pelagics FMP fisheries are in decline, except for some olive ridley subpopulations, which appear to be increasing, and the Hawaiian green turtle population which is increasing. Impacts to sea turtles throughout the world are primarily due to the composite effect of human activities which include: the legal harvest and illegal poaching of adults, immatures, and eggs; incidental capture in fisheries (coastal and high-seas); and loss and degradation of nesting and foraging habitat as a result of coastal development, including predation by domestic dogs and pigs foraging on nesting beaches (associated with human settlement). Increased environmental contaminants (e.g. sewage, industrial discharge) and marine debris, which adversely impact nearshore ecosystems that turtles depend on for food and shelter, including sea grass and coral reef communities, also contribute to the overall decline. While it is generally accepted by turtle biologists and others that these factors are the primary cause of turtle population declines, in many cases there is a paucity of quantitative data on the magnitude of human-caused mortality.

Green turtles, hawksbills, loggerheads, leatherbacks and olive ridleys are highly migratory or have a highly migratory phase in their life history, which makes them susceptible to being incidentally caught by fisheries operating throughout the Pacific Ocean. The Hawaii-based longline fishery under the Pelagics FMP is known to interact with all of these species, except hawksbills. In addition to anthropogenic factors, natural threats to the nesting beaches and pelagic-phase turtles such as coastal erosion, seasonal storms, predators, temperature variations, and phenomena such as El Niño also affect the survival and recovery of sea turtle populations. More information on the status of these species along with an assessment of overall impacts are found in this section as well as the Pacific Sea Turtle Recovery Plans (NMFS and USFWS, 1998a-e) and are reviewed extensively in Eckert (1993).

1. Green Turtles

a. Global status

Green turtles are listed as threatened under the ESA, except for breeding populations found in Florida and the Pacific coast of Mexico, which are listed as endangered. The International Union for Conservation of Nature and Natural Resources (IUCN) has classified the green turtle as "endangered"[13] due to an "observed, estimated, inferred or suspected reduction of at least 50% over the last 10 years or three generations, whichever is longer," based on: (a) direct observation; (b) an index of abundance appropriate for the species; and (c) actual or potential levels of exploitation. Using a conservative approach, Seminoff (2002) estimates that the global green turtle population has declined by 34% to 58% over the last three generations (approximately 150 years) although actual declines may be closer to 70% to 80%. Causes for this decline include harvest of eggs, subadults and adults, incidental capture by fisheries, loss of habitat, and disease.

b. Taxonomy

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

c. Physical Description

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

d. Distribution

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

Smaller nesting aggregations include: Angola, Bangladesh, Bikar Atoll, Brazil, Chagos Archipelago, China, Costa Rica, Cuba, Cyprus, Democratic Republic of Yemen, Dominican

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

Republic, d'Entrecasteaux Reef, French Guiana, Ghana, Guyana, India, Iran, Japan, Kenya, Madagascar, Maldives Islands, Mayotte Archipelago, Mexico, Micronesia, Pakistan, Palmerston Atoll, Papua New Guinea, Primieras Islands, Sao Tome é Principe, Sierra Leone, Solomon Islands, Somalia, Sri Lanka, Taiwan, Tanzania, Thailand, Turkey, Scilly Atoll, United States (Hawaii), Venezuela, and Vietnam (Seminoff, 2002).

e. Life Cycle and Population Dynamics

Figure III-8 illustrates the basic life cycle of green turtles (based on Chaloupka, 2002). This cycle is broken into six life stages: (1) egg/neonate; (2) pelagic juvenile; (3) benthic juvenile; (4) sub-adult; (5) maturing adult; and (6) adult, each with their own expected survival rate (Table III-7). Arrows along the bottom represent the probability of each ageclass surviving and remaining in the ageclass. Arrows between each ageclass represent the probability of the ageclass surviving and growing to the next ageclass, and the arrows along the top represent the ageclass-specific fertility. The thickness or length of the lines do not indicate a level of probability or fecundity. Available information on the behavior, physiology, and biological requirements of these stages is summarized below.

Figure III-8. Life-cycle graph of the green turtle

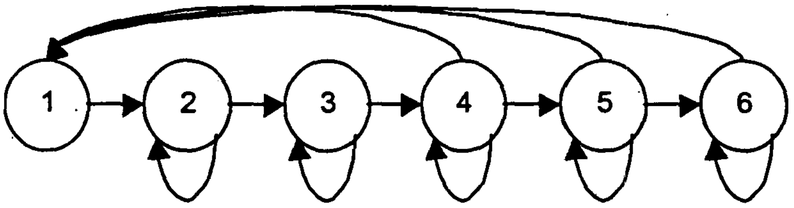

Table III-7: Stage specific demographic information for the southern Great Barrier Reef green turtle (Chaloupka 2002)

Life Stage	Name	Mean Stage Duration (# years)	Stable Stage Structure	Survival Probability (lx)	Fecundity (eggs/female)
1	Egg-neonate	1	38.0%	0.4394	0
2	Pelagic Juvenile	4	38.8%	0.6445	0

3	Benthic Juvenile	11	18.1%	0.8804	0
4	Subadult	19	4.4%	0.8474	.2488
5	Maturing Adult	5	0.1%	0.9482	40.59
6	Adult	19	0.45%	0.9482	68.84

Numerical analyses of the survival rates, transition rates, and fecundities in Table III-7 indicated that the southern Great Barrier Reef green turtle population has a finite population growth rate (λ) of approximately 1, which suggests a population that is stationary – neither increasing nor declining. This nesting aggregation has not been seriously exposed to incidental capture in fisheries or direct harvest and has shown no evidence of a population decline (Chaloupka, 2002) and therefore may be viewed as a surrogate example of green turtle population dynamics in the absence of anthropogenic activities. The stable stage structure for this nesting aggregation of green turtles is typical of long-lived species with delayed maturity – a life history with large numbers of early stage individuals (as a result of high fecundity in the adult life stages) of which relatively few survive through the rigors of natural mortality from predation, environmental variation, and individual fitness to older reproductive stages (Crouse, 1999). The earliest life stages (Stages 1 and 2) have the highest proportion of individuals but the lowest survival probabilities. Because of the high natural variability in the survival rates of the earliest life stages, the population is less susceptible to additional fluctuations in the survival rate of these life stages due to perturbations like catastrophes or anthropogenic activities. In contrast, the adult life stages, which make up a very small proportion of the overall population, have very high survival rates. Therefore, despite the low abundance of these life stages, mature individuals have more chances to reproduce and replace themselves. Consequently, changes in the survival rates of the adult life stages would have immediate and significant effect on the growth and persistence of this population.

A review of the elasticity, or proportional effect of a change in the vital rates of a stage on λ, of this stage structure confirms the general relationships in this life cycle. Table III-8 includes the elasticities of the vital rates of each life stage in the green turtle life cycle.

Table III-8. Stage elasticities (Chaloupka, 2002)

Life Stage	Survival Rate	Transition Rate	Fecundity
1	0	0.0277	0
2	0.0367	0.0277	0
3	0.1466	0.0277	0
4	0.1457	0.0268	0.0008
5	0.0942	0.0227	0.0041
6	0.4166	0	0.0228

Based on these data, a change in the survival rate of an adult green turtle (or the proportion of the stage population that survives as a reproductive adult another year) will have the highest proportional change on λ. Changes in the survival rates of the 3rd, 4th, and 5th life stages have the next highest proportional effect on λ, followed by smaller proportional effects due to changes in the survival of pelagic juveniles (Stage 2), transition rates between all stages, or fecundity. The growth, decline, or persistence of the population is determined by the survival rate of reproductive adults, sub-adults, and benthic juveniles. This is not particularly surprising given that these are the longest duration stages for this species. Persistence of long-lived species with delayed maturity would be most vulnerable to impacts that preclude individuals from attaining age and sexual maturity.

The observed declines in the green turtle populations attest to the effect of changing these survival rates on species' persistence. Green turtles have long survived natural fluctuations in environmental conditions (environmental stochasticity) such as changes in climate, coastal erosion, or destruction of nesting beaches by hurricanes and typhoons. Green turtles have survived these phenomena by evolving a life history strategy that allows their populations to withstand periodic, and often significant, losses in the life stages that would be most vulnerable to environmental change (that is, eggs, hatchlings, and juveniles) while buffering the adult life stages from these environmental changes through ocean dispersal. Although adult females on nesting beaches are also vulnerable to phenomena like beach erosion, hurricanes, and typhoons, the reproductive pattern in which adult females only nest every two or more years exposes only a small portion of the breeding population to these risks. Conversely, most anthropogenic activities such as harvest and poaching of eggs and adults, incidental capture in fisheries, or human destruction or encroachment of nesting habitat place these populations under constant pressure, can affect entire regions in short periods of time, and can affect all life stages simultaneously.

For example, green turtle eggs and hatchlings are vulnerable to many of the same factors affecting other sea turtle populations: beach erosion, human or wildlife poaching and predation, and widely fluctuating beach temperatures. Once the green turtles transition into the oceanic environment, however, individual life stages are vulnerable to different impacts based on the habitats they inhabit. Pelagic individuals are incidentally captured in pelagic fisheries such as longline. Benthic life stages are injured or killed by coastal fisheries and other hazards associated with the nearshore environment. Based on past observations in the Hawaii-based longline fishery, sub-adult and adult green turtles are the life stage most commonly captured and injured or killed. Because changes in the survival rates of these stages have the highest proportional effect on a population's finite growth rate (λ), the consequences of these fisheries on the survival and recovery of green turtle populations would be significant, particularly when these losses are added to losses in other life stages. The combined effect of these activities, which affect most or all life stages of most green turtle populations, would cause these populations to have λs significantly lower than the southern Great Barrier Reef green turtle population, meaning that these populations would be declining.

f. Biological Characteristics

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

The nonbreeding range of green turtles is generally tropical, and can extend thousands of miles from shore in certain regions. Hawaiian green turtles monitored through satellite transmitters were found to travel more than 1,100 km from their nesting beach in the French Frigate Shoals, south and southwest against prevailing currents to numerous distant foraging grounds within the 2,400 kilometer span of the archipelago (Balazs, 1994; Balazs, *et al.*, 1994; Balazs and Ellis, 1996). Three green turtles outfitted with satellite tags on the Rose Atoll (the easternmost island at the Samoan Archipelago) traveled on a southwesterly course to Fiji, approximately 1,500 km distance (Balazs, *et al.*, 1994).

Tag returns of eastern Pacific green turtles establish that these turtles travel long distances between foraging and nesting grounds. In fact, 75 percent of tag recoveries from 1982-90 were from turtles that had traveled more than 1,000 kilometers from Michoacán, Mexico. Even though these turtles were found in coastal waters, the species is not confined to these areas, as indicated by 1990 sightings records from a NOAA research ship. Observers documented green turtles 1,000-2,000 statute miles from shore (Eckert, 1993). The east Pacific green is also the second-most sighted turtle in the east Pacific during tuna fishing cruises; they are frequent along a north-south band from 15°N to 5°S along 90°W, and between the Galapagos Islands and Central American Coast (NMFS and USFWS, 1998a). In a review of sea turtle sighting records from northern Baja California to Alaska, Stinson (1984) determined that the green turtle was the most commonly observed sea turtle on the U.S. Pacific Coast, with 62% reported in a band from southern California and southward. The northernmost reported resident population of green turtles occurs in San Diego Bay, where about 50-60 mature and immature turtles concentrate in the warm water effluent discharged by a power plant (McDonald, *et al.*, 1994). These turtles appear to have originated from east Pacific nesting beaches and the Revillagigedo Islands (west of Baja California), based on morphology, genetic analyses, and tagging data (*in* NMFS and USFWS, 1998a; P. Dutton, NMFS, personal communication, March, 2002); however, the possibility exists that some are from Hawaii (P. Dutton, NMFS, personal communication, January, 2001).

Green turtles appear to prefer waters that usually remain around 20°C in the coldest month; for example, during warm spells (e.g., El Niño), green turtles may be found considerably north of their normal distribution. Stinson (1984) found green turtles to appear most frequently in U.S. coastal waters with temperatures exceeding 18°C. An east Pacific green turtle equipped with a satellite transmitter was tracked along the California coast and showed a distinct preference for waters with temperatures above 20°C (Eckert, unpublished data).

Based on the behavior of post-hatchlings and juvenile green turtles raised in captivity, it is presumed that those in pelagic habitats live and feed at or near the ocean surface, and that their dives do not normally exceed several meters in depth (NMFS and USFWS, 1998a). The maximum recorded dive depth for an adult green turtle was 110 meters (Berkson, 1967, *in* Lutcavage and Lutz, 1997), while subadults routinely dive 20 meters for 9-23 minutes, with a maximum recorded dive of 66 minutes (Brill, *et al.*, 1995, *in* Lutcavage and Lutz, 1997). Additionally, it is presumed that drift lines or surface current convergences are preferential zones due to increased densities of likely food items. In the western Atlantic, drift lines commonly contain floating *Sargassum* capable of providing small turtles with shelter and sufficient buoyancy to raft upon (NMFS and USFWS, 1998a). Underwater resting sites include coral recesses, the underside of ledges, and sand bottom areas that are relatively free of strong currents and disturbance from natural predators and humans. In the MHI these foraging and resting areas for adults usually occur at depths greater than 10 meters, but probably not normally exceeding 40 meters. Available information indicates that green turtle resting areas are in proximity to their feeding pastures (NMFS, 2000e). Immature Hawaiian green turtles have been found in increasing numbers residing in "foraging pastures" around the eight main Hawaiian Islands. These pastures consist of a narrow band of shallow water around these islands and "accounts for 96% of the benthic habitat potentially available for recruitment by post-pelagic green turtles" (Balazs, 1996).

Although most green turtles appear to have a nearly exclusive herbivorous diet, consisting primarily of sea grass and algae (Wetherall *et al.*, 1993; Hirth, 1997), those along the east Pacific coast seem to have a more carnivorous diet. Analysis of stomach contents of green turtles found off Peru revealed a large percentage of molluscs and polychaetes, while fish and fish eggs, and jellyfish and commensal amphipods comprised a lesser percentage (Bjorndal, 1997). In the Hawaiian Islands, green turtles are site-specific and consistently feed in the same areas on preferred substrates, which vary by location and between islands (*in* Landsberg, *et al.*, 1999).

g. Population Status and Trends

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

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

Green turtles are thought to be declining throughout the Pacific Ocean, with the exception of Hawaii, as a direct consequence of a historical combination of overexploitation and habitat loss (Eckert, 1993; Seminoff, 2002). A more detailed description of the abundance, distribution, and population trends for green turtles in the Pacific Ocean is presented in the following subsection.

h. Distribution and Abundance of Nesting Females in the Pacific Ocean

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

Although there are no current estimates available, Pulau Redang, a coral fringed island located approximately 45 kilometers off the coast of Terengganu, Malaysia contains one of the largest green turtle rookeries in peninsular Malaysia, and a 1 nautical mile no-fishing zone has been established around the island to prevent interactions between fishing gear and internesting females (Liew and Chan, 1994).

Smaller colonies of green turtles occur in the islands of Polynesia, Micronesia, and Malaysia (Wetherall *et al.*, 1993). Although green turtles used to nest in large numbers at Scilly, Motu-one, and Mopelia, located in the western limits of French Polynesia, their populations have declined in recent decades due mainly to commercial exploitation for markets in Tahiti (Balazs, *et al.*, 1995). Currently, Scilly is the only known sea turtle nesting site of any magnitude throughout the 130 islands and atolls that comprise French Polynesia. Although residents of Scilly are allowed to harvest 50 adult turtles annually, Balazs *et al.* (1995) estimates that the number of green turtles nesting annually in 1991 is approximately 300-400 turtles, similar to what Lebeau (1985 *in* Balazs, *et al.*, 1995) estimated several years earlier.

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

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

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

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

Scattered low density nesting of green turtles occur on beaches in Taiwan and Vietnam. In Taiwan, Cheng and Chen (1996) report that between 1992 and 1994, green turtles were found nesting on 9 of 11 beaches on Wan-An Island (Peng-Hu Archipelago). The numbers, however, were small, between 8 and 14 females nested during each of these 3 years. Cheng (2002) recently reported similar numbers of nesting greens for those areas: 2-19 nesters on Wan-an Island and 4 to 11 nesters on Lanyu Island.

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

In Japan, the Ogasawara Islands, located approximately 1,000 km south of Tokyo, serve as the northern edge of green turtles rookeries in the western Pacific. In the late 1800s, when Japan first colonized the islands, the government encouraged a sea turtle fishery. Declines in catch were steady from 1880-1890s (1,000-1,800 adults taken annually) through the mid-1920s (250 taken annually). Data from 1945-1972 (American occupation) indicate that 20-80 turtles were taken annually, and since then, annual harvests have fluctuated from 45-225 turtles per year (Horikoshi, *et al.*, 1994). Suganuma, *et al.* (1996) estimates 100 mating adults are speared by fishermen annually. Beach census data from 1985-93 indicate that 170-649 clutches were deposited each year (43 to 162 nesting females, assuming a female deposited 4 clutches during a nesting season). The Ogasawara population has declined in part due to past commercial exploitation, and it is likely to continue if fishery effort continues (Horikoshi, *et al.*, 1994).

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

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

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

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

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

2. Hawksbill Turtles

a. Global Status

The hawksbill turtle is listed as endangered under the ESA and in the International Union for the Conservation of Nature (IUCN) Red Data Book. Under Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the hawksbill is identified as "most endangered". Anecdotal reports throughout the Pacific indicate that the current population is well below historical levels. In the Pacific, this species is rapidly approaching extinction primarily due to the harvesting of the species for its meat, eggs, and shell, as well as the destruction of nesting habitat by human occupation and disruption (Meylan and Donnelly 1999, NMFS, 2001)

b. Distribution

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

Hawksbills are observed in Florida with some regularity on the reefs off Palm Beach County, where the warm Gulf Stream current passes close to shore, and in the Florida Keys. Texas is the only other state where hawksbills are sighted with any regularity. Most sightings involve posthatchlings and juveniles. These small turtles are believed to originate from nesting beaches in Mexico.

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

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

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

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

c. Physical Description

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

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

d. Life Cycle and Population Dynamics

The best estimate of sexual maturity for hawksbill turtles is about 20 to 40 years (Chaloupka and Limpus, 1997; Crouse, 1999a). Boulon (1994) estimated that juvenile hawksbills from the U.S. Virgin Islands would require between 16.5 and 19.3 additional years to reach maturity after entering nearshore habitats at several years of age at 21.4 cm straight carapace length.

Growth rates within benthic stage (juvenile turtles which have returned from pelagic developmental habitats) Australian hawksbill turtles are sex dependent with the female growing faster. Maximal growth rates for both males and females occurred at 60 cm curved carapace length (CCL) and then declined to minimal rates of growth as the turtles neared maturity at 80 cm CCL (Chaloupka and Limpus, 1997). The growth rates of Australian hawksbills appear to be less than those of Caribbean turtles, indicating geographic variation in growth.

Data on the transition rates between life stages are unavailable for hawksbill turtles. As a result, we were unable to analyze the stage structure of this species to estimate its finite population growth rate (λ) or the elasticities of the various life stages. The typical population structure for long-lived, late-maturing species like hawksbill turtles would be expected to have the largest proportion of individuals and the highest mortality rates in the earliest stages; proportions and mortality decline through successive stages with the smallest proportion of the total population in the adult stages, which also have the lowest mortality rates.

e. Biological Characteristics

There is limited information on the biology of hawksbills, probably because they are sparsely distributed throughout their range and they nest in very isolated locations (Eckert, 1993). Hawksbills have a relatively unique diet of sponges (Meylan, 1985; 1988). While data are somewhat limited on diet in the Pacific, it is well documented in the Caribbean where hawksbill turtles are selective spongivores, preferring particular sponge species over others (Dam and Diez, 1997b). Foraging dive durations are often a function of turtle size with larger turtles diving deeper and longer. At a study site also in the northern Caribbean, foraging dives were made only during the day and dive durations ranged from 19-26 minutes in duration at depths of 8-10 m. At night, resting dives ranged from 35-47 minutes in duration (Dam and Diez, 1997a).

As hawksbill turtle grows from a juvenile to an adult, data suggest that the turtle switches foraging behaviors from pelagic surface feeding to benthic reef feeding (Limpus, 1992). Within the Great Barrier Reef of Australia hawksbills move from a pelagic existence to a "neritic" life on the reef at minimum CCL of 35 cm. The maturing turtle established foraging territory and will remain in this territory until it is displaced (Limpus, 1992). As with other sea turtles, hawksbills will make long reproductive migrations between foraging and nesting area (Meylan, 1999), but otherwise they remain within coastal reef habitats. In Australia, juvenile turtles outnumber adults 100:1. These populations are also sex biased with females outnumbering males 2.57:1 (Limpus, 1992).

Although hawksbill nesting is broadly distributed, at no one place do hawksbills nest in large numbers, and many areas have experienced notable declines. Hawksbills utilize both low- and high-energy nesting beaches in tropical oceans of the world. Both insular and mainland nesting sites are known. Hawksbills will nest on small pocket beaches, and, because of their small body size and great agility, can traverse fringing reefs that limit access by other species. They exhibit a wide tolerance for nesting substrate type. Nests are typically placed under vegetation.

Hawksbills nest throughout the insular tropical Pacific, though only in low density colonies. In the Campbell Island colony of northeastern Australia, nesting females average 83.2 cm CCL, weigh 51.6 kg and lay three clutches of eggs 14 days apart. Average clutch size was 132 eggs (Limpus *et al.*, 1983). In Independent Samoa, hawksbill nesting occurs from September-July. Nests averaged 149.5 eggs. In the eastern Pacific a single hawksbill female nesting at Ostional National Wildlife Refuge, measured 82 cm CCL and laid 120 eggs (Almengor *et al.*, 1994).

Within the State of Hawaii, hawksbill turtles are known to nest on the Hawaiian Islands of Maui, Molokai, and Hawaii. Two nesting sites are located in the Hawaii Volcanoes National Park (Balazs *et al.*, 1992; Katahira *et al.*, 1994). In surveys conducted between 1989 and 1993, 18 hawksbill turtles were tagged and 98 nests documented (NMFS and USFWS, 1998b). Although total population numbers and trends in abundance are not known for the Hawaiian population of hawksbill turtles, probably no more than 35 females nest annually on all beaches combined (J. Wetherall, NMFS, personal communication, 1999). The peak nesting occurs from late July to early September (Katahira *et al.*, 1994). Recent nesting activity has occurred at Kealia Beach on Maui. There are no records of nesting hawksbill turtles or reported observations of their occurrence near the NWHI, although they may have occupied the region in the past. Hawksbill turtles appear to prefer nesting sites with steep beaches and coarse sand, and this may explain, in part, their presence in the main Hawaiian Islands.

There is much variation in clutch size from site to site and among sizes of turtles, with the larger turtles laying the largest clutches. Known clutch size in the Pacific averages 130 eggs per clutch, around 3 clutches per year, and anecdotal reports indicate that hawksbill remigration intervals average around two years (Eckert, 1993; NMFS and USFWS, 1998b). Mrosovsky *et al.* (1995)evaluated the effect of incubation temperature on sex determination in hawksbill hatchlings. Incubation temperatures warmer than approximately 29.2°C produced females, while cooler temperatures produced males (Mrosovsky *et al.*, 1995). The largest nesting concentrations of hawksbills occur on remote oceanic islands off Australia (Torres Strait), while remote beaches in the Solomon Islands, Papua New Guinea, Indonesia, and Malaysia serve as less significant sites. Otherwise, hawksbill nesting does not occur in abundance in the Pacific. Throughout Micronesia, hawksbill nesting is in decline, with Palau representing the highest activity, with conceivably as few as 20 nesting females per year (NMFS and USFWS, 1998b). In Japan, nesting is very rare and is confined to the southern islands. Hawksbill nesting also occurs in Viet Nam and China, although the status in these areas is unknown. Nesting is widespread throughout the Philippines, although the sites are relatively poorly known, and population abundance has not been quantified (Eckert, 1993).

f. Population Status and Trends

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

Hawksbills appear to be declining throughout their range. By far the most serious problem hawksbill turtles face is the harvest by humans, while a less significant threat, but no less important, is loss of habitat due to expansion of resident human populations and/or increased tourism development. Dramatic reductions in the numbers of nesting and foraging hawksbills have occurred in Micronesia and the Mexican Pacific coast, probably due largely to technological advances in fishing gear, which facilitate legal and illegal harvest. In addition, the hawksbill tortoiseshell trade probably remains an important contributing factor in the decline of the hawksbill. Although the Japanese market was closed in 1994, southeast Asia and Indonesia markets remain lucrative (NMFS and USFWS, 1998b). In addition to the demand for the hawksbill's shell, there is a demand for other products including leather, oil, perfume, and cosmetics. Prior to being certified under the Pelly Amendment, Japan had been importing about 20 metric tons of hawksbill shell per year, representing approximately 19,000 turtles. A negotiated settlement was reached regarding this trade on June 19, 1992. The hawksbill shell commands high prices (currently $225/kilogram), a major factor preventing effective protection[14]

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

g. Distribution and Abundance of Nesting Females in the Pacific Ocean

The Palau nesting population of hawksbills is the largest in Oceania north of the equator; nesting is concentrated on small beaches of the Rock Islands between Koror and Peleliu islands (Maragos 1991). This population is severely stressed by chronic egg poaching and the hunting of

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[14] Http://www.nmfs.noaa.gov/prot_res/species/turtles/hawksbill.html

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

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

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

3. Leatherback Turtles

a. Global Status

The leatherback turtle is listed as endangered under the ESA throughout its global range. Furthermore, the Red List 2000 of the IUCN has classified the leatherback as "critically endangered"[15] due to "an observed, estimated, inferred or suspected reduction of at least 80% over three generations" based on: (a) direct observation; (b) an index of abundance appropriate for the taxon; and (c) actual or potential levels of exploitation. Increases in the number of nesting females have been noted at some sites *in the Atlantic*, but these are far outweighed by local extinctions, especially of island populations, and the demise of once large populations *throughout the Pacific*, such as in Malaysia and Mexico. Spotila *et al.* (1996) estimated the *global* population of female leatherback turtles to be only 34,500 (confidence limits: 26,200 to 42,900) nesting females; however, the eastern Pacific population has continued to decline since that estimate, leading some researchers to conclude that the leatherback is now on the verge of extinction in the Pacific Ocean (e.g. Spotila, *et al.*, 1996; Spotila, *et al.*, 2000).

b. Physical Description

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

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

c. Distribution

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

d. Life Cycle and Population Dynamics

Figure III-9 illustrates the basic life cycle of the leatherback turtle (based on data presented by Chaloupka, (2001) for western Pacific leatherback nesting aggregations). This cycle is broken into seven life stages based on age: (1) egg/hatchling; (2) neonate; (3) warm water juvenile, (4) cool water juvenile, (5) immature, (6) sub-adult, and (7) adult, each with their own expected survival rate (Table III-9). Arrows along the bottom represent the probability of each ageclass surviving and remaining in the ageclass. Arrows between each ageclass represent the probability of the ageclass surviving and growing to the next ageclass, and the arrows along the top represent the ageclass-specific fertility. The thickness or length of the lines do not indicate a level of probability or fecundity. Available information on the behavior, physiology, and biological requirements of these stages is summarized below.

Figure III-9. Life-cycle graph of the leatherback turtle (based on Chaloupka, 2001)

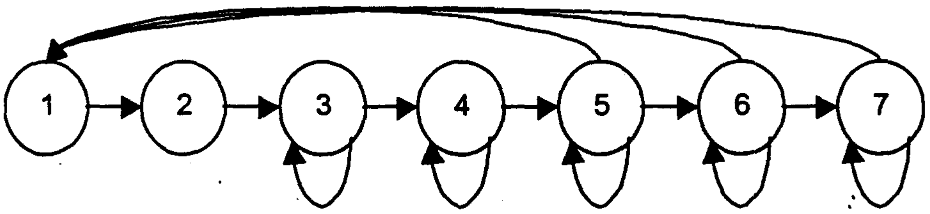

Table III-9: Stage structure and vital rates for leatherback turtles (Chaloupka, 2001; 2002)

Stage	Name	Age	Stable Stage Structure[1]	Survival Probability (lx)[2]	Fecundity[2]
1	Egg-hatchling	0	not estimated	various	0
2	Neonate	1	65.12%	0.25	0
3	Warm Water Juvenile	2-4	21.38%	0.75	0
4	Cool Water Juvenile	4-5	4.02%	0.75	0
5	Immature	5-9	5.99%	0.85	79-90
6	Sub-adult	10-14	1.46%	0.9	79-90
7	Adult	15+	1.97%	0.9	79-90

[1] Stable age structure proportions estimated from Chaloupka (2002) leatherback simulation model parameters for initial abundance of western Pacific population in 1900.

[2] Eckert (2000)

Data on the transition rates between life stages are unavailable; the species spends most of its life in the pelagic environment which makes studies of their abundance, life history and ecology, and pelagic distribution difficult. As a result, we were unable to analyze the stage structure of this population to estimate its finite population growth rate (λ) or the elasticities of the various life stages. However, the stable stage structure likely reflects a relatively undisturbed population (based on Chaloupka's (2002) estimation of the population stage abundances in 1900, before the advent of the major anthropogenic activities which have directly and indirectly affected the species' status and trend). The typical population structure for long-lived, late-maturing species like leatherback turtles has the largest proportion of individuals and the highest mortality rates in the earliest stages; proportions and mortality decline through successive stages with the smallest proportion of the total population in the adult stages, which also have the lowest mortality rates. For further discussion of these population structures, see Crouse (1999) and Stearns (1992). An undisturbed population of sea turtles is likely to have a λ and life stage elasticities similar to those described above in the *Life Cycle and Population Dynamics* discussion for green turtles. That green turtle population had a λ of approximately 1, indicating a stationary population, or one that is neither increasing nor decreasing. In addition, a change in the survival rate of an adult green turtle will have the largest proportional change on λ. Changes in the survival rates of the juvenile and sub-adult life stages have the next largest proportional effect on λ. As a result, the growth, decline, or maintenance of the population is determined by the survival rate of reproductive adults, sub-adults, and juveniles. This is not particularly surprising given that these are the longest duration stages for sea turtles. Conversely, the population's λ would be relatively insensitive to changes in the survival rates of eggs or hatchlings; the species has evolved to withstand high natural variability in these survival rates. Persistence of long-lived species with delayed maturity would be most vulnerable to impacts that preclude individuals from 1) attaining age and sexual maturity, or 2) surviving to produce sufficient offspring to replace themselves.

However, the dynamics of most leatherback turtle populations today likely reflect the effects of numerous anthropogenic activities which have caused or exacerbated the declines in abundance noted in many leatherback nesting aggregations, such as those documented in Malaysia. As a result, the λ and life stage elasticities of these populations are likely indicative of declining populations (λs less than 1, and changed proportional importance of different life stage elasticities on λ). For an example of the changed dynamics of a declining sea turtle population, see the *Life Cycle and Population Dynamics* discussion for loggerhead turtles below. In a disturbed population, the survival rates of adult turtles may still have the highest elasticities, typical for long-lived species with delayed maturity. However, the survival rates of life stages relatively undisturbed by chronic or significant sources of mortality increase in importance as the population relies upon these stages to supply enough individuals to survive the rigors of subsequent life stages and reach sexual maturity. In the case of a population where the survival of all life stages has been decreased by anthropogenic activities, stage elasticities may change such that the proportional effect of a change in survival rate in any stage can have significant effect on λ.

Leatherback populations currently face high probabilities of extinction as a result of both environmental and demographic stochasticity. Demographic stochasticity, or chance variation in the birth or death of an individual of the population, is facilitated by the increases in mortality rates of leatherback populations due to harvest of individuals (either eggs or reproductive females on nesting beaches) or incidental capture and mortality of individuals in various fisheries. Environmental stochasticity, or random environmental changes that deteriorate or degrade environmental quality, is facilitated by destruction of nesting beach habitat or changes in nest temperature from loss of shade on nesting beaches. Loss of habitat or deterioration in habitat quality can reduce egg survival or even change the sex ratios of produced hatchlings. In both cases, the variation in rate or ratio due to environmental stochasticity exacerbate demographic stochasticity through increased mortality, or decreased breeding probability as individuals in a sex-skewed population have more difficulty finding members of the opposite sex. Increases in demographic stochasticity tend to increase the variance in the population growth rate (Gilpin and Soule, 1986). As this variance increases, a population's probability of extinction due to chance events increases. As a result, declines in a species' abundance due to increased mortality or the loss of some resource (nesting habitat, prey, etc.,) that might otherwise lead to extinction through deterministic processes also increase a species' chance of extinction via other random occurrences (Gilpin and Soule, 1986).

Based on past observations, the leatherback turtles that are captured and killed in Hawaii-based longline fisheries are primarily sub-adult and adult leatherback turtles (see the discussion in the *Effects of the Action* section). Over the history of these fisheries, the effect of these annual deaths would significantly reduce the survival rates of individuals in these life stages in the nesting aggregations that interact with these fisheries. From our analyses, these reductions would be expected to have a significant, adverse affect on the trend of those nesting aggregations, particularly if these losses are added to losses in other life stages. The combined effect of these activities, which affect most or all life stages of most leatherback turtle populations, would significantly reduce the population growth rates of the nesting aggregations that interact with these fisheries.

e. Biological Characteristics

Leatherback turtles have the most extensive range of any living reptile and have been reported circumglobally from 71°N to 47°S latitude in the pelagic Pacific and in all other major pelagic ocean habitats (NMFS and USFWS, 1998c). For this reason, however, studies of their abundance, life history and ecology, and pelagic distribution are exceedingly difficult. Leatherback turtles lead a completely pelagic existence, foraging widely in temperate waters except during the nesting season, when gravid females return to tropical beaches to lay eggs. Males are rarely observed near nesting areas, and it has been proposed that mating most likely takes place outside of the tropical waters, before females move to their nesting beaches (Eckert and Eckert, 1988). Leatherbacks are highly migratory, exploiting convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Morreale, *et al.*, 1994; Eckert, 1998; Eckert, 1999a). In a single year, a leatherback may swim more than 10,000 kilometers (Eckert, 1998).

Recent satellite telemetry studies indicate that adult leatherback turtles follow bathymetric contours over their long pelagic migrations and typically feed on cnidarians (jellyfish and siphonophores) and tunicates (pyrosomas and salps), and their commensals, parasites and prey (NMFS and USFWS, 1998c). Because of the low nutritive value of jellyfish and tunicates, it has been estimated that an adult leatherback would need to eat about 50 large jellyfish (equivalent to approximately 200 liters) per day to maintain its nutritional needs (Duron, 1978, *in* Bjorndal, 1997). Compared to greens and loggerheads, which consume approximately 3-5% of their body weight per day, leatherback turtles may consume perhaps 20-30% of their body weight per day (Davenport and Balazs, 1991). Surface feeding has been reported in U.S. waters, especially off the west coast (Eisenberg and Frazier, 1983), but foraging may also occur at depth. Based on offshore studies of diving by adult females nesting on St. Croix, U.S. Virgin Islands, Eckert *et al.* (1989) proposed that observed internesting[16] dive behavior reflected nocturnal feeding within the deep scattering layer (strata comprised primarily of vertically migrating zooplankton, chiefly siphonophore and salp colonies, as well as medusae). Hartog (1980, *in* NMFS and USFWS, 1998c) also speculated that foraging may occur at depth, when nematocysts from deep water siphonophores were found in leatherback stomach samples. Davenport (1988, *in* Davenport and Balazs, 1991) speculated that leatherback turtles may locate pyrosomas at night due to their bioluminescence; however direct evidence is lacking.

Leatherback turtles also appear to spend almost the entire portion of each dive traveling to and from maximum depth, suggesting that maximum exploitation of the water column is of paramount importance to the leatherback (Eckert, *et al.*, 1989). Maximum dive depths for post-nesting females in the Carribean have been recorded at 475 meters and over 1,000 meters, with routine dives recorded at between 50 and 84 meters. The maximum dive length recorded for such female leatherback turtles was 37.4 minutes, while routine dives ranged from 4-14.5 minutes (*in* Lutcavage and Lutz, 1997). A total of six adult female leatherback turtles from Playa Grande, Costa Rica were monitored at sea during their internesting intervals and during the 1995 through 1998 nesting seasons. The turtles dived continuously for the majority of their time at sea, spending 57-68% of their time submerged. Mean dive depth was 19 ± 1 meters and the mean dive duration was 7.4 ± 0.6 minutes (Southwood, *et al.*, 1999). Migrating leatherback

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[16] Internesting – time spent between laying clutches of eggs during a single nesting season.

turtles also spend a majority of time at sea submerged, and they display a pattern of continual diving (Standora, *et al.*, 1984, *in* Southwood, *et al.*, 1999). Eckert (1999a) placed transmitters on nine leatherback females nesting at Mexiquillo Beach and recorded dive behavior during the nesting season. The majority of the dives were less than 150 meters depth, although maximum depths ranged from 132 meters to over 750 meters. Although the dive durations varied between individuals, the majority of them made a large proportion of very short dives (less than two minutes), although Eckert (1999a) speculates that these short duration dives most likely represent just surfacing activity after each dive. Excluding these short dives, five of the turtles had dive durations greater than 24 minutes, while three others had dive durations between 12-16 minutes. Based on depth profiles of four leatherbacks tagged and tracked from Monterey Bay, California in 2000 and 2001, using satellite-linked dive recorders, most of the dives were to depths of less than 100 meters and most of the time was spent shallower than 80 meters. Based on preliminary data analysis, 75-90% of the time the leatherback turtles were at depths less than 80 meters.

On the Pacific coast of Mexico, female leatherback turtles lay an average of 4 clutches per season, with clutch size averaging 64 yolked eggs per clutch (García and Sarti, 2000) (each clutch contains a complement of yolkless eggs, sometimes comprising as much as 50 percent of total clutch size, a unique phenomenon among leatherback turtles and some hawksbills (Hirth and Ogren, 1987)). Each clutch is laid within a 9.3 day interval (García and Sarti, 2000). Clutch sizes in Terengganu, Malaysia, and in Pacific Australia were larger, averaging around 85-95 yolked eggs and 83 yolked eggs, respectively (*in* Eckert, 1993). Females are believed to migrate long distances between foraging and breeding grounds, at intervals of typically two or four years (García and Sarti, 2000). Spotila *et al.* (2000), found the mean re-nesting interval of females on Playa Grande, Costa Rica to be 3.7 years, while in Mexico, 3 years was the typical reported interval (L. Sarti, Universidad Naçional Autonoma de Mexico, personal communication, 2000). In Mexico, the nesting season generally extends from November to February, although some females arrive as early as August (Sarti *et al.*, 1989). In the western Pacific, nesting peaks on Jamursba-Medi Beach (Irian Jaya) from May to August, on War Mon Beach (also Irian Jaya) from November to January (Starbird and Suarez, 1994), in peninsular Malaysia in June and July (Chan and Liew, 1989), and in Queensland, Australia in December and January (Limpus and Riemer, 1984).

Using a small sample size of leatherback sclerotic ossicles, analysis by Zug and Parham (1996) suggested that mean age at sexual maturity for leatherback turtles is around 13 to 14 years, giving them the highest juvenile growth rate of all sea turtle species. Zug and Parham (1996) concluded that for conservation and management purposes, 9 years is a likely minimum age for maturity of leatherback turtles, based on the youngest adult in their sample. The natural longevity of leatherback turtles has not been determined (NMFS and USFWS, 1998c), although there are recorded documentations of post-maturation survival on the order of about 20 years (Pritchard, 1996).

Migratory routes of leatherback turtles originating from eastern and western Pacific nesting beaches are not entirely known. However, satellite tracking of post-nesting females and genetic analyses of leatherback turtles caught in U.S. Pacific fisheries or stranded on the west coast of the U.S. present some strong insight into at least a portion of their routes and the importance of particular foraging areas. Current data from genetic research suggest that Pacific leatherback stock structure (natal origins) may vary by region. Because leatherback turtles are highly migratory and stocks mix in high seas foraging areas, and based on genetic analyses of samples collected by Hawaii-based longline observers, leatherback turtles inhabiting the action area are comprised of individuals originating from nesting assemblages located south of the equator in Indonesia and in the eastern Pacific along the Americas (e.g., Mexico, Costa Rica) (Dutton, *et al.*, 2000).

For female leatherback turtles nesting at Mexiquillo Beach, Mexico, the eastern Pacific region has been shown to be a critical migratory route. Nine females outfitted with satellite transmitters in 1997 traveled along almost identical pathways away from the nesting beach. These individuals moved south and, upon encountering the North Equatorial Current at about 8°N, diverted west for approximately 800 km and then moved east/southeast towards the waters off Peru and Chile (Eckert, 1999a). In addition, four leatherback turtles recovered from Chilean fishing vessels from 1988-91 had been tagged on nesting beaches in Costa Rica and Mexico (Brito-Montero, 1995, *in* Donoso, 2000).

Morreale *et al.* (1994) demonstrated that satellite tagged, post-nesting leatherback turtles leaving Costa Rica followed precisely defined, long-distance migratory pathways after nesting. Despite differences in dates of departure from the nesting areas, nesting cohorts followed along nearly identical pathways. All 6 leatherback turtles' (from the Pacific and Caribbean coasts of Costa Rica) movements paralleled deepwater bathymetric contours ranging from 200-3,500 meters. When a turtle's path intersected an abyssal plain, it veered along the outer slope, and when an abyssal plain was unavoidable, the turtle crossed it at its narrowest point. These studies underscore the importance of this offshore habitat and migratory corridors and the likelihood that sea turtles are present on fishing grounds, particularly for large commercial fishing fleets south of the equator (Eckert, 1997). Eckert (1999a) speculates that leatherback turtles leaving the nesting areas of Mexico and Costa Rica may be resource-stressed by a long reproductive season with limited food and the high energetic requirements brought about by the demands of reproduction, elevated water temperatures, or both. When they leave, their greatest need is to replenish energy stores (e.g. fat) and they must move to areas where food is concentrated (e.g. upwelling areas). Most of these eastern Pacific nesting stocks migrate south, although one genetic sample from a leatherback turtle caught south of the main Hawaiian Islands by the Hawaii-based longline fishery indicated representation from eastern Pacific nesting beaches (P. Dutton, NMFS, personal communication, October 2002).

Migratory corridors of leatherback turtles originating from western Pacific nesting beaches most likely exist along the eastern seaboards of Australia and Asia, including the former Soviet Union (NMFS and USFWS, 1998c). Recent information on leatherbacks tagged off the west coast of the United States has also revealed an important migratory corridor from central California, to south of the Hawaiian Islands, leading to western Pacific nesting beaches. Leatherback turtles originating from western Pacific beaches have been found along the U.S. mainland. Here, leatherback turtles have been sighted and reported stranded as far north as Alaska (60°N) and as far south as San Diego, California (NMFS and USFWS, 1998c). Of the stranded leatherback turtles that have been sampled to date from the U.S. mainland, all have been of western Pacific nesting stock origin (P. Dutton, NMFS, personal communication, 2000). Genetic analysis of samples from two leatherback turtles taken off California and Oregon by the CA/OR drift gillnet fishery revealed that they both originated from western Pacific nesting beaches (i.e. Indonesia/Solomon Islands/Malaysia) (P. Dutton, NMFS, personal communication, March, 2000).

Four leatherback turtles have been captured, tagged, and fitted with transmitters in Monterey Bay, California, in the fall of 2000 and 2001. Of two females caught in 2000, one was of a size normally associated with the western Pacific nesting stock, which are, on average, 10-20 centimeters larger than eastern Pacific nesting stocks (Zug and Parham, 1996). Both headed on a southwest migratory path, appearing to be heading to the western Pacific nesting beaches (Dutton and Eckert in press). On 11/17/00, the larger female stopped transmitting when it entered an area southeast of the Hawaiian Islands (145°W longitude, 15°N latitude). The other leatherback continued to travel west along the North Equatorial Current towards Indonesia, headed up north, and then headed back east. Transmissions were lost on 12/28/01 at approximately 180° longitude and 13°N latitude, southwest of the Hawaiian Islands. A male and female leatherback were caught and tagged in 2001. The male headed north of the "migratory corridor" taken by the two females the year before and stopped transmitting on 12/17/01, while the female traveled north to the Farallon Islands and then headed west, where transmissions stopped on 10/11/01 (D. Parker and P. Dutton, NMFS, personal communication, June, 2002). Genetic analysis confirmed that all four of these leatherbacks tagged and outfitted with transmitters were from the western Pacific stock (P. Dutton, NMFS, personal communication, October 2002).

Genetic markers in 16 of 17 leatherback turtles sampled to date from the central North Pacific (captured in the Hawaii-based longline fishery) have identified those turtles as originating from nesting populations in the southwestern Pacific; the other specimen, taken in the southern range of the Hawaii fishery, was from nesting beaches in the eastern Pacific (Dutton and Eckert, in press). In addition, genetic analyses of two leatherback turtles taken by fishing vessels in Chilean waters suggest that one is from a western Pacific or Indian Pacific nesting population and the other is of eastern Pacific origin. This is the first evidence that leatherback turtles from western Pacific nesting beaches occur in Chilean waters, confirming transoceanic migration to eastern Pacific forage areas in the southern hemisphere (Donoso, *et al.*, 2000).

Hawaiian fishermen in offshore waters have seen leatherback turtles generally beyond 100 fathoms, but within sight of land. Two areas where sightings have taken place are off the north coast of Oahu and the west coast of the Island of Hawaii. The pelagic zone surrounding the Hawaiian Islands apparently is regularly used as foraging habitat and migratory pathways for this species (NMFS, 1991). Stranding records from 1982-2001 indicate that the leatherback rarely strands in the Hawaiian Islands; only five leatherback turtles have been recorded stranded in 20 years (G. Balazs, NMFS, personal communication, 2002).

The distribution of juvenile leatherback turtles has long been a mystery. However, a recent compilation and analysis of sighting and stranding data for the species has yielded some interesting insight into the developmental habitats of this species at earlier life stages. It appears that young leatherback turtles (carapace length <100 cm) reside only in waters warmer than 26°C, which should generally place them outside of areas in which longline swordfish fleets operate (Eckert, 1999b; Eckert, 2002). However, as discussed further in the *Effects of the Action* section, the Hawaii-based longline fishery has been observed to take a few subadult leatherback turtles (straight carapace length < 100 cm).

f. Population Status and Trends

Leatherback turtles are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic and Pacific Oceans, the Caribbean Sea, and the Gulf of Mexico (Ernst and Barbour, 1972). Globally, leatherback turtle populations have been decimated worldwide. In 1980, the leatherback population was estimated at approximately 115,000 (adult females) globally (Pritchard, 1982b). By 1995, this global population of adult females had declined to 34,500 (Spotila *et al.* 1996). Populations have declined in Mexico, Costa Rica, Malaysia, India, Sri Lanka, Thailand, Trinidad, Tobago, and Papua New Guinea. Throughout the Pacific, leatherbacks are seriously declining at all major nesting beaches. The decline can be attributed to many factors, including fisheries interactions, direct harvest, egg collection, and degradation of habitat. On some beaches, nearly 100% of the eggs laid have been harvested. Eckert (1996) and Spotila *et al.* (1996) note that adult mortality has also increased significantly, particularly as a result of driftnet and longline fisheries.

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

Leatherbacks are exposed to commercial fisheries in many areas of the Atlantic Ocean. For example, leatherback entanglements in fishing gear are common in Canadian waters where Goff and Lien (1988) reported that 14 of 20 leatherbacks encountered off the coast of Newfoundland/Labrador were entangled in fishing gear including salmon net, herring net, gillnet, trawl line and crab pot line. Leatherbacks are reported taken by the many other nations that participate in Atlantic pelagic longline fisheries (see NMFS SEFSC 2001, for a complete description of take records), including Taiwan, Brazil, Trinidad, Morocco, Cyprus, Venezuela, Korea, Mexico, Cuba, U.K., Bermuda, People's Republic of China, Grenada, Canada, Belize, France, and Ireland. Leatherbacks are known to drown in fish nets set in coastal waters of Sao Tome, West Africa (Castroviejo *et al.*, 1994; Graff, 1995). Gillnets are one of the suspected causes for the decline in the leatherback turtle population in French Guiana (Chevalier *et al.*, 1999), and gillnets targeting green and hawksbill turtles in the waters of coastal Nicaragua also incidentally catch leatherback turtles (Lagueux *et al.*, 1998). Observers on shrimp trawlers operating in the northeastern region of Venezuela documented the capture of six leatherbacks from 13,600 trawls (Marcano and Alio, 2000). An estimated 1,000 mature female leatherback turtles are caught annually off of Trinidad and Tobago with mortality estimated to be between 50-95% (Eckert and Lien, 1999). However, many of the turtles do not die as a result of drowning, but rather because the fishermen butcher them in order to get them out of their nets (NMFS SEFSC 2001). There are known to be many sizeable populations of leatherbacks nesting in West Africa, possibly as many as 20,000 females nesting annually (Fretey 2001). In Ghana, nearly two thirds of the leatherback turtles that come up to nest on the beach are killed by local fishermen.

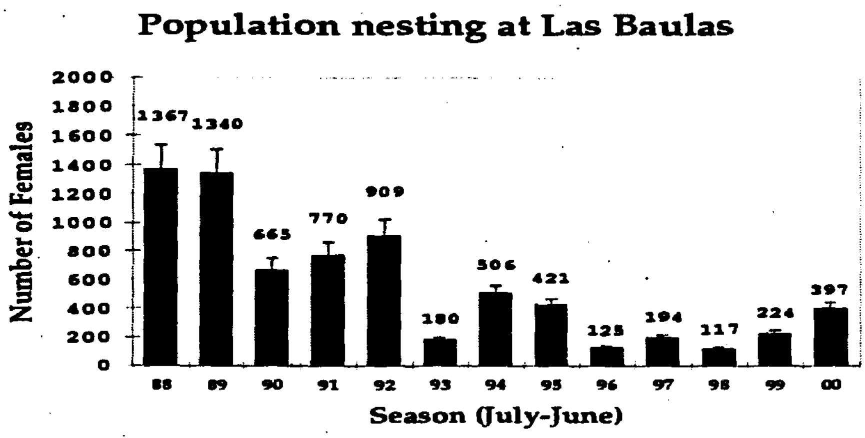
g. Distribution and Abundance of Nesting Females in the Pacific Ocean

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

h. Eastern Pacific Nesting Populations of Leatherbacks

Leatherback nesting populations are declining at a rapid rate along the Pacific coast of Mexico and Costa Rica (see Appendix B, Table 1). Leatherback turtles have been studied at Playa Grande (in Las Baulas), the fourth largest leatherback nesting colony in the world, since 1988. As shown in Figure III-10, during the 1988-89 season (July-June), 1,367 leatherback turtles nested on this beach, and by the 1998-99 season, only 117 leatherback turtles nested (Spotila, 2000). The 1999-2000 and 2000-01 season showed increases in the number of adult females nesting here, with 224 and 397 leatherbacks nesting, respectively. Although analysis has not been completed for the 2001-02 season, Reina (Drexel University, personal communication, March, 2002) preliminarily estimated that 75 females nested here during the full season, "a major decrease from last year."

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



During the last three nesting seasons in Las Baulas (1996 through 1999), an average of only 25% of the turtles were remigrants (turtles returning to nest that were observed nesting in previous nesting seasons). Less than 20% of the turtles tagged in 1993 through 1995 returned to nest in the next five years (Spotila, *et al.*, 2000). Remigration intervals for leatherback turtles at nesting beaches in the U.S. Caribbean have been documented as over 97% returning within 5 years or less (Dutton *et al.*, in press). Comparatively few leatherback turtles are returning to nest on east Pacific nesting beaches and it is likely that leatherback turtles are experiencing abnormally high mortalities during non-nesting years. Since 1993, environmental education and conservation efforts through active law enforcement has greatly reduced egg poaching in Costa Rica (Chaves, *et al.*, 1996). For example, during the 1993-94 nesting season, poaching accounted for only 1.3 percent of the loss of nests on Playa Grande. Other losses were due to predation, tidal effects and failure in egg development or infestation by maggots (Schwandt, *et al.*, 1996). Researchers at Playa Grande have also found that temperature of the sand surrounding the egg will determine the sex of the hatchlings during a critical phase of their embryonic development. At this beach, temperatures above 29.5°C produce female hatchlings, while below 29.5°C, the hatchlings are male.

The decline of leatherback subpopulations is even more dramatic off Mexico. According to reports from the late 1970s and early 1980s, three beaches located on the Pacific coast of Mexico (Chacahua, Oaxaca, Tierra Colorada, Guerrero and Mexiquillo, Michoacán) sustained a large portion of all global nesting of leatherback turtles, perhaps as much as one-half. Because nearly 100% of the clutches in these areas were poached by local people, a monitoring plan was implemented to evaluate the nesting population and establish measures for the protection of eggs. Surveys indicate that the eastern Pacific Mexican population of adult female leatherback turtles has declined from 70,000[17] in 1980 (Pritchard, 1982b, *in* Spotila *et al.*, 1996) to slightly more than 200 adult females during the 1996-97 and 1997-1998 nesting seasons (Table III-10) (Sarti *et al.*, 2000). Censuses of four index beaches in Mexico (representing approximately 40% of all Pacific leatherback nesting in Mexico) during the 2000-2001 nesting season (October - March) showed a slight increase in the numbers of females nesting compared to the all-time lows observed from 1996 through 1999 (Sarti *et al.* in prep). However, the number of females nesting during the 2001-2002 is the lowest ever recorded - Sarti (Universidad Naçional Autonoma de Mexico, personal communication, March 2002) reports that there have been a total of only 36 turtles seen at all four index beaches - 4 turtles at Mexiquillo, 11 at Tierra Colorada, 9 at Llano Grande, and 12 at Barrade La Cruz. Based on aerial surveys and ground surveys, it is estimated that 109-120 leatherbacks nested in 2001/02 (Sarti *et al.*, 2002).

Table III-10. Total leatherback nestings counted and total number of females estimated to nest along the Mexican Pacific coast per season.

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

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

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

> "While reporting the results for the 1995-96 nesting season (Sarti *et al.*, 1996), we regarded beaches having densities higher than 50 nests per kilometer as the most important. In the present season [1997-98] no beach reached such density values: the main beaches had 5 or more nests per kilometer, and none were higher than 25. This is evidence of the large decrement witnessed from the start of the aerial surveys, and may indicate that the nesting population still has a declining trend despite the protection efforts in the major beaches."

Furthermore, Sarti, *et al.* (2000) notes that during the 1980s, 30% of the nesting females per season were remigrants, but since the mid-1990s, there has been very little evidence of remigration, even with more efficient tagging methods. Sarti (2002) reported that during the

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[17] 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).

1999-2000 and 2000-01 nesting seasons, only a small increment in the number of remigrant turtles was observed.

Although the causes of the decline in the eastern Pacific nesting populations are not entirely clear, Sarti *et al.* (1998) surmises that the decline could be a result of intensive egg poaching in the nesting areas, incidental capture of adults or 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 Píedra de Tiacoyunque, Guerrero (Sarti, *et al.*, 2000). Nichols (2002) notes that leatherbacks were once harvested off Baja California but their meat is now considered inferior for human consumption. In addition, 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 have 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.

Most conservation programs aimed at protecting nesting sea turtles in Mexico have continued since the early 1980s, and there is little information on the degree of poaching prior to the establishment of these programs. However, Sarti *et al.* (1998) estimates that as much as 100% of the clutches were taken from the Mexican beaches. Since protective measures have been in place, particularly emergency measures recommended by a joint U.S./Mexico leatherback working group meeting in 1999, there has been greater nest protection and nest success (Table III-11). Mexican military personnel were present during the 1999-2000 season at three of the primary nesting beaches in Mexico (Llano Grande, Mexiquillo, and Tierra Colorado), responsible for approximately 34% of all nesting activity in Mexico. Of 1,294 nests documented, 736 were protected (57%), resulting in a total of 25,802 hatchlings. Monitoring and protection measures at two secondary nesting beaches resulted in the protection of 67% and 10% at Barra de la Cruz and Playa Ventura, respectively. Beginning in 2000, the primary management objective has been to protect over 95% of nests laid at the three index beaches (includes protecting nesting females, eliminating illegal egg harvest, and relocating nests to protected hatcheries) and to maximize protection of all the secondary nesting beaches over the next three years. NMFS has committed funding for three years to help implement these objectives (Dutton *et al.*, 2002).

Table III-11. Nest protection at index beaches on the Pacific coast of Mexico (Source: Sarti *et al.*, personal communication, 2000)

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

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

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

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

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

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

i. Western Pacific Nesting Populations of leatherbacks

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

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

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

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

The decline of leatherback turtles is severe at one of the most significant nesting sites in the western Pacific region - Terengganu, Malaysia, with current nesting representing less than 2 percent of the levels recorded in the 1950s, and the decline is continuing. The nesting population at this location has declined from 3,103 females estimated nesting in 1968 to 2 nesting females in 1994 (Chan and Liew, 1996) (Table III-12). With one or two females reportedly nesting each year, this population has essentially been eradicated (P. Dutton, personal communication, 2000). Years of excessive egg harvest, egg poaching, the direct harvest of adults in this area, as well as incidental capture in various fisheries in territorial and international waters, have impacted the Malaysian population of leatherback turtles. There were two periods in which there were sharp declines in nesting leatherback turtles at this location: 1972-74 and 1978-80. Between 1972 and 1974, the number of females nesting declined 21% and coincided with a period of rapid development in the fishing industry, particularly trawling, in Terengganu (Chan *et al.*, 1988 *in* Chan and Liew, 1996). Between 1978 and 1980, nestings dropped an average of 31% annually, and coincided directly with the introduction of the Japanese high seas squid fishery of the North Pacific in 1978 (Yatsu *et al.*, 1991, *in* Chan and Liew, 1996). Because tagged individuals from Rantau Abang have been recovered from as far away as Taiwan, Japan and Hawaii, this fishery, as well as fisheries operating within the South China Sea, may have impacted the Malaysian leatherback population (Chan and Liew, 1996). After 1980, rates of decline averaged 16% annually, suggesting continuing threats from fisheries (Chan and Liew, 1996).

Table III-12. **Number of nesting females per year in Terengganu, Malaysia (summarized in Spotilla, *et al.*, 1996)**

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

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

A summary of data collected from leatherback nesting surveys from 1984 to 2001 for Jamursba-Medi has been compiled, re-analyzed, and standardized and is shown in Table III-13 (Hittipeuw and Maturbongs (2002). The number of nests were adjusted to correct for the days or months of the survey missed during the nesting season, and the average number of nests per female is assumed to range between 4.4 to 5.8 (see footnotes in Table III-13). Gaps in the data for the year 1998 and 2000 were due to lack of financial support and transition of management changes of WWF Indonesia, which has been helping to monitor the leatherback nesting populations at these beaches since the early 1980s.

Table III-13. **Estimated numbers of female leatherback turtles nesting along the north coast of Irian Jaya (Summarized by Hittipeuw and Maturbongs *in* Proceedings of W. Pacific Sea Turtle Coop Research and Management Workshop, 2002 (Jamursba-Medi Beach)) and Suarez *et al.* in press (War-Mon Beach)**

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

War-Mon Beach:			
Nov. 1984 - Jan. 1985	1,012	N/A	175-230
Dec. 1993	406	653	128 - 169

[1]The total number of nests reported during aerial surveys were adjusted to account for loss of nests prior to the survey. Based on data from other surveys on Jamursba-Medi, on average 44% of all nests are lost by the end of August.

[2]The total number of nests have been adjusted based on data from Bhaskar's surveys from 1984-85 from which it was determined that 26% of the total number of nests laid during the season (4/1-10/1) are laid between April and May.

[3]Based on Bhaskar's tagging data, an average number of nests laid by leatherback turtles on Jamursba-Medi in 1985 was 4.4 nests per female. This is consistent with estimates for the average number of nests by leatherback turtles during a season on beaches in Pacific Mexico, which range from 4.4 to 5.8 nests per female (Sarti *et al.*, unpub. report). The range of the number of females is estimated using these data.

[4]Number adjusted from Bhaskar (1984), where percentage of nests laid in April and September is 9% and 3%, respectively, of the total nests laid during the season.

Suarez *et al.* (in press) has also compiled information on the estimated number of nests lost due to both natural and anthropogenic causes. For example, during 1984 and 1985, on Jamursba-Medi, 40-60% of nests were lost to inundation and erosion, while 90% of those nests not taken by poachers[18] or by the sea were destroyed by feral pigs (*Sus scrofa*). Eggs from poached nests were commercially harvested for sale in the Sarong markets until 1993, when the beaches first received protection by the Indonesian government (J. Bakarbessy, personal communication, *in* Suarez and Starbird, 1996a). During the 1993-96 seasons, environmental education activities in nearby villages and protection measures on this same beach were put into place, with unreported results. Again, approximately 90% of those nests not taken by poachers or the sea[19] were destroyed by pigs (Suarez *et al.* in press). War-Mon beach supports a lower percentage of nesting females, yet egg poaching for subsistence accounted for over 60% of total nest loss during 1993-94, and total loss of nests due to pig predation was 40% (because there are more people in this region, there is more pig hunting; hence less pig predation of leatherback eggs (Starbird and Suarez, 1994)). In 2001 and 2002, conservation measures have reduced predation of eggs by pigs (P. Dutton, NMFS, personal communication, October 2002).

As shown in Table III-13, since the early 1990s, the number of female leatherback turtles nesting annually on the two primary beaches of Irian Jaya appear to be stable. However, given the current, serious threats to all life stages of the Indonesian leatherback populations, this trend may not be sustained and this population could collapse, similar to what occurred in Terrengganu, Malaysia. As human populations in Indonesia increase, the need for meat and competition between the expanding human population and turtles for space increases, all leading to more direct takes of leatherback turtles or incidental take by local fisheries. There is no evidence to indicate that the preceding threats are not continuing today, as problems with nest destruction by feral pigs, beach erosion, and harvest of adults in local waters have been reported (Suarez et al., unpublished report). In addition, local Indonesian villagers report dramatic declines in local sea turtle populations (Suarez, 1999); without adequate protection of nesting beaches, emerging hatchlings, and adults, this population will continue to decline.

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[18] Suarez, *et al.* (in press) provided no information on the estimated percentage of nests lost to poachers.

[19] No information on percentage of nests lost to poachers or the sea were given, except that it was "noted."

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

j. Conclusion on Status of Eastern and Western Pacific leatherback turtles

Although quantitative data on human-caused mortality are scarce available information suggests that leatherback mortality on many nesting beaches remains at unsustainable levels (Tillman, 2000). In addition, except for elimination of fishing mortality in the now-defunct high-seas driftnet fisheries in the North and South Pacific, and reductions of effort in a few other fisheries, risks of mortality in fisheries generally have not been reduced.

Conservation efforts during the last few years at nesting beaches in Mexico and Costa Rica have led to increased survival of eggs, and therefore greater hatchling production per nesting female. This has the potential for increasing future recruitment if post-hatchling survival is not further reduced; however, since numbers of nests are so low, and post-hatchling and juvenile natural mortality are assumed to be high, this increase in hatchling production may only result in the addition of a few adults annually. In western Pacific populations, particularly Irian Jaya, nest destruction by beach erosion and feral pig predation is widespread, and hatchling production is likely to be low relative to the numbers of nests laid. Overall, both eastern and western Pacific populations appear to have low female abundance as a result of legal harvest of eggs and nesting females, poaching, and incidental take in fisheries. Representation in the various age classes of female leatherback turtles is most likely unbalanced as a result of losses of adult females, juveniles and eggs and sub-adults and adults as a result of on-going fisheries and the now-defunct high seas driftnet fisheries. Gaps in age structure may cause sudden collapse of nesting populations when age classes with few individuals recruit into the reproductive population as older individuals die or are removed.

4. Loggerhead Turtles

a. Global Status

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

b. Physical Description

The loggerhead is characterized by a reddish brown, bony carapace, with a comparatively large head, up to 25 cm wide in some adults. Adults typically weigh between 80 and 150 kg, with average CCL measurements for adult females worldwide between 95-100 cm CCL (*in* Dodd, 1988) and adult males in Australia averaging around 97 cm CCL (Limpus, 1985, *in* Eckert, 1993). Juveniles found off California and Mexico measured between 20 and 80 cm (average 60 cm) in length (Bartlett, 1989, *in* Eckert, 1993). Skeletochronological age estimates and growth rates were derived from small loggerheads caught in the Pacific high-seas driftnet fishery. Loggerheads less than 20 cm were estimated to be 3 years or less, while those greater than 36 cm were estimated to be 6 years or more. Age-specific growth rates for the first 10 years were estimated to be 4.2 cm/year (Zug, *et al.*, 1995).

c. Distribution

Loggerhead turtles are a cosmopolitan species, found in temperate and subtropical waters and inhabiting pelagic waters, continental shelves, bays, estuaries and lagoons. The species is divided into five populations: the Atlantic Ocean, Pacific Ocean, Indian Ocean, Caribbean Sea and Mediterranean Sea populations. These populations are further divided into nesting aggregations. In the Pacific Ocean, loggerhead turtles are represented by a northwestern Pacific nesting aggregation (located in Japan) and a smaller southwestern nesting aggregation that occurs in Australia (Great Barrier Reef and Queensland), New Caledonia, New Zealand, Indonesia, and Papua New Guinea. 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° N; (2) a south Florida nesting aggregation, occurring from 29° N on the east coast to Sarasota on the west coast; (3) a Florida panhandle nesting aggregation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida; (4) a Yucatán nesting aggregation, occurring on the eastern Yucatán Peninsula, Mexico; and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (NMFS SEFSC, 2001). In addition, Atlantic and Caribbean nesting aggregations are found in Honduras, Colombia, Panama, the Bahamas, and Cuba. In the Mediterranean Sea, nesting aggregations in Greece, Turkey, Israel, Italy, and several other sites have been recorded. One of the largest loggerhead nesting aggregations in the world is found in Oman, in the Indian Ocean.

d. Life Cycle and Population Dynamics

Figure III-11 illustrates the basic life cycle of the loggerhead turtle (based on data presented by Crouse, *et. al.* (1987) for females of the western Atlantic nesting aggregations). This cycle is broken into seven life stages based on age: (1) egg/hatchling; (2) small juveniles; (3) large juveniles; (4) subadults; (5) novice breeders; (6) first year remigrants; (7) and mature breeders, each with their own expected survival rate (Table III-14). Arrows along the bottom represent the probability of each ageclass surviving and remaining in the ageclass. Arrows between each ageclass represent the probability of the ageclass surviving and growing to the next ageclass, and the arrows along the top represent the ageclass-specific fertility. The thickness or length of the lines do not indicate the level of probability or fecundity. Available information on the behavior, physiology, and biological requirements of these stages is summarized below.

Figure III-11. Life-cycle graph of the loggerhead turtle (Crouse *et. al.*, 1987)

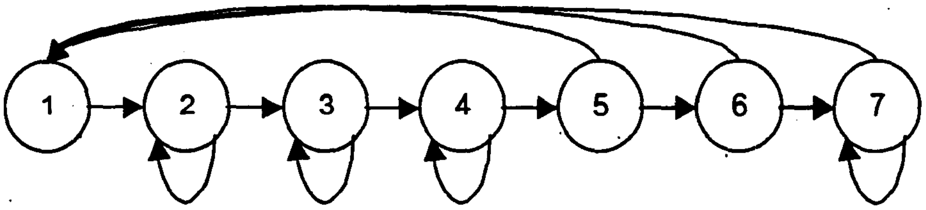

Table III-14: Stage Structure and Vital Rates for Loggerhead Turtles (Crouse, *et. al., 1987*)

Stage	Name	Age	Stable Stage Structure	Survival Probability (lx)	Fecundity (eggs/female)
1	Egg-hatchling	0	20.66%	0.6747	0
2	Small Juvenile (Pelagic)	1-7 (1-12)[1]	66.97%	0.7857	0
3	Large Juvenile (Benthic)	8-15	11.46%	0.6758	0
4	Subadult	16-21	0.66%	0.7425	0
5	Novice Breeder	22	0.04%	0.8091	127
6	First Year Remigrant	23	0.03%	0.8091	4
7	Mature Breeder	25-54	0.18%	0.8091	80

[1] Bjorndal, *et al;* 2001 indicate that the pelagic stage may last from 6.5 to 11.5 years

Numerical analyses of the survival rates, transition rates, and fecundities in Table III-14 indicated that the modeled loggerhead turtle population has a finite population growth rate (λ) of approximately 0.95, which suggests a population that is declining at a rate of approximately 5 percent per year. The stage structure of this population is atypical for long-lived species with delayed maturity[20] and may reflect the effects of various human activities. For example, the survival rates of stage 1 individuals (eggs and hatchlings) probably reflect the combined effects of habitat degradation, feral and wild predators, and beach erosion (NRC 1990). The survival rates of the benthic stages, including adults returning to breed, probably reflect the effects of incidental capture in coastal fisheries and habitat degradation (NRC 1990). By contrast, the survival rate of pelagic juveniles (stage 2) would not have been affected by human activities on land or in coastal waters, which is why a higher proportion of individuals are in that stage. However, this population

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[20] The typical population structure for these species has the largest proportion of individuals and the highest mortality rates in the earliest stages; with proportions and mortality declining through successive stages and the smallest proportion of the total population in the adult stages, which also have the lowest mortality rates. For further discussion of these population structures, see Stearns (1992) and Crouse (1999).

structure is probably an appropriate surrogate of other declining, loggerhead populations because of its atypical structure.

Elasticity analyses for the stage matrix of this population support these general conclusions (Table III-15). The survival rates of adult loggerhead turtles have the highest elasticities, which is typical for long-lived species with delayed maturity. However, the survival rates of pelagic juveniles had the second highest elasticities, which is atypical but, as we discussed previously, may be an artifact of a population whose structure has been modified by various human activities and natural phenomena. These results suggest that changes in the survival rates of mature, reproductive, adults and pelagic juveniles would have the largest proportional effect on this population's trend: increasing those survival rates would help the population recover from its decline, while decreasing those survival rates would exacerbate the population's rate of decline.

Table III-15. Stage elasticities

Stage	Survival Rate	Transition Rate	Fecundity
1	0	0.051	0
2	0.1851	0.051	0
3	0.1186	0.051	0
4	0.1384	0.051	0
5	0	0.039	0.0120
6	0	0.039	0.0003
7	0.2298	0	0.0386

Table III-16. Expected age-class-specific survival probability estimates for southern Great Barrier Reef loggerhead turtles (Chaloupka and Limpus 2002)

Age Class	Survival (Mean)	Survival (95% CI)
Immature[1]	0.8588	0.828-0.885
Adult	0.8749	0.835-.0906

[1] Immature turtles in Chaloupka and Limpus (2001) correspond to stages 3 and 4 of the Crouse model (benthic juveniles and sub-adults).

In contrast to the rates provided in Crouse, *et al.* (1987; Table III-14), Chaloupka and Limpus (2002) reported higher survival rates for immature (benthic juvenile and sub-adult) and adult loggerhead turtles at one large coral reef in the southern Great Barrier Reef (Table III-16). Although this population is exposed to a high risk of incidental capture in coastal Australia otter-trawl fisheries (Chaloupka and Limpus 2002), these higher survival rates are more representative of the expected dynamics of a long-lived, delayed maturity species.

Based on past observations, the loggerhead turtles that are captured and killed in Hawaii-based longline fisheries are primarily pelagic, juvenile loggerhead turtles (see the discussion in the

Effects of the Action section). Over the history of these fisheries, the effect of these annual deaths would significantly reduce the survival rates of individuals in this stage in the nesting aggregations that interact with these fisheries. From our analyses, these reductions would be expected to have a significant, adverse affect on the trend of those nesting aggregations, particularly if these losses are added to losses in other life stages. The combined effect of these activities, which affect most or all life stages of most loggerhead turtle populations, would significantly reduce the growth rates of the nesting aggregations that interact with these fisheries.

e. Biological Characteristics

Nesting loggerheads in the Pacific Basin are found only in the western and southern region (Japan and Australia, primarily); there are no reported loggerhead nesting sites in the eastern or central Pacific. Upon reaching maturity, adult females migrate long distances from resident foraging grounds to their preferred nesting beaches. The average re-migration interval is between 2.6 and 3.5 years (*in* NMFS and USFWS, 1998d). Nesting is preceded by offshore courting, and individuals return faithfully to the same nesting area over many years. Clutch size averages 110 to 130 eggs, and one to six clutches of eggs are deposited during the nesting season (Dodd, 1988). Based on skeletochronological and mark-recapture studies, mean age at sexual maturity for loggerheads ranges between 25 to 35 years of age, depending on the subpopulation (*in* Chaloupka and Musick, 1997), although Frazer *et al.* (1994 *in* NMFS and USFWS, 1998d) determined that maturity of loggerheads in Australia occurs between 34.3 and 37.4 years of age.

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

Tagging programs to study migration and movement of sea turtles provide evidence that loggerhead turtles are highly migratory and capable of trans-Pacific movement. Satellite telemetry studies show that loggerhead turtles tend to follow 17° and 20°C sea surface isotherms north of the Hawaiian Islands (Polovina, *et al.*, 2000; Eckert, unpublished data). Relationships between other turtle species and sea surface temperatures have also been demonstrated, with most species preferring distinct thermal regimes (Stinson, 1984). After capture in the Hawaii-based longline fishery, six satellite transmitter-equipped loggerheads traveled westward along two convergent oceanic fronts, against prevailing currents and associated with a "cool" front characterized by sea surface temperature (17°C), surface chlorophyll and an eastward geostrophic current of about 4 centimeters/second (cm/sec). Three others were associated with a warmer front (20°C), lower chlorophyll levels, and an eastward geostrophic flow of about 7 cm/sec. This study supports a theory that fronts are important juvenile habitat (Polovina, *et al.*, 2000).

For their first years of life, loggerheads forage in open ocean pelagic habitats. Both juvenile and subadult loggerheads feed on pelagic crustaceans, mollusks, fish, and algae. The large aggregations of juveniles off Baja California have been observed foraging on dense concentrations of the pelagic red crab, *Pleuronocodes planipes* (Pitman, 1990; Nichols, *et al.*, 2000). Data collected from stomach samples of turtles captured in North Pacific driftnets indicate a diet of gastropods (*Janthina* sp.), heteropods (*Carinaria* sp.), gooseneck barnacles (*Lepas* sp.), pelagic purple snails (*Janthina* sp.), medusae (*Vellela* sp.), and pyrosomas (tunicate zooids). Other common components include fish eggs, amphipods, and plastics (Parker, *et al.*, in press). These loggerheads in the north Pacific are opportunistic feeders that target items floating at or near the surface, and if high densities of prey are present, they will actively forage at depth (Parker, *et al.*, in press). As they age, some loggerheads begin to move into shallower waters, where, as adults, they forage over a variety of benthic hard- and soft-bottom habitats (reviewed *in* Dodd, 1988). Subadults and adults are found in nearshore benthic habitats around southern Japan, in the East China Sea and the South China Sea (e.g. Philippines, Taiwan, and Viet Nam).

Studies of loggerhead diving behavior indicate varying mean depths and surface intervals, depending on whether they were located in shallow coastal areas (short surface intervals) or in deeper, offshore areas (longer surface intervals). Loggerheads appear to spend a longer portion of their dive time on the bottom (or suspended at depth), which may be related to foraging and refuge. Unlike the leatherback, to the loggerhead foraging in the benthos, bottom time may be more important than absolute depth (Eckert, *et al.*, 1989). The maximum recorded dive depth for a post-nesting female was 211-233 meters, while mean dive depths for both a post-nesting female and a subadult were 9-22 meters. Routine dive times for a post-nesting female were between 15 and 30 minutes, and for a subadult, between 19 and 30 minutes (Sakamoto, *et al.*, 1990 *in* Lutcavage and Lutz, 1997). Based on two loggerheads tagged by Hawaii-based longline observers using satellite-linked dive recorders, data indicate that 90% of the time, was spent at depths less than 40 meters. Only 10 percent of the time did the loggerheads go deeper than 40 meters. The maximum depth recorded was 128 meters. The water temperatures recorded by the satellite transmitters ranged between 15°-25°C (Polovina *et al.*, in press).

f. Population status and trends

Based on genetic analyses conducted at nesting sites, there are five distinct subpopulations of loggerheads in the western Atlantic: (1) a northern nesting subpopulation that occurs from North Carolina to northeast Florida, about 29° N (approximately 7,500 nests in 1998); (2) a south Florida nesting subpopulation, occurring from 29° N on the east coast to Sarasota, Florida on the west coast (approximately 83,400 nests in 1998); (3) a Florida panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida (approximately

1,200 nests in 1998); (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (TEWG, 2000); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (approximately 200 nests per year) (NMFS SEFSC, 2001). The status of the northern population based on the number of loggerhead nests has been classified as stable or declining (TEWG, 2000). Although nesting data from 1990 to the present for the northern loggerhead subpopulation suggests that nests have been increasing annually (2.8 - 2.9%) (NMFS SEFSC, 2001), there are confidence intervals about these estimates that include no growth[21]. Adding to concerns for the long-term stability of the northern subpopulation, genetics data has shown that, unlike the much larger south Florida subpopulation which produces predominantly females (80%), the northern subpopulation produces predominantly males (65%; NMFS SEFSC 2001).

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

Loggerhead turtles are affected by a completely different set of anthropogenic threats in the marine environment. These include oil and gas exploration, coastal development, and transportation; marine pollution; underwater explosions; hopper dredging, offshore artificial lighting; power plant entrainment and/or impingement; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; poaching, and fishery interactions. In the pelagic environment loggerheads are exposed to a series of longline fisheries that include the U.S. Atlantic tuna and swordfish longline fisheries, an Azorean longline fleet, a Spanish longline fleet, and various fleets in the Mediterranean Sea (Aguilar *et al.*, 1995, Bolten *et al.*, 1994, Crouse, 1999). In the benthic environment in waters off the coastal U.S., loggerheads

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

are exposed to a suite of fisheries in federal and state waters including trawl, purse seine, hook and line, gillnet, pound net, longline, and trap fisheries

g. Distribution and Abundance of Nesting Females in the Pacific Ocean

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

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

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

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

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

Loggerhead mortality from human activities is not well-documented except for estimates based on NMFS observer data in the Hawaii-based longline fishery, CA/OR drift gillnet fishery, and recent ongoing studies in Baja California, Mexico (Nichols, *et al.*, 2000; Nichols, 2002). A high mortality in the North Pacific high-seas driftnet fisheries of Japan, Republic of Korea, and Taiwan was estimated in the1980s and 1990s, but those fisheries no longer operate (Wetherall, *et al.*, 1993). Mortality of loggerheads in the East China Sea and other benthic habitats of this population are a concern and thought to be "high," but have not been quantified (Kamezaki, personal communication, *in* Tillman, 2000).

Of the loggerheads taken in the Hawaii-based longline fishery, all were determined to have originated from Japanese nesting beaches, based on genetic analyses (P. Dutton, NMFS, personal communication, October 2002). Therefore, this fishery is impacting a subpopulation that consists of approximately 1,000 females nesting annually.

5. Olive Ridley Turtle

a. Global Status

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

b. Physical Description

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

c. Distribution

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

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

d. Life Cycle and Population Dynamics

Figure III-12 illustrates the basic life cycle of the olive ridley turtle (based on general life history information presented by Marquez (1994) for the Kemp's ridley sea turtle, a surrogate species for the lesser known olive ridley turtle). This cycle is broken into six life stages: (1) egg/hatchling; (2) pelagic juvenile; (3) sub-adult; (4) neophyte breeder; (5) remigrant; and (6) adult. Arrows along the bottom represent the probability of each ageclass surviving and remaining in the ageclass. Arrows between each ageclass represent the probability of the ageclass surviving and growing to the next ageclass, and the arrows along the top represent the ageclass-specific fertility. The thickness or length of the lines do not indicate the level of probability or fecundity. Information on the life stage survival rates and fecundities of olive ridley turtles is sparse. Table III-17 includes the available information on the Kemp's ridley turtle (*Lepidochelys kempi*). Available information on the behavior, physiology, and biological requirements of the olive ridley turtle is summarized below.

Figure III-12. Life-cycle graph of the olive ridley

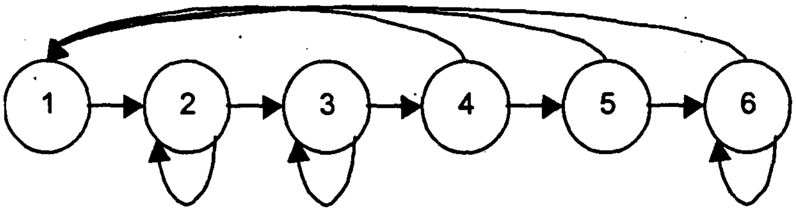

Table III-17: Stage structure and vital rates for olive ridleys (based on Marquez (1981, 1994) data for Kemp's ridley turtles)

Stage	Name	Age	Survival Probability (lx)	Fecundity
1	Egg-hatchling	0	0.609	0
2	Pelagic Juvenile	1	0.565	0
3	Sub-adult	na	0.445	0
4	Neophyte	8	0.421	80
5	Remigrant	9	0.421	84
6	Mature Breeder	10-	0.421 (0.48)[1]	81

[1] Marquez *et al.* (1982a, *in* Chaloupka and Limpus 2002) report a survival rate of 0.48 for adult female olive ridley turtles.

Data on the transition rates between life stages are unavailable; the olive ridleys spend most of their life in the pelagic environment which makes studies of their abundance, life history and ecology, and pelagic distribution difficult. As a result, we were unable to analyze the stage structure of this population to estimate its finite population growth rate (λ) or the elasticities of the various life stages. The typical population structure for long-lived, late-maturing species like olive ridley turtles has the largest proportion of individuals and the highest mortality rates in the earliest stages; proportions and mortality decline through successive stages with the smallest proportion of the total population in the adult stages, which also have the lowest mortality rates. For further discussion of these population structures, see Crouse (1999) and Stearns (1992). An undisturbed population of olive ridley turtles is likely to have a λ and life stage elasticities similar to those described above in the *Life Cycle and Population Dynamics* discussion for green turtles. That green turtle population had a λ of approximately 1, indicating a stationary population, or one that is neither increasing nor decreasing. In addition, a change in the survival rate of an adult green turtle will have the largest proportional change on λ. Changes in the survival rates of the juvenile and sub-adult life stages have the next largest proportional effect on λ. As a result, the growth, decline, or maintenance of the population is determined by the survival rate of reproductive adults, sub-adults, and juveniles. This is not particularly surprising given that these are the longest duration stages for sea turtles. Conversely, the population's λ would be relatively insensitive to changes in the survival rates of eggs or hatchlings; the species has evolved to withstand high natural variability in these survival rates. Persistence of long-lived species with delayed maturity would be most vulnerable to impacts that preclude individuals from 1) attaining age and sexual maturity, or 2) surviving to produce sufficient offspring to replace themselves.

However, the dynamics of some olive ridley turtle populations today likely reflect the effects of numerous anthropogenic activities which have caused or exacerbated the declines in abundance noted in some olive ridley nesting aggregations, such as those in areas of India, Malaysia, Costa Rica, and Guatemala. As a result, the λ and life stage elasticities of these populations are likely indicative of declining populations (λs less than1, and changed proportional importance of different life stage elasticities on λ). For an example of the changed dynamics of a declining sea turtle population, see the *Life Cycle and Population Dynamics* discussion for loggerhead turtles above. In a disturbed population the survival rates of adult turtles may still have the highest elasticities, typical for long-lived species with delayed maturity. However, the survival rates of life stages relatively undisturbed by chronic or significant sources of mortality increase in importance as the population relies upon these stages to supply enough individuals to survive the rigors of subsequent life stages and reach sexual maturity. In the case of a population where the survival of all life stages has been decreased by anthropogenic activities, stage elasticities may change such that the proportional effect of a change in survival rate in any stage can have significant effect on λ.

Based on past observations, the olive ridley turtles that are captured and killed in Hawaii-based longline fisheries are primarily sub-adults and adults (see the discussion in the *Effects of the Action* section). As a result, olive ridley nesting aggregations affected by the Pelagics FMP fisheries could experience declines in adult and sub-adult life stage survival rates, with a corresponding proportional effect on the growth rate of that aggregation. Depending on the magnitude of the change in survival rates and λ, some of these aggregations could slow their rate of increase, begin to decline, or increase the rate of their decline.

e. *Biological Characteristics*

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

Olive ridleys feed on tunicates, salps, crustaceans, other invertebrates and small fish. Although they are generally thought to be surface feeders, olive ridleys have been caught in trawls at depths of 80-110 meters (NMFS and USFWS, 1998e), and a post-nesting female reportedly dove to a maximum depth of 290 meters. The average dive length for an adult female and adult male is reported to be 54.3 and 28.5 minutes, respectively (Plotkin, 1994, *in* Lutcavage and Lutz, 1997). Based on two olive ridleys tagged by Hawaii-based longline observers using satellite-linked dive recorders, data indicate that olive ridleys spend about 20 percent of their time at the surface. Sixty percent of the time the animals were in ocean waters less than 40 meters. Forty percent of the time the animals went to depths greater than 40 meters. The maximum depth recorded was 238 meters. The range of water temperatures recorded was between 23° and 28°C (Polovina *et al.*, in press). In addition, in 1999 eight olive ridley turtles (4 adult females, 3 adult males, and 1 juvenile) were tagged using satellite-linked dive recorders during a research survey in the eastern tropical Pacific Ocean. Sixty percent of the dives were of two minutes or less in duration. The average of the longest dive time for females was 120-180 minutes, 75 minutes for males, and 45-60 minutes for the one juvenile. A diurnal dive behavior was seen where most turtles spent more time near the surface during daylight hours, which were between 9 a.m. to 2 p.m., between 22-56% (mean of 37%) of the total dive time was spent near the surface during this 6-hour period. Female olive ridleys in this study spent significantly more time at 40 to 80 meters than did the males, and the thermocline is an important foraging area for the olive ridley as both male and female turtles spent a significant amount of time in the region of the thermocline (Parker *et al.*, in press).

Olive ridley turtles begin to aggregate near the nesting beach two months before the nesting season, and most mating is generally assumed to occur in the vicinity of the nesting beaches, although copulating pairs have been reported over 100 km from the nearest nesting beach. Olive ridleys are considered to reach sexual maturity between 8 and 10 years of age, and approximately 3 percent of the number of hatchlings recruit to the reproductive population (Marquez, 1982 *in* Salazar, *et al.*, 1998). The mean clutch size for females nesting on Mexican beaches is 105.3 eggs, in Costa Rica, clutch size averages between 100 and 107 eggs (*in* NMFS and USFWS, 1998e). Females generally lay 1.6 clutches of eggs per season by Mexico (Salazar, *et al.*, 1998) and two clutches of eggs per season in Costa Rica (Eckert, 1993). Data on the remigration intervals of olive ridleys in the eastern Pacific are scarce; however, in the western Pacific (Orissa, India), females showed an annual mean remigration interval of 1.1 years. Reproductive span in females of this area was shown to be up to 21 years (Pandav and Kar, 2000).

f. Population status and trends

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

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

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

g. *Distribution and Abundance of Nesting Females in the Pacific Ocean*

In the eastern Pacific, nesting occurs all along the Mexico and Central American coast, with large nesting aggregations occurring at a few select beaches located in Mexico and Costa Rica. Few turtles nest as far north as southern Baja California, Mexico (Fritts, *et al.*, 1982) or as far south as Peru (Brown and Brown, 1982). A single olive ridley nested in 1985 on the island of Maui, Hawaii, but the eggs did not hatch (Balazs and Hau, 1986 *in* NMFS and USFWS, 1998e), and the event was most likely an anomaly. Where population densities are high enough, nesting takes place in synchronized aggregations known as *arribadas*. The largest known *arribadas* in the eastern Pacific are off the coast of Costa Rica (~475,000 - 650,000 females estimated nesting annually) and in southern Mexico (~800,000+ nests/year at La Escobilla, in Oaxaca (Millán, 2000).

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

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

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

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

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

Indonesia and its associated waters also provides habitat for olive ridleys, and there are some recently documented nesting sites. On Jamursba-Medi beach, on the northern coast of Irian Jaya, 77 olive ridley nests were documented from May to October, 1999 (Teguh, 2000 *in* Putrawidjaja, 2000). However, as mentioned in the leatherback subsection, extensive hunting and egg collection, in addition to rapid rural and urban development, have reduced nesting activities in this area. In Jayapura Bay, olive ridleys were often seen feeding, and in June, 1999, an estimated several hundred ridleys were observed nesting on Hamadi beach, despite heavy human population in the nearby area. Locals report daily trading and selling of sea turtles and their eggs in the local fish markets (Putrawidjaja, 2000). At Alas Purwo National Park, located at the eastern-most tip of East Java, olive ridley nesting was documented from 1992-96. Recorded nests were as follows: from September, 1993 to August, 1993, 101 nests; between March and October, 1995, 162 nests;

and between April and June, 1996, 169 nests. From this limited data, no conclusions could be reached regarding population trends (Suwelo, 1999).

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

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

According to Pandav and Choudhury (1999), the number of nesting females at Gahirmatha has declined in recent years, although after three years of low nestings, the 1998-99 season showed an increasing trend (Noronha, Environmental News Service, April 14, 1999), and the 1999-2000 season had the largest recorded number of olive ridleys nesting in 15 years (The Hindu, March 27, 2000; The Times of India, November 15, 2000). During the 1996-97 and 1997-98 seasons, there were no mass nestings of olive ridleys. During the 1998-99 nesting season, around 230,000 females nested during the first arribada, lasting approximately a week (Pandav and Kar, 2000); unfortunately, 80% of the eggs were lost due to inundation and erosion (B. Pandav, personal communication, *in* Shanker and Mohanty, 1999). During 1999-2000, over 700,000 olive ridleys nested at Nasi islands and Babubali island, in the Gahirmatha coast. It is not known how many eggs and nests were lost to high winds and strong waves, predicted to cause erosion on the islands (The Hindu, March 27, 2000), and an estimated 6,000 turtles were killed during this period due to illegal mechanized trawlers and non-use of the prohibited turtle excluder devices (S. Sahoo, January, 2001 in rediff.com[22]).

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

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

C. Factors Affecting Listed Marine Mammals

Because marine mammal species in the Pacific Ocean are subject to different impacts, the fisheries and non-fisheries related threats to the listed marine mammals in the Pacific Ocean that are affected by the pelagic fisheries of the fishery management plan under the western Pacific region are discussed for each species.

1. Humpback whale

In the 1990s, no more than 3 humpback whales were killed annually in U.S. waters by commercial fishing operations in the Atlantic and Pacific Oceans. Between 1990 and 1997, no humpback whale deaths have been attributed to interactions with groundfish trawl, longline and pot fisheries in the Bering Sea/Aleutian Islands, and Gulf of Alaska (Hill and DeMaster 1999). Humpback whales have been injured or killed elsewhere along the mainland U.S. and Hawaii (Barlow et al. 1997). In 1991, a humpback whale was observed entangled in longline gear and released alive (Hill et al. 1997). This interaction occurred inside what is now the protected species zone of the islands and atolls of the Northwestern Hawaiian Islands. In 1995, a humpback whale in Maui waters was found trailing numerous lines (not fishery-related) and entangled in mooring lines. The whale was successfully released, but subsequently stranded and was attacked and killed by tiger sharks in the surf zone. In 1996, a humpback whale calf was found stranded on Oahu with evidence of vessel collision (propeller cuts; NMFS unpublished data). Also in 1996, a vessel from Pacific Missile Range Facility in Hawaii rescued an entangled humpback, removing two crab pot floats from the whale; the gear was traced to a recreational fisherman in southeast Alaska. In 2001 and 2002, NMFS observed a humpback whale entangled in the mainline of Hawaii-based longline vessels. The animals were released alive, although one may have had a small length of trailing line attached. No information is available on the number of humpback whales that have

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[22] http://www.rediff.com/news/2001/jan/22oris.htm

been killed or seriously injured by interactions with fishing fleets outside of U.S. waters in the North Pacific Ocean.

Humpback whales seem to respond to moving sound sources, such as whale-watching vessels, fishing vessels, recreational vessels, and low-flying aircraft (Beach and Weinrich 1989, Clapham et al. 1993, Atkins and Swartz 1989). Their responses to noise are variable and have been correlated with the size, composition, and behavior of the whales when the noises occurred (Herman et al. 1980, Watkins et al. 1981, Krieger and Wing 1986). Several investigators have suggested that noise may have caused humpback whales to avoid or leave feeding or nursery areas (Jurasz and Jurasz 1979b, Dean et al. 1985), while others have suggested that humpback whales may become habituated to vessel traffic and its associated noise. Still other researchers suggest that humpback whales may become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle et al. 1993; Wiley et al. 1995). In Hawaii, regulations prohibit boats from approaching within 91 m of adult whales and within 274 m in areas protected for mothers with a calf. Likewise, in Alaska, the number of cruise ships entering Glacier Bay has been limited to reduce possible disturbance.

Humpback whales are killed by ship strikes along both coasts of the U.S. On the Pacific coast, a humpback whale is killed about every other year by ship strikes (Barlow et al. 1997). On the Atlantic coast, 6 out of 20 humpback whales stranded along the mid-Atlantic coast showed signs of major ship strike injuries (Wiley et al. 1995). Almost no information is available on the number of humpback whales killed or seriously injured by ship strikes outside of U.S. waters.

2. Monk seal

This analysis describes factors affecting the environment of the species or critical habitat in the action area, including state, local, and private actions already affecting the species or actions that occur contemporaneously with the consultation in progress. Unrelated Federal actions affecting (adverse or beneficial effects) the same species or critical habitat are also part of the environmental baseline considered in this section.

- *Fisheries*

Several fisheries operate in the areas utilized by the Hawaiian monk seal. Some of the fisheries are federally managed fisheries. These are: the bottomfish fishery, the crustacean fishery, and the precious coral fishery. Other fisheries that operate in areas utilized by the monk seal include fisheries managed by the State of Hawaii. These fisheries include: the state-managed MHI bottomfish fishery, commercial and recreational nearshore fisheries, akule fishery, collection for the aquarium trade, and commercial and recreational gillnet fisheries.

(a) The NWHI Crustacean Fishery

The NWHI lobster fishery is managed under the Fishery Management Plan for the Crustacean Fishery for the Western Pacific Region (Crustaceans FMP). The lobster fishery began in the 1970's and annual landings peaked at 1.92 million lobsters in 1985. Since then, landings have decreased. The number of vessels participating in the lobster fishery has ranged from 0 to 17, with only 5 and 6 vessels participating during 1998 and1999, respectively (Al Katekaru, NMFS, pers. comm., 2001).

Historically, effort has been concentrated near the islands and atolls of the NWHI where monk seals occur. Data reports[23] show no monk seal entanglements or other interactions. However, in 1986 near Necker Island, one monk seal died as a result of entanglement with a bridle rope from a lobster trap. This incident was reported by NMFS research cruise personnel. Separate from the bridle rope incident, a precautionary measure was taken in 1983 to redesign the entrance cone to ensure that monk seals could not get caught in lobster traps entrances.[24]

Lobster is a known prey item of the monk seal, but the importance of lobster in their diet has not been quantified. Ongoing foraging and prey identification studies will help understand the effect, if any, of the lobster fishery on monk seal populations in the NWHI.

The lobster fishery was closed in1993 based on the harvest quota set for the fishery under Amendment 7 of the Crustacean FMP. The fishery re-opened in 1994 with five vessels participating in the fishery; in 1995 the fishery was closed; however, one vessel was allowed to fish under an experimental fishing permit issued by NMFS to obtain scientific information on the lobster stock. From 1996 through 1999 the fishery had 5, 9, 5, and 6 vessels participating respectively. Although the lobster fishery was not overfished, NMFS closed the fishery in 2000 through 2002 because of an increased level of uncertainty in the model assumptions used to estimate the lobster harvests (65 FR 39314). Harvest guidelines for the 2001 and 2002 fishery were not issued by NMFS (66 FR 11156, Feb. 22, 2001). Furthermore, the fishery has remained closed under a Court order (NMFS v. Greenpeace Foundation) until an environmental impact statement and biological opinion for the fishery have been completed.

Under the authority of the National Marine Sanctuaries Act, President Clinton approved Executive Orders 13178 (Dec. 4, 2000) and 13196 (Jan. 18, 2001) permanently establishing the NWHI Coral Reef Ecosystem Reserve. The Executive Orders limit the NWHI lobster fishery as a result of conservation measures that severely restrict all consumptive and exploitative activities throughout the Reserve, including the harvest of lobsters, bottomfish and precious corals (discussed below).

(b) The Precious Coral Fishery

Precious corals are harvested under the Fishery Management Plan for Precious Coral

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[23] The lobster fishery was "observed" on a voluntary basis starting in 1997. NMFS scientific data collectors were dispatched on each of the lobster trips during 1997 through 1999. In 2000, 2001 and 2002, the lobster fishery was closed.

[24] Plastic dome-shaped single-chambered traps with two entrance funnels or cones located on opposite ends are employed in the lobster fishery. All traps are required to have escape vents (for smaller lobster). The traps are usually set in strings of about one hundred per string, with several strings fished at a time.

Fisheries of the Western Pacific Region (Precious Corals FMP). NMFS has determined that the harvest would not adversely affect the monk seal (NMFS, 2000). Regulatory changes to the Precious Corals FMP recommended by the WPRFMC were partially approved by NOAA Fisheries in 2002. Those parts specific to the Northwestern Hawaiian Islands were disapproved because they were deemed to be in conflict with (or redundant with) the E.O. 13178 and 13198 establishing the NWHI Coral Reef Ecosystem Reserve.

Pink, gold and bamboo varieties of coral are typically found at depth ranges between 350 to 1500 m, while black coral occurs at considerably shallower depths of less than 100 m. Exploitable beds have been surveyed at seven locations. The six known beds of pink, gold and bamboo corals are Keahole Point, Makapuu, Kaena Point, Wespac, Brooks Bank and 180 Fathom Bank. A seventh bed was recently discovered near French Frigate Shoals. The only exploitable black coral bed is located in the MHIs in the Auau channel. (WPRFMC, 2001).

The contribution of coral beds to prey aggregation and prey availability for monk seals remains unclear. As discussed previously, monk seal diet studies indicate that monk seals are opportunistic and feed on a wide variety of prey (Goodman-Lowe 1998). Research from Parrish et al., (in press) and Abernathy and Siniff (1998) ishows that some seals forage at depths where precious coral beds occur. However, the absence of deep diving activity at Pearl and Hermes suggests that monk seals at French Frigate Shoals may vary their foraging behavior depending on the availability of prey resources.

Potential increases in fishing pressure on precious corals in the Northwestern Hawaiian Islands and the possible importance of precious coral beds as foraging areas for monk seals prompted the Western Pacific Fishery Management Council to recommend additional management measures for the precious coral fishery. However, those measures pertaining to the Northwestern Hawaiian Islands were not promulgated by NMFS because they were deemed to conflict, if not duplicate, with the NWHI Coral Reef Ecosystem Reserve program. Today, the precious coral fishery is inactive and is likely to remain dormant in the foreseeable future due to high operating costs and poor economic conditions locally and abroad.

(c) Recreational Fisheries

i. NWHI Recreational Fishing

In the NWHI, the U.S. Fish and Wildlife Service contracted a concession that operated an ecosystem station at Midway Island. Recreational fishing is allowed in the lagoon and waters around the island, however little to no recreational fishing currently occurs there. The USFWS is currently seeking avenues for reopening the ecotourism operations at Midway, thus the potential for interactions in this Opinion are based on information from the operations as they existed until March 2002. Fishers are advised to stop fishing and move out of the area if monk seals approach a vessel. A study conducted in 1998 recorded monk seal interactions at 6 locations during fishing activities. The report indicated that chum in the water may not influence monk seal behavior. However, it was reported that when two monk seals "took note of the fisher/observer" they "swam on and out of the area" (Bonnet and Gilmartin, 1998). Inquisitive, newly weaned pups sometimes approach fishing activities, presumably to investigate human activity. (Shallenberger, pers. comm., 2001).

Three monk seals were reported to have been hooked as a result of recreational fishing during the operation of the U.S. Coast Guard station at Kure Atoll, which closed in 1993 (Forney et al., 2000).

ii. The MHI Bottomfish Fishery and Recreational Fisheries (State Managed Fisheries)

In the MHI, the state regulated bottomfish fishery operates off-shore of shoreline areas where monk seals are sometimes observed. Although there have been no reported interactions between monk seals and this fishery, there is some indication that interaction are occurring. Some areas off-shore of regularly utilized monk seal haul-out areas have been closed to bottomfish operations due to concerns about overfishing.

The fisheries for big game (*ulua*) and small game (*papio* and other smaller fish) are two of the largest components of the shore-based recreational fisheries in Hawaii. The term *ulua* mainly refers to two species, the White ulua (*Caranx ignobilis*) and the Black ulua (*C. lugubris*). Ulua can also be used to refer to larger *Caranx* (ten or more lb). The term *papio* can refer to *Caranx ignoblis* and *C. lugubris* under 10 lbs as well as to six to eight other smaller carangids commonly found in near-shore waters. The two fisheries differ more in the gear used rather than the target species. Any of the species can be and are taken in both fisheries. The two predominant fishing methods employed are "slide-bait" and "shore casting".

Big game shorefishing, primarily targeting large ulua, usually utilizes slide-baiting techniques. Slide bait rigs have a large hook tied or crimped to a short length of wire or heavy monofilament leader which is in turn tied or crimped to a "slide bait" swivel. The slide-bait fishery almost exclusively employs circle hooks of sizes corresponding to Mustad sizes 14/0 and larger. This leader and hook set up is independent of the wired weight set up. These two independent sets of gear combine to make a whole slide bait rig. The weight is cast out and anchored before the slide bait hook rig is attached to mainline and allowed to "slide" down and out to its final fishing position. The preferred baits are moray eels, "white eel" or "tohei"(conger eel), and octopus. Live reef fish of all kinds are also among the preferred baits.

The mainline (line on the fishing reel) used in slide baiting varies according to the individual, but is generally heavy line in the 80-100 lb plus test weight. The fishing weights generally have 4-5 inch soft wires extending from the terminal end. These wires are bent into a grapnel shape to snag onto rocks and coral to provide a solid anchoring point from which to suspend the large baits off the bottom and prevent the rig from moving with the current or swell. The limited movement prevents tangling with other rigs. The wires used are malleable enough to be straightened with pressure from the rod. The line connecting the weight to the swivel is of a lesser strength than the mainline and designed to break should the weight become inextricably stuck on the bottom.

Small game fishing uses a general rig in which a hook(s) and lead is attached to a swivel and is cast as a single unit. It uses smaller hooks and lighter leaders. The major difference between big game fishing and small game fishing is the kind of rig used and the size of the gear and the general kinds of areas that are preferred by each. The slide-bait fishery is generally associated with close proximity of deep water (20-100 ft) because the technique depends on gravity or the live bait to take the bait down the mainline to the strike zone. Shorecasting for small game is done anywhere along the shoreline.

The third shore based fishery is locally referred to as "whipping." Whipping involves standing on the shore, usually a rocky area, and casting and quickly retrieving an artificial lure into breaking waves headed towards shore. The lure usually has treble or double hooks attached. Fishing line in the 20-50 lb test weight range is commonly used in this fishery. Often the leader, the first few feet of line directly attached to the lure, is a thicker line for protection from chafing on the fish's teeth or the reef and rocks. Whipping is also successfully done from boats.

Ulua are also fished from boats. A variety of gear may be employed; typical are the trolling set-up, with down riggers or trolling planes, and surface plugs or casting jigs. Trolling usually takes place at depths of 50-200 ft, with depth fished highly dependent on local conditions and bottom topography. Artificial lures, such as plugs and lead-head jigs, are used just outside the breaking surf. The lures used generally have either treble or double hooks attached directly to the lure. The line weights vary from 20 lb or heavier test weight.

The gear used in these recreational fisheries varies, but the most popular gear composition is a circle hook with a slide bait swivel on a wire leader. There is some overlap with the type of hook used (circle hooks) in the bottomfish fishery although the size of the *ulua* circle hook tends to be larger than that used in the bottomfish fishery. Some of the hooks embedded in monk seals have been identified as gear used in the state *ulua* fishery based on gear, size of hook, and location of the monk seal when discovered, while other hooks have been identified as bottomfish fishery hooks (see Table III-18).

Table III-18. List of Hooks and Net Entanglements as a Source of Information on Fishery Interactions. (Source: NMFS, unpubl. data 2001)

	Date and Location	Description	Outcome
1	1982 French Frigate Shoals	Adult female was observed with bottomfish hook in mouth.	Resighted without hook at French Frigate Shoals
2	1985 NWHI - Kure Atoll	Female weaned pup hooked in lip	Hook removed by NMFS personnel; small hook and rig characteristic of on-site recreational fishery
3	1986 NWHI - Necker	Monk seal entangled in bridle rope of lobster trap	Found dead
4	1990 MHI - Kauai	Juvenile observed with hook	NMFS response included capture and hook removal. Hook identified as type used in the *ulua* shore-based fishery.

	Date and Location	Description	Outcome
5	1991 NWHI - FFS	Adult male observed with hook in chest, trailing monofilament line	Hook removed, reported in injury reports form FWS in NMFS field report: Reported to be a longline hook
6	1991 NWHI - FFS	Adult male observed with hook in lower jaw trailing monofilament line	Hook removed by NMFS; Hook idenitified as longline hook
7	1991 NWHI - Kure Atoll	Weaned female pup observed with hook in lip	NMFS personnel captured seal and removed hook. Hook was small, characteristic of on-site recreational fishery.
8	1991 NWHI - Kure Atoll	Subadult female observed with hook in corner of mouth	Seal subsequently seen without hook; hook never recovered or identified.
9	1994 NWHI- French Frigate Shoals	Pregnant female with hook	Hook stated by observers to be a swordfish fishery hook. No confirmation of report (NMFS, 1996)
10	1994 NWHI	Monk seal reported taken in longline logbook report	Reported released injured
11	1994 MHI - Kauai	Monk seal observed with hook in mouth trailing monofilament line	Outcome unknown; Reported in DLNR memo
12	1994 MHI - Oahu	Report of dead seal in gillnet off Waianae	reliable but unconfirmed report, no seal recovered
13	1994 NWHI-"No Name Bank"	Active hooking of adult seal during bottomfishing; seal had stolen catch and had become hooked	Fisherman pulled seal to boat and cut leader 12"-18" from the seal.
14	1995 MHI - Kauai	Juvenile male found dead, necropsy revealed fishhook in lower esophagus	mortality; hook was "slide rig" characteristic of shore-based *ulua* fishery
15	1996 MHI - Oahu (Ala Moana Beach) (first sighted on Maui)	Adult male observed with hook in mouth. The seal was identified as a seal that had been translocated from Laysan Island, NWHI.	Hook removed by NMFS. Hook identified as from slide rig, shore based *ulua* fishery.
16	1996 NWHI - French Frigate Shoals	Adult male observed with hook in mouth	Hook removed by researchers. Hook identified as type used in the *ulua* shore-based fishery and bottomfish fishery.
17	1996 MHI - Maui	Adult hooked during fishing tournament	Out loose, probably with hook in mouth or jaw
18	1996 MHI - Oahu	Male weaned pup cited with hook in foreflipper	No subsequent observation

	Date and Location	Description	Outcome
19	1998 MHI - Maui	Hooked seal reported to NMFS; Juvenile female. Observers stated it was a #7 or #9 *ulua* hook	NMFS response included capture and physical exam, No hook was found, but some minor trauma was observed in mouth where hook had been present
20	2000 MHI - Molokai	Juvenile male observed with 2 hooks and line embedded in chest (ventral) area.	NMFS response included capture and physical exam of seal. No hooks or line present, but slight injury was documented by veterinarian.
21	2000 MHI - Kauai (Ha'ena Beach)	Adult female observed with hook in mouth.	NMFS response included capture and hook removal. Hook identified as type used in the *ulua* shore-based fishery.
22	2001 MHI - Kauai (Mahaulepu Beach)	Juvenile female with hook in lower lip and base of jaw.	Hook removed by DLNR personnel. Hook and leader determined to be from recreational ulua fishery
23	2001 MHI - Kahoolawe	Adult male with hook in abdomen or front flipper	Hook not removed as of July, 2001. Fishery type unknown.
24	2001 MHI - Hawaii	Weaned male pup (Southpoint) reported with small hook in back (photo)	Resighted without hook
25	2001MHI - Hawaii	Weaned male pup (Southpoint) reported with hook	NMFS captured and removed hook; ulua shorebased hook
26	2002 MHI - Oahu	Adult female with hook in mouth, trailing line (Ewa Beach)	NMFS responded, removed hook; recreational ulua hook
27	2002 MHI - Oahu	Monk seal reported entangled and released from gillnet	Monk seal reported released alive
28	2002 MHI - Kauai	Monk seal adult female hoooked through neck, 10-15 feet of line trailing	DLNR captured and removed hook.

Although there is only one report of a hooking of a monk seal on gear being actively fished, several monk seals have been observed with embedded hooks. Sometimes the hooks have trailing line which poses a potential entanglement hazard. NMFS researchers and veterinarians have responded to some of these reports and have treated the monk seals and provided descriptions of the wounds caused by the hook. Based on these descriptions and outcome (when known), the injuries sustained by monk seals from embedded hooks have been classified as injuries or serious injuries. An embedded hook was considered a serious injury if it hooked in the mouth deeper than the lip. Thus, hooks embedded inside the mouth, in the tongue, the mandible or upper jaw, throat, or deeper are classified as serious injuries, whereas "lip hookings" and other shallow embedded hooks are considered nonserious. The rationale for this division is that foraging would likely be impeded by the serious injuries. Hooks embedded in the lip or shallowly embedded hooks in other body areas would most likely fall out and would not impair feeding or other activities. Considering the information available, the above classification approach is consistent with the views expressed by researchers and veterinarians in a workshop held to discuss the serious injury guidelines.[25]

(d) Documented Monk Seal Interactions with Other Fishing Operations in the NWHI

Reports suggest that the distribution of interaction events with monk seals is non-random with respect to location and vessel. Fishery participants have reported seeing monk seals in the vicinity of islands where they are known to breed. Humphreys (1981) reviewed three categories of data for observations and interactions with fishing operations in the NWHI (French Frigate Shoals and Lisianski Island). Although the review was undertaken to characterize the interaction level with the lobster fishery in the NWHI, other fishery operations were considered. The review included commercial vessels, NMFS research vessels and charter vessels. Data pooled from all three sources yielded 35 sightings and 3 interactions with listed species. Two of the three interactions occurred near French Frigate Shoals and involved monk seals that seemed attracted to vessel lighting during night research/fishing operations. In one instance, two monk seals interfered with mackerel (scad) fishing under a light by removing hooked fish from lines before the fish could be retrieved. In another instance, a monk seal interfered with night-light operations by chasing fish away from the light and tugging on the light cord with its mouth. No hookings of monk seals were reported. (Humphreys, 1981)

(e) Vessel groundings/Vessel collisions

In April, 1999, a longline vessel (*F/V Van Loi*) grounded on a reef off of Kapaa, Kauai. The vessel had 16,000 gallons of diesel fuel onboard and was carrying 3 tons of bait and gear. All fuel, bait, and gear (including monofilament line and hooks) went overboard into the marine environment. Monk seals and sea turtles were observed in the area, but no adverse interaction with fuel or gear was reported by wildlife resource managers on scene. In addition, another longline vessel grounded at Pearl and Hermes Reef, and a lobster boat at Kure Atoll.

In August 1998, Tesoro Hawaii Corporation fuel operations resulted in a spill of about 5,000 gallons of bunker fuel off of Barber's Point, leeward Oahu. The waters and shoreline of Kauai were affected, and oiled monk seals were reported in the area. During September 1998, up to 5 oiled monk seals were observed. One monk seal had its entire oral mucosa coated with red, blood-like fluid. This monk seal was later resighted and exhibited signs of a respiratory infection. Another monk seal exhibited "gagging behavior". As there were no physical exams conducted on the animals observed, the wildlife resource agencies could not reach a conclusion about the effects of the oil on the monk seals (Natural Resources Trustees, 2000).

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[25] "Injury of pinnipeds: A brief discussion of injuries reported for pinnipeds indicated that an animal hooked in the mouth (internally) or trailing gear should be considered seriously injured. Some participants felt that an animal hooked in its body would likely not be seriously injured." (Differentiating Serious and Non-Serious Injury of Marine Mammals taken Incidental to Commercial Fishing Operations: Report of the Serious Injury Workshop held in Silver Spring, MD, April 1-2, 1997)

In addition to the vessel groundings, a pup born at the Pacific Missile Range Facility on Kauai was reported dead in 1999. There was an anonymous and unconfirmed report that the pup may have been hit by a zodiac-type vessel employed in the tourist industry.

b. Marine Debris

Monk seal death and injury attributable to entanglement in marine debris has been documented in the NWHI. Lines, nets, and other debris have been removed from monk seals by government personnel. Although steps have been taken to reduce the debris load in the NWHI, the debris accumulation in these areas is incessant due to contributions from various sources (vessels of unknown origin) and currents to the NWHI. Much of this debris comes from north of the Hawaiian Archipelago (Kubota, 1999).

Information on marine debris entanglement and injuries, including mortalities, has been collected by NMFS since 1982. For the purposes of this biological opinion, NMFS reviewed documented entanglements of monk seals for the period 1982-2000 to determine the effects of marine debris. Entanglements in all debris types (fishery related debris and non-fishery related debris) were considered (Table III-19). Fishery related gear was considered to comprise of nets, any net/line aggregate, "eel cones" (cones from hagfish traps), monofilament line, any line with attached floats, and lines with head/foot rope from a net. All other identified entangling items were considered non-fishery related. These items included unspecified lines (e.g. "ropes"), packing straps, plastic rings of unknown source, and assorted miscellaneous objects. Entanglements by unknown items, which were documented only by the presence of a recently acquired entanglement scar on a seal, were assigned to fishery or non-fishery items by multiplying the total unknowns times the ratio of known fishery items to all known items.

Table III-19. Categories of Marine Debris that Entangle Monk Seals 1982-2000. (Source: NMFS, unpublished data, 2001; Henderson, 1990)

	category	description
	Nets	All nets or net fragments of fishery origin, including drift nets, trawl nets, or seines.
	Lines	All "ropes" or fishing line; lines are certainly of maritime origin, but are not necessarily of fishery origin.
	Net/Line Combination	Collection of nets and lines, probably aggregated at sea by ocean currents. Because nets are a part of the aggregate, the item is considered of fishery origin.
	Cone	Black plastic mesh cones which are part of traps used in the hagfish fishery.
	Rings	All rings other than the cones noted above. This category may include rims from plastic lids or other circular items; origin unknown.

	category	description
	Straps	Plastic packing band used around boxes; origin fishery and non-fishery.
	Other/Unknown	All items not in previous categories which have entangled monk seals; Monk seals with scars/wounds attributed to entanglement are considered to have been entangled by an unknown item.

The data were examined to determine which incidents resulted in "serious injuries", i.e. any injury that will likely result in mortality. The following were considered serious injuries:

1. Any entanglement which caused a wound, i.e. in which the seal's skin was broken. This definition includes seals observed with an entanglement scar, since the scar resulted from a wound.

2. Any entanglement in which the seal was immobilized by entangling debris on an offshore reef, even if the seal was released by humans without having incurred a wound. Any seal so trapped would likely have died from drowning, predation, or starvation had it not been released.

3. Any entanglement in which the entangling item was removed without having inflicted an external wound, but for which the observer specifically stated that the item would not have come off without human assistance, or that the seal probably would have died.

Considering the information available, the above classification approach is consistent with the views expressed by researchers and veterinarians in a workshop held to discuss the serious injury guidelines.[26]

Figure III-13. Number of Hawaiian monk seal entanglements observed, 1982-2000. (Source: Laurs, 2000)

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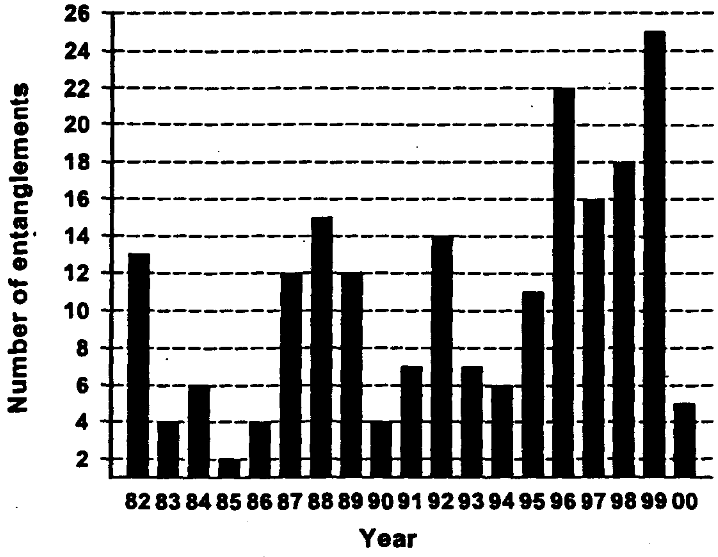
[26] In the discussion on the entanglement and injury of pinnipeds, one veterinarian noted that, "lesions from netting or packing bands are often infected and associated with necrotic tissue. If such an injury is in the neck region and if the infection surpasses the ability of the lymph system to control it, the lungs will often become infected, often leading to mortality. In addition, microbes that enter the blood stream can cause secondary infections in the heart (e.g. heart valves), brain, or other vital organs. . . ." (Differentiating Serious and Non-Serious Injury of Marine Mammals taken Incidental to Commercial Fishing Operations: Report of the Serious Injury Workshop held in Silver Spring, MD, April 1-2, 1997, p. 23).



(a) *Injuries*

A total of 204 entanglements were documented (see Figure III-13), 96 by fishery items (5.05 per yr), 96 by non-fishery items (5.05 per yr), and 12 by unknown items (0.64 per yr). Assigning the unknowns to fishery or non-fishery according to the formula given above results in 102 entanglements by fishery items (5.37 per year) and 102 entanglements by non-fishery items (5.37 per yr).[27]

(b) *Serious Injuries*

Of the total number of entanglements, a total of 47 serious injuries from entanglement were documented, including 27 by fishery items (1.42 per year), 8 by non-fishery items (0.42 per year), and 12 by unknown items (0.64 per year). Assigning the unknowns to fishery or non-fishery results in a total of 36 serious injuries from entanglements in fishery items (average of 1.91 per year) and total of 11 serious injuries from non-fishery items (average of 0.58 per year).

(c) *Mortalities*

Mortalities from entanglement were also documented: 7 mortalities were documented (0.37 per year), 6 mortalities were from fishery items (0.32 per year) and 1 was from a non-fishery item (0.05 per year) (see Table III-20).

Table III-20. Known Marine Debris Related Mortalities 1982-2000. (Source: NMFS, unpublished data, 2001)

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[27] The assignments of unknowns were allocated according to the ratio of known items causing serious injury (not merely entanglement) and known items causing nonserious injury.

No.	Year and Location	Description
1	1986– French Frigate Shoals	Weaned male tangled in wire which was relic of USCG or Navy occupation; in water
2	1987–Lisianski Is.	Pup (uncertain if nursing or weaned) dead in aggregate of trawl net and line on shore
3	1987–French Frigate Shoals	Juvenile dead in aggregate of trawl net and line on shore
4	1988–Lisianski Is.	Weaned pup dead in large trawl net on shore
5	1995–Pearl and Hermes Reef	Bones of adult found scattered in line awash on shore
6	1997-French Frigate Shoals	Subadult dead in trawl net on reef
7	1998–Laysan Island	Weaned pup dead in trawl net on nearshore reef

As most of the monk seal population is located on uninhabited islands and atolls, observation and monitoring by NMFS and other agencies occurs during only part of each year. The serious injuries and mortalities documented above represent a minimum combined serious injury and mortality rate of 2.48 per year (1.91 serious injuries and 0.74 mortalities). It cannot be assumed that entanglements would be observed at a directly proportionally increased rate if year-round observations were made. For instance, NMFS biologists on site in the NWHI during pupping season have observed more weaned pups entangled in marine debris than other size classes of monk seals (Henderson 1990). At this time, the 2.48 rate of serious injury and mortality from fishery related marine debris should be considered a minimum serious injury and mortality rate.

c. *Contaminants*

Contaminants in the marine and terrestrial environment also pose a potential but unknown risk to monk seal recovery and survival. Effects on monk seals are unknown at this time. However, tissue samples from monk seals indicate that PCB levels are lower in monk seals than in other pinnipeds and the values at French Frigate Shoals are less than the values from samples obtained from monk seals at Midway Islands (NMFS unpub. preliminary data, 1999). The significance of these levels to monk seal health is unknown at this time. However, the ecological effects of clean-up and containment operations at Tern Island (French Frigate Shoals), Johnston Atoll, and Midway Island may have short-term adverse effects on the surrounding corals, fish and invertebrates. Reductions in prey abundance due to clean-up efforts could reduce foraging success and survival rates of monk seals near these areas.

d. Tern Island Sea Wall Entrapment

Monk seals at Tern Island, French Frigate Shoals, have on occasion become entrapped behind a deteriorating sea wall. The seawall was built by the U.S. Navy when it converted the 11-acre sandbar into a 34 acre expanse with an airfield and area for support facilities. The U.S. Fish and Wildlife Service regained possession of Tern Island in 1979. Records from 1988 show that some monk seals have been entrapped behind the seawall. Most of these monk seals have been redirected to the water by U.S. Fish and Wildlife Service (FWS) and NMFS personnel on site. Two subadult male monk seals have died as a result of becoming entrapped behind the sea wall.

The numbers of entrapments and deaths (indicated by an asterisk) are listed below in Table III-21. The restoration of the Tern Island sea wall is planned to take place in 2002 and is the subject of a separate section 7 consultation.

Table III-21: Incidence of Monk Seal Entrapments and Deaths on Tern Island From 1988 - 2000 (Source: USFWS, 2000)

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
# of seals	1*	3	1	6 1*	4	2	3	3	0	0	5	4	4

e. Human Interactions

(a) Disturbance at Haul-Out Sites

Some monks seals hauled-out on beaches are viewed by tourists and residents who are often unfamiliar with the take prohibitions and/or the normal behavior of monk seals. NMFS receives at least 2 reports per week of "stranded" monk seals. Some people attempt to haze the animal back into the water. Most often, the animal reported is exhibiting normal haul-out behavior. Another common harassment is people approaching too closely to take photographs of the seal on land or in the water. One female monk seal was intentionally harassed when a resident threw coconuts at it (Henderson, pers. comm., 2001). On Kauai, a monk seal was bitten by a pet dog (Honda., pers. comm., 2001). Disturbance to monk seals may result in modified behavior making them more susceptible to predators when forced to enter the water or causing an unnecessary expenditure of energy required for thermal homeostasis or catching prey. These incidents may increase as monk seal haul-outs increase in the MHI (Ragen, 1999).

(b) Research in NWHI

Since 1982, Hawaiian monk seals have been removed from the wild or translocated between locations by the Marine Mammal Research Program (MMRP) of the Honolulu Laboratory as part of research and management to facilitate recovery of the species. These removals and translocations are summarized below.

Selective criteria are used to identify monk seals for research, removal, and translocation. All criteria are designed to minimize risks to the monk seal population. For example, monk seals collected for rehabilitation were selected because of their low probability of survival in the wild. When these monk seals moved to Kure Atoll, some of them are known to have contributed to increased numbers of pups born into that population. Additionally, the removal of monk seals selected for translocation because of concerns for aggressive behavior resulted in fewer deaths at French Frigate Shoals and, probably at Laysan Island.

i. Rehabilitation-Release

Pups which wean prematurely from their mothers may be in poor condition, and are known to have a minimal probability of surviving their first year; some of these animals, as well as emaciated juvenile monk seals, have been collected for rehabilitation and release back into the wild. This project was initiated to salvage the reproductive potential of the females that would have otherwise been lost due to their high mortality rate. A total of 104 seals (mostly females) have been so taken; 68 were successfully rehabilitated and released into the wild, 22 died during rehabilitation, and 14 were judged to be unsuitable for release and were placed into public aquaria and oceanaria for research. Of the 68 monk seals which were rehabilitated and released from 1984 through 1993, 19 were alive as of 2001 (NMFS unpublished data). Some of the surviving 19, most of which are located at Kure Atoll, are pupping. In 2000, at least 4 of the 19 rehabilitated seals gave birth at Kure (Johanos and Baker, 2002).

Of the remaining 49 monk seals that were rehabilitated and released, the following information has been gathered: 29 disappeared within one year of release; 15 disappeared from 2-11 years after release; and 5 were found dead within one year of release. Overall the mortality rate for all rehabilitated seals was lower than the rate if none of them had been rehabilitated. NMFS selected candidates for rehabilitation that were undersized at weaning, and NMFS had assessed that the mortality rates for these selectees in the wild would have been 100%. Regarding the expected success rate, the success of the program was somewhat lower than expectations, primarily because of very poor survival rate of 18 seals which were released at Midway rather than Kure Atoll.

ii. Aggressive male translocation and removal

Adult male monk seals have been documented to injure and kill other monk seals, including adult females, immature monk seals of either sex, and weaned pups. Some of the attacks have been made by groups of adult males, while others were by individual males. To reduce injuries and mortalities, NMFS has removed aggressive adult males from some sites. A total of 40 adult male seals have been taken; 32 were translocated to locations distant from the site where the attacks had occurred (21 were moved to the MHI in 1994 and 11 were moved to Johnston Atoll (9 in 1984 and 2 in 1998)); 5 were placed into permanent captivity; 2 died while being held in temporary pens for translocation, and 1 was euthanized. Although there is no systematic sighting effort for the 21 adult males translocated to the MHI, one sighting was made on Kauai in April, 2001.[28] The effects of male aggression are considered separately below. None of the adult monk seals translocated to Johnston Atoll have been resighted since the year in which they were translocated.

iii. Other Translocations

Monk seals have been moved between populations for reasons other than mitigation of adult male attacks. A total of ten seals have been so taken; five healthy female weaned pups were

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[28] Salt Pond City and County Beach Park, Kauai. A monk seal with a red tag # 4A0 was reported acting aggressively toward another monk seal (Freeman, pers. comm., 2001). That tag number was confirmed by NMFS to be the tag number of an adult monk seal relocated from Laysan in 1994 (Henderson, pers. comm., 2001).

translocated from French Frigate Shoals to Kure Atoll in an effort to bolster the population and increase the reproductive potential at Kure, and four healthy seals born in the main islands were translocated, after having weaned, to areas less utilized by humans to minimize the potential of human harassment.

Of the five monk seals translocated from French Frigate Shoals to Kure Atoll in 1990, two are known to remain alive at Kure as of 2001. Of the four monk seals relocated from sites in the MHI, one was observed alive at Kure Atoll in 2001, two were observed alive on Kauai in 2000, and one which was translocated to Niihau was reported to have been killed sometime after 1994 by a boat propellor, although this report is unconfirmed (Henderson, pers. comm., 2001).

iv. *Permanent Captivity*

In addition to using unsuccessfully rehabilitated monk seals or aggressive males as captive research animals, some monk seals have been collected from the wild and placed directly into captivity. From 1983 to 1991 a total of 4 animals were taken; 2 monk seals were collected from the NWHI, and 2 monk seals found badly injured in the MHI, were treated and placed into permanent captivity (NMFS unpub. data, 2001).

In 1995, twelve monk seal pups were taken into captivity by NMFS for the purposes of rehabilitation and eventual return to the wild population. At the time of capture, some of the pups exhibited clinical signs associated with conjunctivitis, red eyes, blepharism, blepharospasm, and photosensitivity. Of the twelve monk seals pups, nine later developed corneal opacities and subsequent cataracts, and one developed cataracts (with no corneal opacities), and two of these total of ten monk seals later died (due to causes unrelated to blindness). (NMFS, 1997 - workshop report) The remaining 10 monk seals (eight blind and two sighted) were transferred to Sea World of Texas where they are research animals.

v. *Research Handling*

The MMRP handles monk seals in the wild as part NMFS' research to monitor the population and facilitate recovery. Takes have included tagging, instrumentation, and sampling for health assessment. MMRP has handled seals 3,343 times as part of its research activities since 1981. Three seals (3) died during research handling. All three individuals were adult male seals. Results of necropsies on these seals varied, but in general all three were older seals whose health had been compromised by chronic illness.

(c) *Intentional Injuries to Monk Seals*

There is no recent evidence of intentional injuries from acts such as clubbing or shooting to monk seals in the NWHI. The NMFS Marine Mammal Research Program annually monitors all major breeding populations of monk seals, and collects data on any injuries or other events which could affect the survival of individual seals. The program has not documented any injuries or mortalities in the NWHI that could be attributed to clubbing, shooting, or other intentional wounding of monk seals since the establishment of the Protected Species Zone in 1991. (Johanos and Ragen, 1996a, 1996b,1997, 1999a, 1999b; Johanos and Baker, 2000): Although a Court

Order[29] has found that intentional acts to monk seals occur, NMFS' monitoring of monk seal populations thus far indicates that intentional acts in the NWHI are not occurring.

f. Disease

Although some information concerning medical conditions affecting the Hawaiian monk seal is available, the etiology and impact of disease on wild animals at the population level is far from clear. There are substantial data gaps regarding the prevalence of disease conditions in populations of Hawaiian monk seals in the wild, and thus their potential impact on population dynamics is unknown. In the wild, even massive epizootics in remote locations may pass undetected (Aguirre, 2000).

There have been periods of unusually high mortalities in subpopulations located in the NWHI. A die-off occurred in 1978 at Laysan Island (Johnson and Johnson, 1981). More than 50 seal carcasses were found in an advanced state of decomposition, and although the cause of the mortality was not identified, it may have been disease related. Also, survival of immature seals severely declined at French Frigate Shoals after 1987, and the reproductive potential of the species was being seriously compromised by the loss of young females. The cause has been attributed to emaciation/starvation; however, the role of endoparasites or disease is unknown. During 1992-93, undersized pup and juvenile seals from French Frigate Shoals were rehabilitated and released at Midway Atoll with poor success.

Health assessment and collection of baseline information on diseases is considered important to the recovery of the Hawaiian monk seal population (Gilmartin 1983, Aguirre et al., 1999). Banish and Gilmartin (1992) summarized pathological conditions found in 42 carcasses recovered from 1981 to 1985. Frequent findings included parasites, trauma, cardiovascular disease, and respiratory infections. Emaciation was a common condition. Banish and Gilmartin (1992) did not assess causes of death from any of their samples, but nonetheless concluded that there was no evidence of any disease phenomenon affecting the population in a manner which would significantly hinder recovery of the species. A series of examinations of 23 dead seals collected from 1989 to 1995 (T. Work, unpubl. data) ascribed causes of death as follows: emaciation (7); emaciation compounded by senescence (1); trauma (2); foreign body aspiration (1); and euthanasia(1) (see (g.) Male Aggression and Mobbing, below). Cause of death was not determined in 11 animals.

The relative significance of disease and related factors and their effect on population trends are poorly understood. Disease processes may be important determinants of population trends through long-term low levels of mortality, or through episodic die-offs. Table III-22 describes the findings of health and disease studies on monk seals between 1925 and 1997.

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[29] The Order Granting in Part and Denying In Part Plaintiffs' Motion for Summary Judgement, Granting in Part and Denying in Part Defendants' Cross-Motion for Summary Judgement, and Granting in Part Plaintiffs' Motion for a Permanent Injunction Motion for Summary Judgement in Greenpeace Foundation, *et. al.*, v. Norman Mineta, *et. al.* Civil No. 00-00068SPKFIY. U.S. District Court of Hawaii, November 15, 2000, p. 30.

Table III-22. Health and disease studies in Hawaiian monk seals (*Monachus schauinslandi*), 1925-97. (Source: Aguirre, 1999)

1925	Internal parasites were first reported (Chapin, 1925).
1952	Diphyllobothriid cestodes were first reported (Markowski, 1952).
1959	The Acanthocephalan *Corynosoma* sp.was first reported (Golvan, 1959).
1969	Diphyllobothriid cestodes were reported (Rausch, 1969).
1978	Known as the Laysan epizootic, ≥50 monk seals were found dead. Specimens from 19 dead and 18 live seals were collected. All carcasses found with stomach ulceration and heavy parasite burdens and in severe state of emaciation. Livers from two carcasses tested positive to ciguatoxin and maitotoxin. There was serologic evidence to caliciviruses but serum specimens were negative for *Leptospira*. *Salmonella sieburg* was isolated from a rectal swab. Many parasite ova and products in coprologic exams were identified. Diagnosis was inconclusive (Johnson and Johnson, 1981; Gilmartin et al., 1980).
1979	*Contracecum* ulceration of a young seal was first reported (Whittow et al., 1979).
1980	Lung mites from the family Halarechnidae were first reported (Furman and Dailey, 1980).
1980	The Hawaiian monk seal die-off response plan was developed with the support of the Marine Mammal Commission (Gilmartin, 1987).
1983	The Recovery Plan for the Hawaiian monk seal addressed the importance of disease investigations (Gilmartin, 1983).
1988	A coprologic survey for parasites was performed from field scats collected in 1985 (Dailey et al., 1988).
1988	The hematology and serum biochemistry of 12 weaned pups collected between 1984 and 1987 for their rehabilitation in Oahu were reported (Banish and Gilmartin, 1988).
1992	Pathology of 42 seals collected between 1981-85 was summarized (Banish and Gilmartin, 1992).
1992	The French Frigate Shoals relocation project of 19 immature seals was initiated. Basic hematology, serum biochemistry, serology for leptospirosis and calicivirus infection, virus isolation, fecal culture for *Salmonella* and coproparasitoscopic examination were performed for their disease evaluation. Two of seven seals died of bacterial and aspiration pneumonia in *(sic)* Oahu, with positive titers to *Leptospira*. Detection of calicivirus by cDNA hybridization probe in 13 seals with viral particles seen by electron microscopy occurred in five seals. It was concluded that endemic disease agents identified in those seals were *Salmonella* and endoparasites (Gilmartin, 1993a; Poet et al., 1993).
1993	Inoculation of four monk seals with a killed virus distemper vaccine was experimentally performed on three seals at the Waikiki Aquarium (Gilmartin, 1993b; Osterhaus, unpubl. data 1997).
1995	An eye disease of unknown etiology was first diagnosed in 12 female monk seal pups that were transported to Oahu for rehabilitation. To date the cause remains unknown (NMFS files 1995-97, unpubl. data).
1996	Histopathology of selected tissues collected from 23 seals between 1989 and 1995 was performed by personnel of the National Wildlife Health Research Center, Honolulu Station (T. Work, unpubl. data, 1996).
1997	Two captive seals died of causes unrelated to the eye disease. One seal was diagnosed with *Clostridium* septicemia and another seal with hepatic sarcocystosis (Yantis et al., 1998).
1997	The Monk Seal Captive Care Review Panel developed recommendations to evaluate the health assessment and future disposition of 10 captive seals and the future of captive care and release efforts to enhance the recovery of the species (NMFS, unpubl. data, 1997).

2001 Unusual Mortality Event in the NWHI

In April, 2001, an "Unusual Mortality Event[30]" was declared on the basis of four juvenile monk seal deaths within nine days at Laysan Island, a death of a yearling at Midway, discovery of three decomposed carcasses (one subadult, one pup, and two juveniles) and one fresh dead carcass at Lisianski Island, a death of a yearling at French Frigate Shoals, and lethargic, thin juvenile monk seals observed at Laysan and Midway Islands. The Unusual Mortality Event was declared over in early 2002, and the analysis of data collected is currently underway. However, there is no clear indication of the cause of the deaths or condition of the monk seals at this time

g. *Male Aggression and Mobbing Behavior*

Male aggression, including singular or multiple adult males attacking another seal (mobbing), can lead to monk seal injury and death. Removal of aggressive males has been undertaken to improve pup, juvenile and female survival rates. At French Frigate Shoals, individual adult males have presented more of a problem than groups of males. Individuals which were directly observed injuring or killing pups were removed, either by translocation or euthanasia. At Laysan Island, injuries and deaths have tended to result from massed attacks, or mobbings, by large numbers of adult males. The problem may be more related to an imbalanced adult sex ratio than to individual "rogue" males as evidenced by the decrease in mobbings and related injuries at sites where sex ratios were imbalanced but later came into balance (Johanos, et al., 1999). Males that were removed from Laysan Island included seals which had been observed participating in mobbings, as well as other animals whose behavioral profile matched that of known "mobbers". Removal was effected either by translocation or by transfer into permanent captivity. Ten males were removed in 1984, 5 in 1987, and 22 in 1994.

Removal of individual male seals from French Frigate Shoals markedly decreased the number of injuries and deaths attributable to adult male aggression (See Table III-23 below). The results of removing adult males from Laysan Island are less clear (See Figure III-14). Injuries and deaths from adult male aggression at Laysan Island have diminished, but it is not known how much male removal has contributed to this decline.

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[30] The MMPA defines an Unusual Mortality Event (UME) to be an occurrence which 1) is unexpected; 2) involves a significant die-off of a marine mammal population; and 3) demands an immediate response. In addition to the above conditions, an immediate response is warranted under two other circumstances: 1) mass stranding of an unusual species of cetacean; and 2) small numbers of a severely endangered species of marine mammal are affected.

Table III-23. Record of Monk Seal Removals and Pre and Post Removal Levels of Injuries and Mortalities caused by Adult Male Attacks.[31] **(Source: NMFS unpubl. data, 2001)**

Location and Year of Removal and Location	No. of Injuries/Mortalities Caused by Adult Male Attacks in Year Prior to Removal	No. of Males Removed	No. Of Injuries/mortalities Caused by Adult Male Attacks in Year Subsequent to Removal
1984 Laysan	1983: 12 injuries; 3 mortalities	10 removed (9 translocated to Johnston, 1 died)	11 injuries; 5 mortalities
1984 Laysan	1983: 12 injuries; 3 mortalities	10 removed (9 translocated to Johnston, 1 died)	11 injuries; 5 mortalities
1987 Laysan	1986: 12 injuries; 5 mortalities	5 removed (translocated to permanent captivity)	1988: 25 injuries; 11 mortalities
1991 French Frigate Shoals	9 injuries; 4 mortalities (all mortalities attributable to single male) (as tallied from 1991, prior to male removal)	1 (euthanized)	5 injuries; 1 mortality
1994 Laysan	1993: 1 injury; 0 mortalities , plus an undetermined number of injuries before removal in 1994 for a total preremoval: 6 injuries; 3 mortalities.	22 (21 translocated to MHI, 1 died)	1995: 3 injuries; 1 mortality
1998 French Frigate Shoals	6 injuries; 11 mortalities	2 (translocated to Johnston Atoll)	2 injuries; 1 mortality

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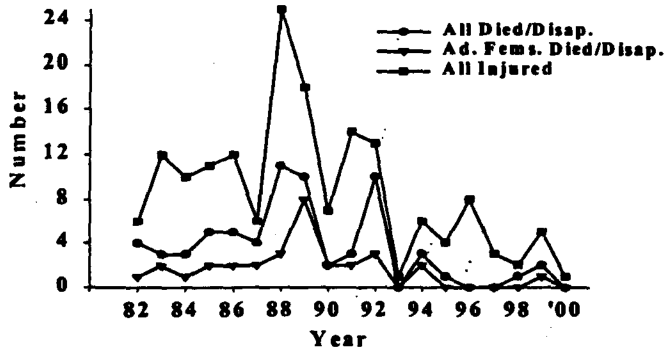
[31] NMFS is currently reviewing the data on injuries and mortalities caused by instances of male aggression.

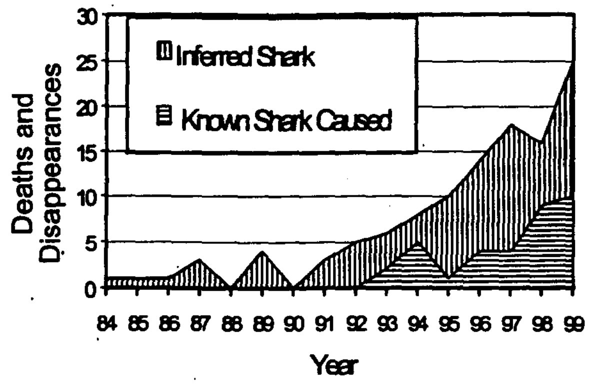
Figure III-14. **Mortalities and Injuries to Monk Seals at Laysan Island from 1982 to 2000. (Source: NMFS unpub. data)**



h. *Shark Predation*

Shark related injury and mortality has been documented in the NWHI at French Frigate Shoals. Although researchers had concluded shark predation was not the cause of the population decline at that location (Ragen, 1993), NMFS considers shark predation to be a significant factor in pup mortality at French Frigate Shoals. NMFS Honolulu Laboratory infers shark related mortality whenever a newborn to approximately three week old pup disappears at French Frigate Shoals, especially during periods when large sharks are observed patrolling near pupping beaches. Shark predation is inferred to be the primary cause of disappearance of these pups because attacks by male adults (the other possible primary cause of mortality) are unlikely because nursing pups are defended by their mothers. However, sharks have been observed killing pups in this age category despite their mother's defense tactics against shark predation. In 1999, shark predation was estimated to account for the deaths of 51.1 percent (23 out of 45) of the pups born at Trig Island, French Frigate Shoals. Overall, 9.4 percent (25 out of 244) of pups born in the NWHI were inferred or known to be preyed upon by sharks in 1999 (Figure III-15). One shark was removed pursuant to a shark removal plan implemented in 2000 to improve pup survival and possibly slow the French Frigate Shoals population decline (thereby facilitating recovery).

Figure III-15. **Trends in number of known and inferred shark-caused deaths of Hawaiian monk seal pups at French Frigate Shoals. (Source: Laurs, 2000)**



The dramatic increase in deaths and disappearances from shark attacks at French Frigate Shoals has been the result of an increased number of Galapagos sharks (*Carcharhinus galapagensis*) in the immediate vicinity of monk seal pupping areas. The occurrence and escalation of Galapagos shark predation on pups may be related to a episode of adult male monk seal aggression against pups, which resulted in pup deaths and the presence of carcasses remaining in the waters surrounding the pupping area. These carcasses may have attracted sharks to the new prey resource of nursing seal pups. Also, the disappearance of Whale-Skate Island, which had been a large pupping site, may have resulted in more pups being born at Trig Island where sharks can easily approach the shoreline.

3. Sperm Whale

In U.S. waters in the Pacific, sperm whales are known to have been incidentally taken only in drift gillnet operations, which killed or seriously injured an average of 9 sperm whales per year from 1991–95 (Barlow et al. 1997). In 1997, NMFS implemented the Pacific Offshore Cetacean Take Reduction Plan. Since the implementation of the plan, the mean annual take is estimated to be 1.7 (Coefficient of Variation = 0.89) using 1997 through 1999 observer data (Carretta *et al.*, 2001). More recent observer data indicate Interactions between longline fisheries and sperm whales in the Gulf of Alaska have been reported over the past decade (Rice 1989, Hill and DeMaster 1999). Observers aboard Alaskan sablefish and halibut longline vessels have documented sperm whales feeding on fish caught in longlines in the Gulf of Alaska. During 1997, the first entanglement of a sperm whale in Alaska's longline fishery was recorded, although the animal was not seriously injured (Hill and DeMaster 1998). The available evidence does not indicate sperm whales are being killed or seriously injured as a result of these interactions, although the nature and extent of interactions between sperm whales and long-line gear is not yet clear. In 2000, the Japanese Whaling Association announced that it proposed to kill 10 sperm whales in the Pacific Ocean for research purposes, which was the first time sperm whales have been taken since the international ban on commercial whaling took effect in 1987. Despite protests from the U.S. government and members of the IWC, the Japanese government plans to conduct this research.

C. Factors Affecting Sea Turtles in the Pacific Ocean

Because impacts to sea turtles in the Pacific Ocean are generally non-discriminatory insofar as the different species are concerned, the following is a description of fisheries and non-fisheries-related threats to all sea turtles in the Pacific Ocean.

1. Fisheries impacts

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

This section will summarize known fisheries that have been observed or reported to incidentally or intentionally take sea turtles in the Pacific Ocean. The past effects of the fisheries of the Pelagics FMP are summarized in Section IV, the Effects of the Action section of this Opinion.

Appendix A provides a summary of current trends in fishing effort in the eastern and western Pacific Ocean, by year, and country. Estimates of total fishing effort are complicated by the fact that not all active vessels fish equivalent number of days per trip or annually, or use the same number of hooks, length of net, or mesh size, or have the same carrying capacity. However, even with minimum effort estimates, it is apparent that there is significant fishing effort in the Pacific Ocean for which NMFS has no bycatch information for sea turtles.

a. North Pacific Driftnet Fisheries (before December 1992)

Foreign high-seas driftnet fishing in the north Pacific Ocean for squid, tuna and billfish ended with a United Nations moratorium in December, 1992. Except for observer data collected in 1990-1991, there is virtually no information on the incidental take of sea turtle species by the driftnet fisheries prior to the moratorium.

The high seas squid driftnet fishery in the North Pacific was observed in Japan, Korea, and Taiwan, while the large-mesh fisheries targeting tuna and billfish were observed in the Japanese fleet (1990-91) and the Taiwanese fleet (1990). A combination of observer data and fleet effort statistics indicate that 4,373 turtles, mostly loggerheads and leatherback turtles, were entangled by the combined fleets of Japan, Korea and Taiwan during June, 1990 through May, 1991, when all fleets were monitored (Table III-24). Of these incidental entanglements, an estimated 1,011 turtles were killed (77 percent survival rate).

Table III-24. Estimated annual bycatch and mortality of sea turtles in the North Pacific high-seas driftnet fishery for squid, tuna & billfish in 1990-91 (Wetherall, 1997).

Species	Estimated Annual Take	Estimated Annual Mortality
green	378	93
leatherback	1,002	111
loggerhead	2,986	805
TOTAL	4,366	1,009

Data on size composition of the turtles caught in the high-seas driftnet fisheries were also collected by observers. Green turtles and the majority of loggerheads measured by observers were immature, and most of the actual measured leatherback turtles were immature, although the size of leatherback turtles that were too large to bring on board were only estimated, and are therefore unreliable (Wetherall, 1997).

These rough mortality estimates for a single fishing season provide only a narrow glimpse of the past impacts of the driftnet fishery on sea turtles. A full assessment of impacts would consider the turtle mortality generated by the driftnet fleets over their entire history and geographical range. Unfortunately, comprehensive data are lacking, but the observer data does indicate the possible magnitude of past turtle mortality, given the best information available. Wetherall *et al.* (1993) speculate that "the minimum total turtle mortality in the North Pacific high-seas driftnet fisheries may have been on the order of 2,500 turtles per year during the late 1980s. The actual mortality was probably greater than this, but less than the estimated total driftnet bycatch of perhaps 9,000 turtles per year. Based on 1990 observer data, most of the mortalities would have been loggerheads taken in the Japanese and Taiwanese large-mesh fisheries."

While a comprehensive, quantitative assessment of the past impacts of the North Pacific driftnet fishery on turtles is impossible without a better understanding of turtle population abundance, stock origins, exploitation history and population dynamics, it is likely that the mortality inflicted by the driftnet fisheries in 1990 and in prior years was significant (Wetherall *et al.* 1993), and the effects may still be evident in sea turtle populations today. The high mortality of juvenile, pre-reproductive adults, and reproductive adults in the high-seas driftnet fishery has probably altered the current age structure (especially if certain age groups were more vulnerable to driftnet fisheries) and therefore diminished or limited the reproductive potential of affected sea turtle populations.

b. Japanese tuna longliners in the Western Pacific Ocean and South China Sea

Based on turtle sightings and capture rates reported in a survey of fisheries research and training vessels and extrapolated to total longline fleet effort by the Japanese fleet in 1978, Nishimura and Nakahigashi (1990) estimated that 21,200 turtles, including greens, leatherback turtles, loggerheads, olive ridleys and hawksbills, were captured annually by Japanese tuna longliners in the Western Pacific and South China Sea, with a reported mortality of approximately 12,300 turtles per year. Using commercial tuna longline logbooks, research vessel data and questionnaires, Nishimura and Nakahigashi (1990) estimated that for every 10,000 hooks in the Western Pacific and South China Sea, one turtle is captured, with a mortality rate of 42 percent. Although species-specific information is not available, vessels reported sightings of turtles in locations which overlap with commercial fishing grounds in the following proportions: loggerhead - 36 percent, green turtle - 19 percent, hawksbill - 10.3 percent, olive ridley - 1.7 percent, leatherback - 13.7 percent, and unknown - 19 percent.

Caution should be used in interpreting the results of Nishimura and Nakahigashi (1990), including estimates of sea turtle take rate (per number of hooks) and resultant mortality rate, and estimates of annual take by the fishery, for the following reasons: (1) the data collected was based on observations by training and research vessels, logbooks and a questionnaire (i.e. hypothetical), and do not represent actual, substantiated logged or observed catch of sea turtles by the fishery; (2) the authors assumed that turtles were distributed homogeneously; and (3) the authors used only one year (1978) to estimate total effort and distribution of the Japanese tuna longline fleet. Although the data and analyses provided by Nishimura and Nakahigashi (1990) are conjectural, longliners fishing in the Pacific have had, and (with the current level of effort) probably continue to have significant impacts on sea turtle populations. Unfortunately, current bycatch information is not available for these fisheries, and NMFS is unaware of any follow-up studies since 1990. Future investigations into the level of sea turtle bycatch in these fisheries would allow a more complete assessment of cumulative effects on pelagic sea turtles in the Pacific Ocean.

Tables 1 in Appendix A provides a summary of the number of active Japanese longline vessels fishing mainly for tuna in the Central Western Pacific Ocean from 1990-99.

c. *Japanese coastal fisheries*

Off the coast of Japan, gillnets and pound nets are very common. In addition, there is an intense trawl fishery for anchovy operated off-shore of some major loggerhead rookeries during the nesting season. According to the Sea Turtle Association of Japan (2002), approximately 80 mature loggerheads strand every year in Japan - "these coastal fisheries might be strongly related with stranding." With less than 1,000 female loggerheads nesting annually in Japan, this number of strandings is not insignificant.

d. *Taiwan - coastal setnet and gillnet fishery*

Researchers investigated the incidental capture of sea turtles by the coastal setnet and gillnet fisheries in the eastern waters of Taiwan from 1991 through 1995. Setnets used in the coastal waters off Taiwan are near-shore sedentary trap nets, and rarely extend below 20 meters. During the time of the study, there were 107 setnets in Taiwan, and they provided the second largest total fish yields, after gillnets. According to interviews with fishermen, incidentally caught sea turtles are either sold to dealers in the market or are butchered for meat (subsistence). Fishing grounds including set nets and gillnets were observed from 1991 through 1992, and the fish market was visited once or twice per month from 1991 through 1995 to corroborate bycatch data (Cheng and Chen, 1997).

Of the sea turtles caught, 82% were caught in setnets, and of these, all were alive. As shown in Table III-25, green turtles accounted for 70% of the sea turtles taken, and captured turtles represented all age classes (large juvenile, subadult and adults). Most captured loggerheads were either subadults or adult females (only one male was unidentified), and most of the captured olive ridleys were subadults. The one captured leatherback was released alive. Of all captured turtles, 88% were sold to temples for Chinese religious ceremonies, 8% were stuffed or butchered, and 3% were released at the site (Cheng and Chen, 1997).

Table III-25. Sea turtles incidentally caught in fishing gear off Taiwan from 1991-1995.

Year/Species	1991	1992	1993	1994	1995	Total
green	6	17	28	23	42	116
leatherback	1	0	0	0	0	1
loggerhead	1	4	5	15	1	26
olive ridley	9	0	1	0	4	14

Source: Cheng and Chen, 1997

e. South American fisheries

(1) Chile

Although data on the incidental take of sea turtles in the Chilean swordfish fisheries are sparse, both green and leatherback turtles have been confirmed taken and killed, and olive ridleys and loggerheads may also be taken incidentally by the fishery (Weidner and Serrano, 1997). As described further in Appendix A, the Chilean swordfish fishery is comprised primarily of artisanal fishermen, averaging 500 boats (mainly driftnetters) from 1989 to 1991, and decreasing in numbers after 1991. Since 1991, approximately 20 large industrial (i.e. commercial) boats have fished swordfish in Chile, the effort is comprised of gillnets (27%), pelagic longliners (72%) and boats that switch gear. Effort by the artisanal fishery (including the driftnet fleet) increased from 5,265 days-at-sea in 1987 to 41,315 days-at-sea in 1994 (Barbieri, *et al.*, 1998).

Adult female leatherback turtles tagged in Mexico have been taken in Chilean waters by gillnet *and* purse seine fisheries (Marquez and Villanueva, 1993). In addition, data were recorded opportunistically from the artisanal swordfish fishery (driftnetters primarily) for a single port (San Antonio) over a two year period. This partial record documented leatherback captures and sightings totaling 9 in 1988 and 21 in 1989. A rough estimate of 250 leatherback takes per year without differentiating between kills and total takes for vessels operating out of San Antonio was provided (Frazier and Brito Montero, 1990). A more recent estimated annual take of 500 leatherback turtles was provided by Montero (personal communication, 1997, *in* Eckert, 1997) which was not unreasonable, given the nearly ten-fold increase in fishing effort from 1987 to

1994.[32] As shown in Table III-26, the take of sea turtles by the artisanal driftnet fishery in the late 1980s appeared to be comprised primarily of leatherback turtles.

Table III-26. Chile – turtle bycatch of artisanal driftnet fishermen, 1988-89.

Species	Number	Percentage of Total
Green turtle	42	28%
Leatherback	82	55%
Loggerhead	5	3%
Olive ridley	21	14%
Total	150	100%

Source: José Brito-Montero, personal communication, 3/3/97, *in* Weidner and Serrano, 1997

Effort by the artisanal driftnet fishery for swordfish appears to be relatively constant through 1996, as shown in Table III-27. Given the total sea turtle take estimate from the 1988-89 season, and combining it with the total effort (days-at-sea) data from 1988-1996, and assuming effort was constant and in the same general area during all years, a simple calculation can be made to estimate the incidental take of turtles by the Chilean artisanal driftnet fishery for swordfish during subsequent years (third column in Table III-27). Turtles reportedly began appearing in Chilean markets in 1987, just as the swordfish driftnet fishery was expanding, and Chilean observers have reported occasional individual sets with leatherback mortalities from 3-13 (*in* Weidner and Serrano, 1997). Assuming the current artisanal driftnet fishing effort is equivalent to 1996 and assuming the proportion of species taken is equivalent to data collected from the 1988-89 fishing season, this fishery would currently take an estimated 39 greens, 76 leatherback turtles, 4 loggerheads, and 29 olive ridleys annually. However, Donoso (personal communication, September 2002) reports that the artisanal fleet has declined to maybe a third of its size in recent two years.

Table III-27. Chile - artisanal (driftnet) swordfish effort, by year, from 1989-1996 and calculated (not actual or known) turtle take [note assumptions used in this Opinion].

Year	Effort (Days-at-sea)	Calculated Turtle Take
1989	7,579	150*

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[32] Based on all information from Chile and Peru, Eckert (1997) estimated that a minimum of 2,000 leatherback turtles are killed annually by Peruvian and Chilean swordfish operations, representing a major source of mortality for leatherback turtles originating from and returning to nesting beaches in Costa Rica and Mexico. Because swordfish fishing effort has declined significantly since the early 1990s, incidental take has most likely declined as well, although the current estimate is unknown.

1990	6,226	123
1991	11,450	227
1992	11,209	222
1993	10,755	213
1994	8,393	166
1995	8,152	161
1996	7,041	139

*Calculated turtle take was estimated by comparing effort for 1989 (7,579 days-at-sea) and a known turtle take of 150 (1988-89 season) with subsequent years for which effort was known, but turtle take is not known.

**Estimated take of turtles by Brito-Montero, for the 1988-89 season, and assuming 1989 data is equivalent in effort to 1988-89 effort, for the purpose of comparing year-to-year calculations of estimated turtle take. Source: Weidner and Serrano, 1997.

During 1996, there was a substantial expansion of Chilean longline fishing in offshore areas, but as there has been no collection of data on this fishery as of 1997 (Weidner and Serrano, 1997), the anticipated effects on sea turtle stocks as a result in this change in fishing strategy are not known. Since effort for swordfish in the Chilean fishery or throughout the Pacific has declined significantly overall since 1994 (as a result of concerns about overfishing swordfish stocks), and populations of turtles have declined, the bycatch of sea turtles in this fishery has likely declined as well, although the extent of this decrease is currently unknown. There is very little information on lethal and non-lethal incidental catch per unit effort although new studies are underway to quantify bycatch. In addition to the swordfish fishery, Chile also has a substantial purse seine fleet, which has recently shifted from a reliance on coastal anchovy and sardines to a substantial take of jack mackerel further offshore, where turtle interactions may be more common (Weidner and Serrano, 1997). The extent of the impact of the Chilean purse seine fishery on sea turtles is unknown.

(2) Colombia

A description of known Colombian commercial fisheries is provided in Appendix A and summarized in Table 5 of the Appendix. No information is available on the sea turtle bycatch levels in the shrimp trawl fisheries and other fisheries operating out of Colombia. However, a turtle excluder device program has been initiated in the shrimp trawl fishery to reduce incidental catch. Artisanal fisheries in the past targeted turtles (Weidner and Serrano, 1997); however, no recent information on directed take is available.

(3) Ecuador

Appendix A contains a description of known current commercial and artisanal fisheries in Ecuador. Unfortunately, the composition of turtle species incidentally taken by Ecuadoran commercial and artisanal fisheries is unavailable. Prior to a ban on the commercial harvest for olive ridleys in 1986, artisanal fishermen prosecuted a directed turtle fishery as well as taking them incidentally. During 1985 and 1986, 124 and 715 metric tons of turtles, respectively, were reportedly taken (Table III-21). In 1990, the Ecuadoran government permanently ended the directed fishery, prohibiting the catch as well as domestic and export marketing. Incidental catches of sea turtles by tuna and swordfish longliners are reportedly very rare, but they do occur, and Ecuadoran authorities have seized turtle skins from Japanese longliners (*in* Weidner and Serrano, 1997).

(4) Peru

Appendix A contains a description of known domestic and foreign fisheries in Peru. Peruvian commercial longline fleets have had limited success in fishing for swordfish, so there is probably very little incidental catch of sea turtles in this fishery. Peruvian artisanal fishermen, however, also target fish species normally taken in commercial longline fisheries (especially shark) and have been more successful than the commercial longline fleet, so more turtles may be caught incidental to these artisanal fisheries. Foreign longline fleets are also active and extensive off Peru and the bycatch of sea turtles in these foreign fisheries has been considered significant (Weidner and Serrano, 1997).

Peru conducted directed commercial turtle harvests throughout the 1980s, and, as recently as 1990, over 100 metric tons of turtles were taken (Table III-28) (FAO, Yearbook of Fishery Statistics, 1994, *in* Weidner and Serrano, 1997). Species-specific information was not available. Based on a sighting of 167 leatherback carapaces in a canyon near the port of Pucusana in 1978, Brown and Brown (1982) estimated a minimum of 200 leatherback turtles killed per year at that time. Furthermore, central Peru was known to have had the largest leatherback fishery in the world, taking what appeared to be adults and subadults, thus representing a considerable number of reproductive and near reproductive individuals (*in* Brown and Brown, 1982). The Ministerio de Pesqueria (MIPE), which is the Peruvian agency responsible for fisheries, prohibited the taking of all leatherback turtles and green turtles less than or equal to 80 cm in length through a resolution in January, 1977, although observers report that regulations are rarely enforced. Other species were not protected and were still unprotected as of 1989, although catches appear to have declined to negligible levels (Weidner and Serrano, 1997). Specific take levels remain unknown.

Table III-28. Ecuador and Peru - turtle catch in metric tons, 1985-95.

Year	Catch - Ecuador (metric tons)	Catch - Peru (metric tons)
1985	124	36
1986	715	9
1987	–	305
1988	–	32
1989	–	79
1990	–	101
1991	–	9

1992	–	30
1993	–	28
1994	–	6
1995	10*	4*

Source: FAO, Yearbook of Fishery Statistics, 1994, *in* Weidner and Serrano (1997)
*1995 data would not be found in the above source, yet Weidner and Serrano (1997) provide data for this year.

f. Costa Rica

Sea turtles are impacted by Costa Rican fisheries and by interaction with human activities. 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. In 1999, the fleet was comprised of 678 registered vessels, with lengths varying between 6 and 29.9 meters. Two studies in 1997 and 1998 on two longline fishing cruises (one experimental) documented a high incidental take of sea turtles. On one cruise, a total of 34 turtles (55% olive ridleys and 45% east Pacific green turtles) were taken on two sets containing 1,750 hooks (1.42 turtles per 100 hooks). One additional set caught two leatherbacks. The second cruise documented the incidental take of 26 olive ridleys, with 1,804 hooks deployed (Arauz *et al.*, 2000).

An observer program was put in place from August, 1999 through February, 2000. Seventy seven longline sets were observed on 9 cruises. Of the nearly 40,000 hooks deployed, turtles represented 7.6% of the total catch, with a catch per unit effort of 6.364 turtles/1,000 hooks. The results are shown in Table III-29. Immediate sea turtle mortality was 0%, and most of the hooks were removed prior to release (Arauz, 2001).

Table III-29. Costa Rican longline fleet - observed number and condition of sea turtles taken on nine cruises, August, 1999 - February, 2000

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

Source: Arauz, 2001.

From September to December of 2000, the Sea Turtle Restoration Project documented more than 400 dead turtles washed up along the north and central Pacific coast of Costa Rica. Of 423 dead turtles observed, 84 turtles showed "clear interaction with human activities, such as cracked skulls or carapaces due to collisions with boats, hooks imbedded in the mouth and throat, incisions in the groin to collect eggs, and digital fractures due to entanglement in gillnets. As of 2001, more than 130 dead turtles have been observed." The Costa Rican Fishery Institute (INCOPESCA) has "declared itself incompetent to enforce sea turtle protection laws, and proposes that [the authorities of the Environment] MINAE should be responsible and apply the Wildlife Conservation Law (PESJ-1451-2000). However, while MINAE eludes responsibility, hundreds of dead sea turtles continue to wash up along the coast..." (Sea Turtle Restoration Project press release, 8/6/01[33]).

g. *Distant Water Fishing Nations Longline Fishing in the EEZ around the Federated States of Micronesia*

Heberer (1997) summarized the results of 51 distant-water fishing nation (DWFN) longline trips observed by Micronesian Maritime Authority fisheries observers from 1993 through 1995. Vessels from China, Taiwan, and Japan captured a total of 34 sea turtles. These turtles were reported as 15 olive ridleys, 8 green turtles, and 11 unidentified sea turtles. Thirty of the 34 turtles were released alive and the remainder were dead when landed (11.8% mortality rate). Data on hooking location or entanglement was not reported, nor was the condition of each turtle by species.

The Micronesia Fisheries Authority (previously Micronesian Maritime Authority) places observers aboard distant water fishing vessels fishing by longline in their EEZ. Table III-30 shows the observed catch of sea turtles by these vessels from January 1, 1990 through December, 2000. While the overall data set represents a significant amount of effort - 971 sets and 1,272,000 hooks observed over a 10 year period, the rate of observer coverage is extremely low. From 1990 through 1997, observer coverage ranged from 1 to 3%.

Table III-30. Observed captures of sea turtles aboard distant water longline vessels, January 1990 through December 2000. Source: Micronesian Fisheries Authority

Species	Number	Condition [illegible]	
		% Alive	% Dead
Green	4	100	0
Hawksbill	1	100	0

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[33] http://www.seaturtles.org/press_release2.cfm?pressID=107

Loggerhead	1	100	0
Olive ridley	8	100	0
Unidentified turtle	33	79	21
Total	47		

The information presented above is from two separate data sets, which may not have been coordinated. The study done by Heberer (1997) utilized observers specifically trained and directed to record bycatch information, whereas observers in this fishery typically prioritize the collection of target catch data over bycatch information. This information represents the best available information on bycatch in this fishery. Appendix A provides additional information on fishing effort. However, the above data cannot be compared or used to extrapolate expected rates of turtle bycatch based on small sample sizes, low rates of observer coverage, and prioritization of catch data.

h. U.S. tuna purse seine fishery in the central and western Pacific Ocean

The vast majority of the U.S. western and central Pacific purse seine activity occurs in the highly productive fishing grounds of the equatorial western Pacific (principally in the EEZs surrounding Papua New Guinea, the Federated States of Micronesia and Kiribati) under a multilateral agreement entitled *Treaty on Fisheries Between the Governments of Certain Pacific Island States and the Government of the United States of America* or the South Pacific Tuna Treaty (SPTT). The treaty was signed by the United States and 16 Pacific Island Parties belonging to the Forum Fisheries Agency (FFA), and provides U.S. tuna purse seiners access to tunas in a 25.9 million km^2 area of the central-western Pacific Ocean in exchange for fishing fees and adherence to rules related to closed area, etc (Coan, *et al.*, 1997). The treaty was renegotiated in 1992 for an additional 10 years.

Between 1988 and 1999, the number of licensed U.S. tuna purse seiners ranged from 35 to 51, although only between 31 and 49 vessels fished during those years. Between 71 and 241 trips were made during each calendar year (Coan, *et al.*, 2000), and most of the fishing was conducted in the equatorial belt, extending from around 155°W to 140°E longitude, the traditional fishing zone for the U.S. fleet (Coan, *et al.*, 1997). The U.S. fleet primarily lands their catch in American Samoa (Coan, *et al*, 1997, 2000). From 1988 to 1995, the fleet primarily set on free-swimming school sets and less on log sets; however, beginning in 1996, sets were increasingly made on floating aggregation devices (FADs), and in 1999, nearly 100 % of sets were on FADs (Coan, *et al.*, 2000). Because turtles tend to congregate around floating objects in the open ocean, this change in fishing strategy may increase the likelihood of sea turtle interactions.

The U.S. fleet is required to take Fisheries Forum Agency (FFA) observers on a minimum of 20 percent of their fishing trips, and captains are responsible for recording catch and bycatch data in logbooks. Logbooks are verified by observers, if possible, and are sent to the FFA no later than 14 days after returning to port (K. Staisch, FFA, personal communication, February, 2001). Between 1997 and 1999, there was approximately 20-23% observer coverage (Forum Fisheries Agency, 1998; A. Coan, personal communication, February, 2001). Collecting data on target species (i.e. tuna) is a priority for observers; however, if possible, and when time permits, observers do collect bycatch data. Observers receive limited training on sea turtle identification and are trained to look for tags, but they do not collect information on length or take biopsies, as the turtles are generally released immediately from the net. The incidental catch of sea turtles is a "rare occurrence," and any turtles observed taken have been released alive. Purse seine techniques normally allow turtles to surface for air during the pursing period, and based on observer reports, any turtles caught in nets are usually released as soon as possible. In addition, there have been no reports of turtles caught in the power block (K. Staisch, FFA, personal communication, February, 2001).

i. U.S. tuna purse seine fishery in the eastern tropical Pacific Ocean (ETP)

The number of large (>400 short tons carrying capacity) ETP tuna purse seine vessels has remained steady since 1992, varying between 5 and 7 vessels, and the number of smaller (≤400 st) vessels has also remained steady, averaging 18 vessels between 1993 and 1997 (NMFS, 1998e). Although all large tuna purse seine vessels fishing in the ETP for tuna have been required to carry observers since 1989 (100 percent coverage), smaller purse seine vessels are not required to carry observers. Most smaller tuna vessels fishing off southern California fish on tuna schools because the vessels are old, slow, and lack the resources (e.g. helicopters) needed to place and find floating objects (B. Jacobson, NMFS, personal communication, 1999). Based on observer data from the large vessels, the chances of incidentally capturing a sea turtle during a school set are much less than incidentally capturing a sea turtle during floating object sets; therefore, the incidental take of sea turtles by the small vessel fleet is likely to be less than that of the larger purse seine vessels. However, with no observer coverage, data on sea turtle bycatch are not available for the small tuna purse seine vessels in the ETP.

In addition to collecting tuna life history and marine mammal and bycatch data during a set, observers on large U.S. purse seiners in the ETP complete a sea turtle life history form when a sea turtle is taken in a set (i.e., sea turtle was captured or at any time entangled in the net). Table III-31a shows sea turtle interactions in the large U.S. tuna purse seine fleet from 1990 to 1997. The 1990-1997 data include 174 turtles taken in the fishery that were not identified to species, although only 1 of these unidentified turtles is listed as accidentally killed (as discussed earlier, these estimates may underestimate the number of sea turtles killed in the fishery because some turtles that were lethargic when they were released, which were considered "alive" when they were released, probably died from their injuries subsequent to their release). Most of unidentified sea turtles probably never came on board, but escaped after being encircled or captured, and the observer was not close enough to identify the turtle as it swam away. Assuming that these unidentified turtle interactions occurred in the same proportions as the identified sea turtle interactions, these 174 turtles would most likely be comprised of 143 olive ridleys, 28 green turtles, and 1 to 3 leatherback, hawksbill or loggerhead turtles, in unknown proportion. It is likely that most of these 174 unidentified turtles were uninjured by their capture or encirclement if they did release themselves from the net and swim away. Table III-31b shows sea turtle interactions in the fleet from 1998 through 2001 - note that data for 2001 is incomplete.

Table III-31a. Sea turtle interactions by U.S. tuna purse seine fleet in the ETP (1990 - 1997) - large vessels only*

Set Summary / by calendar year 1/1 – 12/30									
Cruise Year	**1990[1]**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**Total***
Number of sea turtles taken (mortality in parentheses) by species[2]									**Annual Average**
Olive ridley	113(2)	104	132	133(1)	69	69(1)	45(1)	95(1)	**96**
Green turtle	4	8	21	35	28	29	17	11	**19**
Leatherback	3	0	0	2	1	0	0	0	**0.8**
Loggerhead	0	1	0	0	3	0	0	2	**0.8**
Unidentified	36	37	25(1)	21	19	3	25	8	**22**
Totals	**156**	**150**	**178**	**191**	**120**	**101**	**87**	**116**	**137**
Condition of sea turtle when released (injury/mortality due to set)									**Annual Average**
Prev. dead	0	0	2	1	4	2	0	2	**1.4**
Released unharmed	126	137	168	181	115	92	73	110	**127**
Released slightly injured	13	5	7	1	3	6	5	2	**5.3**
Kill accidentally	2	0	1	1	0	1	1	1	**0.9**
Escaped net	11	5	3	6	2	0	7	3	**4.7**
Other/unknown	3	3	0	2	0	4	1	2	**1.9**
Totals	**156**	**150**	**181**	**192**	**124**	**105**	**87**	**120**	**141.1**

[1] First year of sea turtle data collection, did not began until 3/20. Summary reflects cruises from 3/20/90 - 12/30/90, when data was collected. 1,629 sets out of 1,814 for 1990 were observed for sea turtles.

[2] Mortalities are a subset of total incidental take.

*Note: there is some discrepancy between the numbers in the two parts of the table because previously dead turtles were not included in species estimates and hawksbill turtles were not included in the top part of the table and not accounted for it in the lower part

Table III-31b. Sea turtle interactions by U.S. tuna purse seine fleet in the ETP (1998 - 2001) - large vessels only (note: 2001 data is incomplete).

Species/condition	1998	1999	2000	2001
Green turtle				
Released unharmed	3	5	2	2
Total	**3**	**5**	**2**	**2**
Loggerhead				
Released unharmed	0	1	5	0
Total	**0**	**1**	**5**	**0**
Olive ridley				
Released unharmed	38	27	3	16
Light injuries*	4	6	2	0
Grave injuries**	1	0	0	3
Escaped/evaded net	0	0	1	0
Total	**43**	**33**	**6**	**19**
Unidentified turtle				
Released unharmed	2	0	3	5
Light injuries*	0	0	0	1
Escaped/evaded net	2	1	1	0
Other***	1	0	0	1
Total	**5**	**1**	**4**	**7**

*Light injuries are considered to be those that would not be lethal to the turtle
**Grave injuries are considered to be those that would eventually cause death.
***"Other" refers to an unknown condition

In its December 8, 1999, biological opinion on the effects of the interim final rule for the continued authorization of the ETP U.S. tuna purse seine fishery on listed species, NMFS estimated the maximum annual incidental takes and mortalities of sea turtles for 2000-2010: green - 35 taken, 2 killed; leatherback turtles - 2 taken, 1 killed every 10 years; loggerheads - 3 taken, 1 killed every 7 years; olive ridleys - 133 taken, 7 killed (NMFS, 1999).

j. Foreign tuna purse seine fishery in the ETP

The international fleet represents the majority of the fishing effort and carrying capacity in the ETP tuna fishery, with most of the total capacity consisting of purse seiners greater than 400 st. These large vessels comprised about 87 percent of the total fishing capacity operating in the ETP in 1996 (IATTC, 1998). An average of 107 foreign vessels with a carrying capacity greater than 400 st fished in the ETP during 1993 to 1997. In addition to these larger vessels, the foreign fleet contains smaller vessels less than 400 st that target tuna in the ETP. From 1993 to 1997, an average of 63 foreign vessels ranging from 45 to 400 st carrying capacity fished in the ETP each year.

Data from observers on both U.S. and foreign tuna purse seine vessels have been gathered collectively by the IATTC since the early 1990s (Table III-32; data are in addition to Table III-31a). The most recent data from the IATTC indicate that an average of 172 sea turtles per year were killed by vessels over 400 st in the entire ETP purse seine fishery (U.S. included) from 1993-97 (IATTC, 1999).

The 1993-1997 data indicate that 168 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, these 168 turtles would be 140 olive ridleys, 20 green turtles, 7 loggerhead turtles and one would be either a leatherback or hawksbill.

Table III-32. **Estimated sea turtle mortality by species for the entire ETP tuna purse seine fishery (U.S. and foreign) from 1993-1997[1]**

Species/Year	1993	1994	1995	1996	1997
Olive ridley	197	103	94	83	99
Loggerhead	5	10	2	3	7
Green/black	39	8	12	7	19
Leatherback	0	0	0	1	0
Unidentified	46	36	32	29	25
TOTAL	287	157	140	123	150

[1] (M. Hall, IATTC, personal communication, 1999)

k. 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. As discussed earlier, green turtle populations in the Mexican Pacific continue to decline. 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 turtle excluder devices. 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) speculate that mortality of loggerheads due to local fishing in Baja California may primarily be due to a net-based fishery. None of the stranded turtles showed signs of hooking; therefore 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, may interact with loggerheads as they enter coastal waters in the spring and summer. 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 90% of sea turtles recorded dead were either green turtles or loggerheads (Table III-33), 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).

Table III-33. Recorded sea turtle mortality by species during 1994-1999 on the Gulf of California coast and the Pacific coast of Baja California, Mexico.

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

Source: Nichols (2002).

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. Results from a region-wide socioeconomic study conducted with The Universidad Autonoma de Baja California Sur preliminarily suggest that the actual annual harvest of green turtles may be three to four times higher than this estimate (i.e. approximately 23,000 - 31,000 green turtles taken per year). 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, occasionally strand on beaches, and have been found entangled in plastic debris. 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).

l. California/Oregon drift gillnet fishery

The California/Oregon (CA/OR) drift gillnet fishery targets swordfish and thresher shark. The fishery has been observed by NMFS since July 1990, and observer coverage has ranged from 4.4 percent in 1990 to an estimated 22.9 percent in 2000. Between July 1990 and December 31, 2001, NMFS has observed 6,312 sets (NMFS unpublished data). The fishery occurs primarily within 200 nautical miles (nm) of the California coastline and to a lesser extent off the coast of Oregon. Under California state regulations, the fishery is restricted to waters outside 200 nm from February 1 through April 30 and outside 75 nm from May 1 through August 14. Fishing is allowed inside 75 nm from August 15 through January 31. Because of these restrictions, the fishery is not active during February, March, and April. In addition, very little fishing effort occurs during the months of May, June, and July since CA/OR drift gillnet vessels targeting swordfish tend to set on warm ocean water temperature breaks which don't appear along the California coast until late summer. Currently, approximately 90 percent of the fishing effort occurs between August 15 and December 31. On average, about 9 percent of the fishing effort occurs during the month of January, 0 percent occurs February through April, and slightly more than 1 percent occurs between May 1 and August 14 (California Department of Fish and Game, unpublished data).

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

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

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

Table III-34. Estimated mortality (and coefficients of variation) of sea turtles by the California/Oregon drift gillnet fishery based on observer data.

Species	1990[1]	1991[1]	1992[1]	1993[1]	1994[1]	1995[1]	1996	1997	1998	1999	2000	2001
Green	0	0	0	0	0	0	0	0	0	5 (0.90)	0	0
Loggerhead	0	0	7 (0.93)	0	0	0	0	6 (0.95)	5 (0.89)	0	0	0
Leatherback	23 (0.97)	0	15 (0.65)	15 (0.66)	0	26 (0.55)	24 (0.64)	7 (0.95)	0	0	0	0
Olive Ridley	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified Turtle	0	0	0	7 (0.93)	0	0	0	0	0	0	0	0

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

On October 23, 2000, NMFS issued a biological opinion on the issuance of a permit under section 101(a)(5)(E) of the MMPA for the incidental taking of marine mammal species listed under the ESA during commercial fishing operations. After reviewing the available scientific and commercial data, current status of Pacific leatherback and loggerhead turtles, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, the opinion found that the issuance of section 101(a)(5)(E) permits and the associated continued operation of the CA/OR drift gillnet fishery, as regulated under the PCTRP, was likely to jeopardize the continued existence of Pacific leatherback and loggerhead turtles. Based on this opinion, NMFS has implemented regulations that eliminate drift gillnet fishing effort from August 15 through November 15 north of Point Conception in the area bounded by straight lines connecting the following coordinates in the order listed: (A) Point Sur (36°18.5' N) to 34°27' N 123°35' W; (B) 34°27' N 123°35' W to 34°27' N 129° W; (C) 34°27' N 129° W to 45° N 129° W; (D) 45° N 129° W to the point 45° N intersects the Oregon coast. to reduce the likelihood of interactions with leatherback turtles. In addition, fishing effort south of Point Conception will be eliminated during El Niño events in August and January to reduce the likelihood of an interaction with loggerhead turtles.

m. California-based pelagic longline fishery

Longline vessels which fish on the high seas (i.e. outside of U.S. EEZ waters) and unload their catch and re-provision in California ports comprise the California-based pelagic longline fishery. These vessel fish up to 1,000 miles offshore and are prohibited, by state regulations, from fishing within 200 miles of the California Coast. This fishery primarily targets swordfish and occasionally tuna, especially bigeye tuna. From 1991 to late 1993, three vessels participated in the fishery. Then in late August, 1993, longliners from the Gulf of Mexico began arriving in southern California, and by 1994, 31 vessels landed swordfish and tuna in California. By 1995, most of the Gulf of Mexico vessels left, and only 4 to 6 vessels made more than one trip from a California port, although 22 vessels made at least one longline landing. By the end of 1995, 5 vessels from the Hawaii-based fleet began operations in California due to the higher prices paid for their fish, and in 1999, a large group of 25 Hawaii-based longliners established seasonal operations in Los Angeles harbor.

Preliminary and unedited data from fisher logbooks submitted to the CDFG show that the California-based longline fishery does interact with sea turtles. Between August 1, 1995 through December 31, 1999, 33 different vessels fished a total of 2,090 days and deployed 7,071,745 hooks. Although some of the vessels began and ended their fishing trips in California, others may have begun their trip in Hawaii and ended in California. The data have not been standardized for effort, seasonality, size, or any other variables. Furthermore the data represent a subset of the results of an unknown amount of fishing effort expended in the areas of the ocean in which the reporting captains fished (CDFG, 2000). Given those caveats, Table III-35 is a summary of reported sea turtle bycatch in the California-based longline fishery.

Table III-35. Sea turtle bycatch, August, 1995 - December, 1999 in California-based longline fishery, reported logbook data

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

Source: unedited data from high-seas longline logbooks submitted to CDFG, and reported by M. Vojkovich (CDFG) on 9/29/00.

Due to area and gear restrictions applied to Hawaii limited entry permit longline vessels during 2000-2002, the number of vessels participating in the California-based pelagic longline fishery increased to 30-40, most of which de-registered from their Hawaii limited entry permits. NMFS began placing observers aboard California-based pelagic longline fishing vessels on a voluntary basis in October 2001 as a pilot project to assess levels of sea turtle interactions and to collect socio-economic data from vessel owners and operators. Three vessels volunteered to carry an observer during the 2001-2002 fishing season and the overall coverage level achieved was <5%. This limited observer data supports the logbook data that the California-based pelagic longline fishery does interact with sea turtles. The data have not been standardized for effort, seasonality, size, or other variables. The data represent a subset of the results of an unknown amount of fishing effort expended in the areas of the ocean in which the observed vessels fished. Given these caveats, Table III-36 summarizes observed sea turtle bycatch in the California-based pelagic longline fishery.

Table III-36. Sea turtle bycatch, October 2001 - May 2002 in California-based pelagic longline fishery, NMFS observer data of 59 sets

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

Source: NMFS California Pelagic Longline Observer Program, July 2002.

[1] Animals released Injured equals caught hooked.

Beginning in August 2002, NMFS started a mandatory observer program for this fishery. To date, under this mandatory program, three observers have been deployed. Each observer is equipped to collect tissue biopsies, apply flipper tags, and attach satellite tags to hardshell turtles.

The California-based longline fishery is included in the draft Highly Migratory Species Fishery Management Plan currently being considered by the Pacific Regional Fishery Management Council. If the preferred alternative is adopted, the fishery would be subject to current management measures that apply to longline vessels fishing under a Hawaii longline limited access permit or a longline general permit.

n. Hawaii-based longline fishery (Before 2000)

Prior to 2000, Hawaii-based longline vessels targeted swordfish or a mix of tuna and swordfish., or bigeye tuna. However, Hawaii-based longline vessels are now prohibited from using longline gear to fish for or target swordfish north of the equator. In addition, Hawaii longliners are prohibited from using longline gear from April 1 through May 31 in waters bounded by the equator to 15° N and from 145°W to 180°W. Because the past operation of the fishery is no longer part of the action, the Hawaii-based longline fishery prior to 2000 is included in the environmental baseline, whereas, the impacts of the fishery under the existing fishery management plan are discussed in Section IV, *Effects of the Action.*

From February 1994 through December 1999, 239 turtles were observed taken by the Hawaii-based longline fishery. Of these 239, only 14 were observed caught by tuna-style, deep-set fishing gear out of 1,440 observed tuna-style sets (0.0097 turtles per set). Conversely, 225 turtles were observed taken in 1,811 swordfish-style sets (0.1242 turtles per set), a markedly higher interaction rate. From observer data, and using a model-based predictor, McCracken (2000) estimated sea turtles taken and killed each year by the Hawaii-based longline fishery (Table III-37).

Table III-37. Sea Turtle take and kill estimates with 95% prediction intervals (PI) for the Hawaii-based longline fishery as it operated prior to 2000. These estimates include sets targeting swordfish (shallow), mixed tuna and swordfish (shallow), and bigeye tuna (deep) sets.

Year		[illegible]	1994	1995	1996	1997	1998	1999	Annual Avg
Green	Takes	Estimate	37	38	40	38	42	45	40
		95% PI	[15-65]	[15-70]	[19-70]	[14-73]	[18-76]	[18-76]	[18-71]
	Kills	Estimate	5	5	5	5	5	6	5
		95% PI	[0-16]	[0-17]	[1-17]	[0-17]	[1-19]	[1-19]	
Leatherback	Takes	Estimate	109	99	106	88	139	132	112
		95% PI	[68-153]	[62-141]	[69-148]	[55-124]	[79-209]	[76-193]	[75-157]
	Kills	Estimate	9	8	9	7	12	11	9
		95% PI	[0-22]	[0-21]	[1-21]	[0-18]	[1-28]	[1-27]	

Loggerhead	Take	Estimate	501	412	445	371	407	369	418
		95% PI	[315-669]	[244-543]	[290-594]	[236-482]	[259-527]	[234-466]	[273-527]
	Kill	Estimate	88	72	78	65	71	64	73
		95% PI	[36-141]	[31-115]	[34-127]	[28-102]	[32-112]	[28-102]	
Olive Ridley	Take	Estimate	107	143	153	154	157	164	146
		95% PI	[70-156]	[90-205]	[103-210]	[103-216]	[102-221]	[111-231]	[99-203]
	Kill	Estimate	36	47	51	51	52	55	49
		95% PI	[8-64]	[7-84]	[11-90]	[8-92]	[11-92]	[11-96]	

Source: McCracken, 2000 and McCracken, personal communication, March 2001

o. Scientific Research Permit #1303

In January 2002, NMFS issued a section 10 scientific research permit #1303 to the Honolulu Laboratory, authorizing the incidental take of listed sea turtles while conducting experiments on methods for reducing sea turtle take by longline fisheries in the Pacific Ocean. In addition, the permit allows for the importation of living, deeply hooked sea turtles for treatment and rehabilitation. The permit authorizes three types of experiments: (1) stealth and deep fishing gear; (2) hook timers and alternative hook design; and (3) minor gear modifications. The experiment is expected to be conducted over approximately a three-year period and is anticipated to take the following maximum levels of sea turtles over the life of the permit (Table III-38).

Table III-38. Maximum takes and mortalities anticipated during the life of the research permit.

Leatherbacks		**Loggerheads**		**Olive Ridleys**		**Greens**	
Takes	Mortalities	Takes	Mortalities	Takes	Mortalities	Takes	Mortalities
44	**15**	**233**	**87**	**24**	**9**	**15**	**6**

Source NMFS 2002.

Between March 1, 2002 and July 31, 2002, NMFS has observed 16 trips, 194 sets, and 159,468 hooks. During this time period, 2 loggerheads and 1 leatherback were released alive and 1 sperm whale was released injured. These are totals for the experiment to date based on 100% observer coverage.

2. Direct harvest

a. Subsistence harvest in the Solomon Islands

Between 1993 and 1996, Broderick (1997) investigated the subsistence harvest of green (and hawksbill) turtles by people from three different communities, Kia, Wagina, and Katupika on the Solomon Islands. At Kia, the majority of turtles are consumed for feasts, and the meat of the green turtle is more highly valued than that of the hawksbill. Broderick (1997) estimated that a minimum of 1,068 green turtles were harvested per year, and most were immature turtles.

b. Subsistence harvest in Indonesia

In the Kai Islands (also spelled "Kei Islands"), located approximately 1,000 kilometers southwest of the Irian Jaya nesting beaches, adult leatherback turtles are traditionally hunted and captured at sea by local people. Villagers hunt leatherback turtles only for ritual and subsistence purposes, and, according to their beliefs (known as *adat*), they are forbidden to sell or trade the meat. However, due to population increase and deforestation of the area which has lead to the loss of forest resources such as deer, pigs, and birds, villagers are taking leatherback turtles more for their increased need for meat for subsistence than for traditional purposes (Suarez and Starbird, 1996b). The carapace is rendered for oil, and the meat from the plastron is shared among villagers (Starbird and Suarez, 1994). Based on a study conducted during October-November, 1994, Suarez and Starbird (1996a) estimated that approximately 87 leatherback turtles were taken annually by villagers in the Kai Islands, and this estimate did not include incidental take by local gill and shark nets. Locals report that sea turtle populations in the area have declined dramatically (Suarez, 1999). Overall, approximately 200 leatherback turtles, both adult males and females, are killed per year in these traditional fisheries southwest of Kai Kecil during October-April (*in* Chan and Liew, 1996) (the Kai Islands take is assumed included in this estimate), and these takes are most likely continuing (C. Starbird, personal communication, 1998, *in* Clever Magazine, Issue No. 6).

c. Hawksbill Tortoiseshell Trade

By far the most serious problem hawksbill turtles face is the harvest by humans (NMFS and USFWS, 1998b). Turtles have been harvested for centuries by native inhabitants of the Pacific region. Many adults are taken for the shell, which has a commercial value, rather than food. Hawksbill generally are considered to taste poor, and infrequently are toxic to humans (NMFS and USFWS, 1998b). Until recently, tens of thousands of hawksbills were sacrificed each year to meet the demand for jewelry, ornamentation, and whole stuffed turtles (Milliken and Tokunaga *1987 in* Eckert, 1993). In 1988, Japan's imports from Jamaica, Haiti and Cuba represented some 13,383 hawksbills: it is extremely unlikely that this volume could have originated solely from local waters (Greenpeace 1989 *in* Eckert, 1993). Japan ceased the importation of turtle shell in 1992. Today the illegal domestic harvest of eggs and turtles continues in the United States, especially in Caribbean and Pacific island territories. Law enforcement, as well as conservation and management efforts, are hindered by diffuse nesting distributions and the remoteness of some rookeries. It is not easy to determine whether remaining populations are stable, increasing, or declining (Eckert, 1993).

3. Other Impacts

Threats to sea turtles vary among the species, depending on their distribution and behavior. The value of their meat, eggs, shell or other parts plays an important role in the extent of directed harvest. All sea turtle life stages are vulnerable to human-induced mortality. On nesting beaches, direct exploitation of turtles for meat, eggs, skin or shell, and other products takes place for both commercial markets and local utilization, and to a much lesser degree for traditional ceremonies. Nesting beach and in-water habitat degradation and destruction have occurred due to many factors, including coastal development, dredging, vessel traffic, erosion control, sand mining, vehicular traffic on beaches, and artificial lighting, which repels the adults and disorients the hatchlings. In areas where recreational boating and ship traffic is intense, propeller and collision injuries are not uncommon. Human alteration of terrestrial habitats can also change the feeding patterns of natural predators, thereby increasing predation on marine turtle nests and eggs. In addition, the hawksbill's dependence on coral reefs for shelter and food link its well-being to the condition of the reefs. Destruction of reefs from vessels anchoring, striking or grounding is a growing problem.

Petroleum and other forms of chemical pollution (pesticides, heavy metals, and PCB's) affect turtles throughout their marine and terrestrial habitats and have been detected in turtles and eggs. Poisoning, as well as blockage of the gastrointestinal tract by ingested tar balls, has been reported. Low level chemical pollution, possibly causing immunosuppression has been suggested as one factor in the epidemic outbreak of a tumor disease (fibropapilloma) in green turtles. Plastics and other persistent debris discharged into the ocean are also recognized as harmful pollutants in the pelagic environment. Marine turtles such as leatherback turtles actively feed on jellyfish, and plastic bags floating in the water potentially resemble such prey in form, color and texture. Hawksbills also eat a wide variety of debris such as plastic bags, plastic and styrofoam pieces, tar balls, balloons and plastic pellets. Ingested plastics can occlude the gut, preventing or hampering feeding, and causing malnutrition or starvation. Both the entanglement in, and ingestion of, this synthetic debris have been documented (*in* NMFS and USFWS, 1998a-e).

C. Status Summary of Sea Turtle Species

All listed sea turtle populations affected by the proposed action have been impacted by human-induced factors such as commercial fisheries, direct harvest of turtles and eggs, and modification or degradation of the turtle's terrestrial and marine habitats. Nesting beach habitat impacts have resulted in the loss of eggs and hatchlings as well as the deterrence of nesting females, resulting in decreased nesting success. In the marine environment, a significant anthropogenic impact is the incidental capture and mortality of subadult and adult sea turtles in various commercial fisheries. Generally, mortality resulting from the effects of marine pollution are important but less significant (NMFS and USFWS, 1998a-e). Increased mortality from these anthropogenic sources at the egg and early life history stages has impacted the species' ability to maintain or increase their numbers by limiting the number of individuals that survive to sexual maturity. In addition, the human-induced mortality of adult females results in the loss of their future reproductive output. The age at sexual maturity of loggerheads may be as high as 35 years, while green turtles may not reach maturity until 30-60 years (*in* Crouse, 1999). Upon reaching maturity, female sea turtles generally lay between 100-130 eggs per clutch, minimally 2-3 clutches per year, every 2-4 years. Thus, in general, a female sea turtle will lay between 200-390 eggs per season over an average of 2-4 years.

The potential for an egg to develop into a hatchling, into a juvenile, and finally into a sexually mature adult sea turtle varies among species and populations, as well as the degree of threats faced during each life stage. Females killed prior to their first successful nesting will have contributed nothing to the overall maintenance or improvement of the species' status. Anthropogenic mortality to females (or males, for that matter) prior to the end of their reproductive life results in a serious loss of reproductive potential to the population. While quantitative data do not yet exist to provide a precise understanding of the effects of this loss of reproductive potential, the status and trends of the turtles themselves are the best evidence that sea turtle populations cannot withstand current mortality rates. In the face of current levels of mortality and extent of habitat degradation, nesting aggregations of green, leatherback, and loggerhead turtles have declined to levels that place them at a very high risk of extinction within the foreseeable future. Of the sea turtles considered in this Opinion, Hawaii green turtles are increasing, and olive ridley turtle nesting aggregations in the western Pacific appear to be somewhat stable or increasing slightly.

IV. EFFECTS OF THE ACTION

Pursuant to Section 7(a)(2) of the ESA (16 U.S.C. §1536), federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. As described above, the ESA defines a "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 biological opinion assesses the effects of NMFS' Pelagics FMP, as amended, and the fisheries managed under that FMP on threatened and endangered species and critical habitat that has been designated for these species. The fisheries authorized under the Pelagics FMP are likely to adversely affect listed species through gear interactions, primarily entanglement and hooking, which may injure or kill individual animals. In the *Description of the Action* section of this Opinion, NMFS provided an overview of the fisheries, particularly the distribution and timing of fisheries that use gear that has been a problem for threatened and endangered species. In the *Status of the Species* (which is also the *Environmental Baseline*) section of this Opinion, NMFS provided an overview of the threatened and endangered species that are likely to be adversely affected by fisheries authorized under the Pelagics FMP.

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of federal actions to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR 402.02). Section 7 of the ESA and its implementing regulations also require biological opinions to determine if federal actions would appreciably diminish the value of critical habitat for the survival and recovery of listed species (16 U.S.C. §1536; 50 CFR 402.02). Since the proposed action is not likely to affect designated critical habitat, this Opinion will focus only on the jeopardy analysis.

NMFS generally approaches "jeopardy" analyses for fisheries in a series of steps. First, we evaluate the available evidence to identify the direct and indirect physical, chemical, and biotic effects of proposed actions on individual members of listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species - such as entanglements in fishing gear; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering its nesting substrate, or altering its ambient temperature regimes - or adding something novel to a species' environment - such as introducing exotic competitors or a sound). Once we have identified the effects of an action, we evaluate the available evidence to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). We then use the evidence available to determine if these reductions, if there are any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

A. Approach to the Assessment

We assessed the effects of the Western Pacific Pelagic Fisheries on threatened and endangered species using a general risk assessment model patterned after the U.S. Environmental Protection Agency's *Guidelines for Risk Assessment* (U.S. EPA 1998) and models toxicologists and epidemiologists use to assess risks posed by terrestrial, aquatic, and atmospheric pollutants (Kapustka *et al.* 1996, Landis *et al.* 1994, Landis *et al.* 1997, Lipton *et al.* 1993, McCarty and Power 1997, Newman *et al.* 2000, Norton *et al.* 1992, Taub 1997, U.S. EPA 1998, Wentsell 1994). We chose this assessment approach for several reasons: it is a peer-reviewed assessment framework that has been applied to a wide variety of assessment situations that include assessments of the effect of various human activities on threatened and endangered species, it is one of the best-documented assessment approaches available, it accommodates qualitative as well as quantitative information, and it is not defeated by uncertainty.

The first step of our assessment approach examined a species' likelihood of interacting with the Western Pacific Pelagic Fisheries (in this instance, a marine mammal or turtle would have "interacted" with the fishery if it was entangled or hooked by fishing gear using in the fisheries), which included an assessment of the number and kind of interaction (for example, whether a turtle ingested a hook or was hooked in a flipper), the life stage of the marine mammals or turtles involved in the interactions, the frequency of interactions, and the pattern of interactions over time and space. We combined information on the biogeography of the different turtles with the spatial and temporal interaction patterns to make inferences about which populations of marine mammals or subpopulations of sea turtles were probably affected by the fisheries (in this opinion, sea turtles in the Pacific are treated as separate "populations" from sea turtles in the Atlantic and Indian Oceans; a sea turtle population in the Pacific is represented by subpopulations that comprise one or more nesting aggregation).

Our second step was to assess the probable responses of marine mammals and sea turtles that interacted with the fisheries. For example, this step assessed a turtle's likelihood of being injured or killed during an interaction with gear used in the Western Pacific Pelagic Fisheries. In this step, we also estimate rates of post-hooking mortality. In 2001, NMFS recommended assuming a 27% mortality rate for sea turtles that are hooked externally or entangled and 42% for turtles that are hooked internally (that is, if the hook penetrates the turtle's mouth; see Appendix 4 of NMFS 2001 for a complete review and analysis of relevant research and recommendations). NMFS also recommended revising the scheme for classifying the injuries of, and assigning mortality rates to, sea turtles that have interacted with longline fishing gear. The new classification scheme is (1) non-serious injuries (2) minor or moderate injuries, and (3) serious injuries that may result in mortality or reduced ability to contribute to the population when released alive after the interaction.

The third step of our approach estimated the probable risks posed to marine mammals and sea turtles in the Pacific Ocean by the Western Pacific Pelagic Fisheries by integrating our interaction and response analyses. Specifically, we evaluated the available evidence to determine if interactions with gear used in the Western Pacific Pelagic Fisheries are likely to reduce the reproduction, numbers, or distribution of marine mammals and sea turtle populations in the Pacific Ocean by (1) killing individual marine mammals or sea turtles; (2) physically injuring marine mammals or sea turtles in ways that would have acute or chronic effects on their behavioral ecology; or (3) eliciting behavioral responses that would have longer-term, chronic effects on the viability of populations of a species. Although this section of our assessment included concerns for effects on individual animals, our assessment focused on the probable effects of the Western Pacific Pelagic Fisheries on populations and, through populations, listed species.

The final step in our analyses — relating reductions in a species' reproduction, numbers, or distribution to reductions in the species' likelihood of surviving and recovering in the wild — is the most difficult step because (a) the relationship is not linear; (b) to persist over geologic time, most species' have evolved adaptations that allow them to withstand some level of variation in their birth and death rates without a corresponding change in their likelihood of surviving and recovering in the wild; and (c) our knowledge of the population dynamics of other species and their response to human perturbation is usually too limited to support anything more than rough estimates. Nevertheless, we conducted this step of our analyses by estimating the number of marine mammals or sea turtles that would be killed or injured by interacting with the fishery, identifying the populations that would be affected by these interactions, and estimating the effects of those deaths of injuries on those populations' likelihood of surviving and recovering in the wild (for example, we considered the effect of killing a certain number of adult or sub-adult female turtles on nesting aggregations, given the probable size of the aggregation).

Jeopardy analyses must look into the future to encompass any delays between the effects of an action and the population responses of threatened and endangered species. Some human activities appear to have "delayed" effects on plant and animal populations, which can occur for two primary reasons. First, a disease, toxic chemical, or other stressor may take time to accumulate and individual animals may respond only after particular threshold doses. The classic example of this kind of "delayed effects" is the bald eagle's response to DDT: the effect of DDT on bald eagles was delayed until individual eagles received threshold doses of DDT that caused the shells of their eggs to thin. Second, a human stressor may have immediate effects on individuals or populations, but the ecology of the species may mask our ability to detect the effect. In the previous example, the bald eagle populations had declined for several years before humans were able to detect it. This kind of "delayed" effect probably reflects limitations in our ability to detect effects below certain thresholds or our inability to identify abnormal population declines given background rates of population variability.

With sea turtles, we expect the second kind of "delayed" effect. We monitor the abundance of sea turtles by counting the number of adult females on nesting beaches, and as a result, we generally would not detect changes in these populations until the adult, female population changed. The long lives and high, adult survival rates of sea turtles would mask changes in all non-adult age classes: we would not detect changes, even dramatic changes, in non-adult age classes until the adult population changed. Because of these delayed effects, assessments in the Services' biological opinions must look far enough into the future to (1) be certain of detecting a population's response to an effect, (2) be certain of detecting changes in a species' reproduction, numbers, and distribution, and (3) be certain of detecting changes in a species' likelihood of surviving and recovering in the wild (Crouse 1999b). If we do not look far enough into the future, we increase the risk of failing to detect a population's response to a human activities and we are more likely to falsely conclude there was no effect when, in fact, an effect occurred (which, in the case of fisheries, means that adult and subadult turtles will have been captured and killed for a period of years). If we look too far into the future, the passage of time can mask short-term collapses in a population and, again, we increase our likelihood of falsely concluding there was no effect when, in fact, an effect occurred.

In earlier Opinions, we responded to this challenge by basing our projections on the time it would take individuals born in the current year (2001) to enter the adult population and breed (using an approach that was consistent with approaches population biologists normally use when addressing life tables, which follow a cohort's patterns of survival and fecundity from birth to death — for age-based models — or from eggs to adults, for stage-based approaches). In the past, logbooks and observer reports collected over several years provided us with the data we needed to project the effects of the fisheries over time. Since the fisheries, particularly the Hawaii-based longline fishery, were changed in March 2001, we could not use those earlier data to estimate the probable effects of the fishery. We only have one year of monitoring data from the current fishery; in terms of a time series, these data represent a single point that limits our ability to project into the future. For the purposes of this consultation, we assume that current rates of interaction and mortality would continue into the future, although with time, we may discover that the number and rate of interactions and mortalities associated with the fishery is much different than the data that are currently available would suggest.

Information Available for the Assessment

To conduct this assessment, NMFS examined an extensive amount of evidence from a variety of sources. Detailed background information on the status of these species and critical habitat has been published in a number of documents including recent the marine mammal stock assessment reports (Hill et al. 1997, Hill and DeMaster, 1999) and a status report on six whale species that was prepared by Perry et al. (1999), status reviews of sea turtles (NMFS and USFWS, 1995; USFWS, 1997); recovery plans for the recovery plans for the blue whale (NMFS 1998a), humpback whale (NMFS 1991a), right whale (NMFS 1991b), Steller sea lion (NMFS 1992), eastern Pacific green turtle (NMFS and USFWS, 1998a), U.S. Pacific populations of hawksbill sea turtles (NMFS and USFWS, 1998b), loggerhead sea turtle (NMFS and USFWS, 1991), leatherback sea turtle (NMFS and USFWS, 1992), and U.S. Pacific populations of olive-ridley sea turtles (NMFS and USFWS, 1998c); and reports on interactions between sea turtles and gear used in pelagic fisheries (Bolten *et al.*, 1996). In April 2002, Turtle Island Restoration Network convened a meeting of experts to discuss the status of leatherback turtle populations in the Pacific Ocean. In addition, Caswell (2001), Crouse *et al.* (1987), Crowder *et al.* (1994), Ebert (1999), Heppell (1998), and Heppell *et al.* (1996, 1999, and 2000) published results from population models, sensitivity analyses, and elasticity analyses for various species of marine turtles, although most of these models are based on data on loggerhead sea turtles in the Atlantic Ocean. We supplemented these sources using online literature searches (using the search engines available through Library of Congress's website).

In the past few years, our ability to describe the biology and ecology of sea turtles has improved dramatically. Sea turtles that have been fitted with satellite tags have increased our knowledge of the migratory patterns of sea turtles in the Pacific Ocean, genetic analyses have provided essential information on the structure of sea turtles populations in the Pacific Ocean, monitoring efforts at turtle nesting beaches allow us to update our understanding of trends of different nesting aggregations, and numerous investigators continue to publish new insights into the population ecology of sea turtles produced by computer models. Despite these advances, we must still confront large gaps in our understanding of the biology and ecology of sea turtles and much of the information we have is surrounded by uncertainty. For example, our knowledge of the distribution and abundance of male sea turtles and their role on the ecology of sea turtles is still rudimentary. As another example, our ability to quantify many of the phenomena we can describe also remains very limited: we still must make assumptions about a wide array of variables, including age at reproductive maturity, age-specific rates of survivorship and fecundity, and population sizes based largely on information from loggerhead sea turtles in the Atlantic Ocean. These gaps and uncertainties limit our ability to conduct quantitative risk assessments for sea turtles in the Pacific.

In early 2002, Dr. Milani Chaloupka developed a series of simulation models that were designed to help us overcome the limits in our knowledge of the population ecology of sea turtles in the Pacific Ocean (Chaloupka 2002a, 2002b, 2002c). These models use differential equations (running in Berkeley Madonna software) to simulate time-varying demographic processes that can be subject to environmental and demographic stochasticity; the models were designed to allow managers and other interested parties to quickly consider the effects of small changes in some variables on a population's trajectory over time. After carefully reviewing these models, NMFS concluded that, without much more information on the biology and ecology of sea turtles in the Pacific Ocean, it would be inappropriate to use the models as the basis for biological opinions or other, specific management purposes. In particular, comprehensive models like the ones developed by Dr. Chaloupka require detailed information on the biology and ecology of sea turtles and the environmental relationships that, as we discussed in the preceding paragraphs, is not available for sea turtles in the Pacific Ocean. Using this kind of model under those circumstances would give the appearance of numerical precision without the reality of it (Burgman *et al.* 1993, Cortes 1999, Morris and Doak 2002, Reed *et al.* 1998).

Given these limits in our understanding, we relied on conceptual life history and population models to assess the probable responses of the turtle species to the Western Pacific Pelagic Fisheries. Although this approach produced generalizable, qualitative results and more transparent reasoning and assumptions, we sacrificed numerical precision. Nevertheless, general, transparent results were preferable to precise numerical results that were not transparent and could not be verified with existing knowledge.

Assumptions Underlying This Assessment

In the absence of definitive data or conclusive evidence, NMFS made a series of assumptions to overcome limits in our understanding (the information supporting these assumptions is presented after the assumptions). First, we continued to assume that we could assess the status and trends of sea turtle populations by considering only female turtles and ignoring male turtles, despite recent work that argues that ecologists cannot assume that only a minimum threshold number of males is needed to maintain a population and that any additional males are superfluous (Wilson 2002). Nevertheless, our knowledge of the population biology and ecology of male sea turtles is even more limited than our knowledge of female turtles; with few exceptions, we cannot even speculate on their marine distribution, status, and trends. As a result, our analyses probably underestimate the significance of male sea turtles on their species' population ecology.

To assess the potential effects of reductions in sea turtle reproduction, numbers, or distribution on the turtles' likelihood of surviving and recovering in the wild, we used a conceptual model of sea turtle life history. To compensate for a high mortality rate of eggs, hatchlings, and small juveniles each year, sea turtles have evolved a life history strategy that requires adults to produce large numbers of eggs each year, live for many years, and breed repeatedly (National Research Council 1990). Through this life history strategy, the long lives of adult turtles buffer the turtles from dramatic fluctuations caused by large fluctuations in egg, hatchling, and juvenile survival (Crouse 1999b). Now that these species of sea turtles are endangered, however, we assume that the long lives of adult turtles *mask* the effect of previous losses of eggs, hatchlings, and juveniles on the turtle populations (see Crouse 1999b). As a result, we assume that sea turtles probably face a higher risk of extinction than our knowledge allows us to recognize and allow that our assessment probably underestimates the effects of the fisheries on turtles (see Ludwig *et al.* 1993).

All of the affected turtle species and two of the marine mammal species are represented by populations that occur within the Pacific and Atlantic Oceans. For the purposes of section 7 consultations, we treat populations of threatened and endangered species in the Pacific Ocean and the Atlantic Ocean as distinct. We believe this approach is consistent with interagency policy on the recognition of distinct vertebrate populations (Federal Register 61: 4722-4725), although our final jeopardy determination will be made at the scale of the listing for the affected turtles rather than at the distinct population scale. To address specific criteria outlined in that policy, populations of marine mammals and sea turtle in the Atlantic basin are geographically discrete from populations in the Pacific basin, with limited genetic exchange (see NMFS and USFWS 1998a). This approach is also consistent with traditional jeopardy analyses: the loss of marine mammals and sea turtle populations in the Pacific basin would result in a significant gap in the distribution of each turtle species, which makes these populations biologically significant. Finally, the loss of populations of marine mammals and sea turtle in the Pacific basin would dramatically reduce the distribution and abundance of these species and would, by itself, appreciably reduce the entire species' likelihood of surviving and recovering in the wild.

These analyses are based on an implicit understanding that the marine mammals and sea turtles considered in this Opinion are threatened with global extinction by a wide array of human activities and natural phenomena; we have outlined many of those activities in the *Status of the Species* section of this Opinion. NMFS also recognizes that some of these other human activities and natural phenomena pose a much larger and more serious threat to the survival and recovery of sea turtles and whales (and other flora and fauna) than the proposed fisheries. Further, NMFS recognizes that sea turtles will not recover without addressing the full range of human activities and natural phenomena — for turtles, patterns of beach erosion, predation on turtle eggs, and turtle captures, injuries, and deaths in international fisheries and other State, federal, and private activities, for whales, other commercial fisheries and shipping —.that could cause these animals to become extinct in the foreseeable future (USFWS and NMFS 1997).

Nevertheless, this Opinion focuses solely on whether the direct and indirect effects of the Western Pacific Pelagic Fisheries can be expected to appreciably reduce the listed marine mammals and sea turtles' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution. NMFS will consider the effects of other actions on threatened and endangered marine mammals and sea turtles as a separate issue. As stated previously, jeopardy analyses in biological opinion distinguish between the effects of a specific action on a species' likelihood of surviving and recovering in the wild and a species' background likelihood of surviving and recovering given the full set of human actions and natural phenomena that threaten a species.

To conduct our jeopardy analyses, we evaluate the information available on the numbers of marine mammals and sea turtles captured, injured, or killed in the U.S. Pacific pelagic fisheries to determine if these injuries or deaths can be expected to reduce the Pacific Ocean population's reproduction, numbers, or distribution. As part of these analyses, we made assumptions about the number, sex, and life stage of marine mammals and sea turtles that might be captured, injured, or killed in the pelagic fisheries.

We consider these reductions within the context of the Pacific Ocean population's status and trend. We estimate the relative abundance of sea turtle populations based on the numbers of adult females, usually as they return to their nesting beaches. As a result, our population estimates will generally change only in response to changes in (1) the death rate of adult females, (2) the recruitment rate of sub-adult females, (3) the interval between a female's return to nesting beaches, and (4) migration patterns that might cause females to nest on other, uncensused, beaches (given the strong tendency of female turtles to return to the beach of their birth, we discount this latter phenomenon as having minimal effect on population trends). Over any five-ten year interval, the size of sea turtle populations will only change in response to changes in death rates and changes in recruitment rates (this time interval should be long enough to mask differences in re-nesting intervals). Therefore, if a turtle population is increasing, we can infer that the average number of females that recruit into the adult population is greater than the average number of adults that die in the population. If a turtle population is stable, we can infer that the average number of females that recruit into the adult population equals the average number of adults that die in the population. If a turtle population is decreasing, we can infer that the average number of females that recruit into the adult population is less than the average number of adults that die in the population.

B. Conservation and Management of Listed Species under the Magnuson-Stevens Act and the Pelagics Fishery Management Plan

Two of the ten national standards set out by the MSA are relevant to the effects the Pelagics FMP are expected to have on the listed species. As further discussed in the next section, the primary effect of the Pelagics FMP and the fisheries authorized under that FMP is the incidental capture, injury, and mortality of listed species by fishing gear. National standards 1 and 9, as seen in Table IV-1 below, guide the amount of effort and associated bycatch that shall be permitted under an FMP.

Table IV-1: **MSA National Standards** (16 U.S.C. 1851, Sec. 301(a)).

(a) IN GENERAL. – Any fishery management plan prepared, and any regulation promulgated to implement any such plan, pursuant to this title shall be consistent with the following national standards for fishery conservation and management:	
(1)	Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.
(9)	Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.

The Pelagics FMP currently has a non-numerical definition of optimum yield (OY) which is as follows: "OY is the amount of each management unit species or species complex that can be harvested by domestic and foreign fishing vessels in the EEZ and adjacent waters to the extent regulated by the FMP without causing 'local overfishing' or 'economic overfishing' within the EEZ of each island area, and without causing or significantly contributing to 'growth overfishing' or 'recruitment overfishing' on a stock-wide basis" (WPRFMC 1998b). Given that little is known about the status of most of the PMUS, this definition of OY could equate to unrestricted fishing effort under the FMP.

There are several regulations and proposed FMP amendments which limit fishing effort under the FMP in longline fisheries and which institute various conservation measures designed to avoid or reduce protected species interactions with FMP fisheries and the consequences of any remaining interactions. The limited entry program and maximum boat-length limit for the Hawaii based longline fishery limit the amount of effort in that fishery. A proposed limited entry program for the American Samoa longline fishery would do the same there. The 25 to 75 nm longline exclusion zone around the Hawaiian Islands, 100 nm wide protected species zone around the Northwestern Hawaiian Islands, to protect Hawaiian monk seals and to eliminate gear conflicts between fisheries, and new Northwestern Hawaiian Islands Coral Reef Reserve, also serve to limit fishing effort in certain areas by prohibiting longline fishing, while still allowing other gear types. Requirements on turtle handling, including line clippers, dip nets, and use of resuscitation techniques reduce the adverse effects of a gear interaction. Finally, prohibitions on the use of shallow-set gear and other swordfish-targeting techniques, and the time and area closure south of the Hawaiian Islands in April and May reduce the likelihood of interactions between turtles and longline fishing gear.

This assessment is based on the assumption that fishing effort in all the fisheries under the Pelagics FMP, with the exception of the American Samoa-based longline fishery, will continue at the same levels as they have since implementation of the June 12, 2001 emergency regulations and that sea turtle and marine mammal interactions will continue with the same frequency and effect as they have since that date.

C. Effects of Fisheries Authorized Under the Pelagics FMP

As discussed in the Action Area (see *Description of the Action)*, the fisheries authorized under the Pelagics FMP occur throughout the central, western, eastern and northern Pacific Ocean, including waters around the Northwestern Hawaiian Islands, the main Hawaiian Islands, American Samoa, Guam, Commonwealth of the Northern Mariana Islands (Saipan, Rota, and Tinian), and the U.S. possessions of Johnston Atoll, Kingman Reef, and Palmyra, Jarvis, Howland, Baker, Midway, and Wake Islands (see Figure II-8).

The Hawaii longline fishery generally operates around the main and northwestern Hawaiian islands except for prohibited areas described above in the *Description of the Action* section. The other fisheries authorized under the Pelagics FMP generally occur closer to shore. Most of the vessels associated with the pelagic longline fishery based out of American Samoa fish within 25 nautical miles of shore, although newer, larger vessels are capable of fishing out to and beyond 50 nautical miles – a closed area around American Samoa, instituted in March, 2002, prohibits vessels longer than 50 feet from fishing within 50 nautical miles of the shore, with some exceptions. Similarly, the pole-and-line fishery based in Hawaii, the recreational fisheries that target pelagic species around Hawaii, the Hawaiian charter boat fishery, the American Samoa, Guam, Hawaii, and Commonwealth of Northern Mariana Island-based troll fisheries all generally occur within 25 miles of shore (NMFS, 2000). For each of these fisheries some fishing vessels range as far as 100 nautical miles from land.

1. Marine Mammal and Sea Turtle Interaction Analysis

This section of the Opinion evaluates the available information to determine the likelihood of a listed sea turtle or marine mammal interacting (in this instance, an "interaction" consists of an animal that is entangled in or hooked by gear associated with the fisheries) with one or more of the fisheries authorized by the Pelagics FMP. Interaction analyses also evaluate the intensity, duration, and frequency of interactions between sea turtle species and gear associated with the various Pelagic fisheries. These analyses assume that sea turtles or marine mammals are not likely to be adversely affected by a fishery if they do not interact with the fishery; these analyses also assume that the potential effects of the fisheries would be proportional to the number of interactions between the fisheries and sea turtles or marine mammals.

The only source of information available for these interaction analyses are reports of actual interactions between some of the fisheries and sea turtles and marine mammals that have been derived from observer programs and logbooks. These sources do not allow us to determine the abundance of sea turtles from different nesting aggregations that *could* interact with the Pelagics fisheries (that is, the total number and origin of turtles that are susceptible to interactions with the fisheries). As a result, we cannot estimate potential interactions or the probability of interactions that remain unreported and, as with other studies confronting these data limitations, we use our estimates with caution (Kinas 2002). Nevertheless, our analysis assumes that the spatial and temporal patterns derived from reported interactions between the fisheries and turtles represents the actual spatial and temporal distribution of the sea turtle populations in the action area. Given the information available on sea turtle biology and behavior in the pelagic environment, turtles probably occur throughout the entire fishing area but probably within certain zones based on water temperatures, currents, seasonality, and prey abundance.

a. Likelihood of Interactions By Gear Type

In general, five different fishing gear types are used under the Pelagics FMP: troll, handline, pole-and-line, and longline gear. The type of fishing gear used and the area fished will affect the likelihood of an interaction with a sea turtle or marine mammal. The following section discusses the likelihood of interactions between these gear types and sea turtles and marine mammals.

(1) Troll fishing gear

Trolling is conducted by towing lures or baited hooks from a moving vessel, using big-game-type rods and reels as well as hydraulic haulers, outriggers, and other gear. Up to six lines rigged with artificial lures or live bait may be trolled when outrigger poles are used to keep gear from tangling. When using live bait, trollers move at slower speeds to permit the bait to swim naturally (WPRFMC, 1995). Freshly caught small yellowfin tuna or skipjack tuna may be used as live bait to attract marlin. Once a fish is hooked, the gear is immediately retrieved.

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

(2) Pole-and-line

A small pole-and-line fishery operates from Hawaii that targets skipjack tuna. It is sometimes referred to as the aku (skipjack tuna) fishery or baitboat fishery. The pole-and-line fishery uses live bait thrown from a fishing vessel (ranging from 65 to 80 feet) to stimulate a surface tuna school into a feeding frenzy. The pole and line used are of equal length (3 meters). Fishing is conducted using a barbless hook with feather skirts slapped against the water until a fish strikes. The hooked fish is then yanked into the vessel in one motion. The fish unhooks when the line is slacked so that the process can be repeated. The bait most often used is anchovy.

Although the distribution of the pole-and-line fishery overlaps with the distribution of sea turtles and listed marine mammals, there is a very low likelihood of an interaction with a sea turtle or listed marine mammal because the turtle or marine mammal would need to be in the vicinity and the fisher would need to hook the animal or the animal would need to strike the hook. This type of an event is unlikely to occur because sea turtles and listed marine mammals are not likely to prey on anchovy, and the activity of the fish feeding frenzy would deter turtles from remaining in the area. For these reasons, NMFS concludes that the pole-and-line fishery is not likely to adversely affect sea turtle or listed marine mammal populations.

(3) Handline fishery

Two types of pelagic handline fishing methods are practiced in Hawaii, the *ika-shibi* method, and the *palu-ahi* method. The *ika-shibi* or night handline fishery developed from a squid (*ika*) fishery that switched to target the incidental catch of tuna (*shibi*). Lights and chum are used to attract small prey species and larger target tunas to handlines baited with squid. The vessels typically fish between 5 and 6.5 nm from shore. The night-time fishery is mostly conducted off Hilo and off Keahou, both on the island of Hawaii (Hamilton, 1996 *in* NMFS, 2000a).

The *palu-ahi* or day-handline fishery also targets tuna but fishing occurs during the day. A baited hook on the end of a handline is laid against a stone and the line wound around it. Additional pieces of chum are wound into the bundle which is then tied in a slip knot (Rizzuto, 1983 *in* NMFS, 2000a). The bundle is lowered to the preferred depth (commonly 20-30 meters) where the line is jerked to untie the knot so the baited hook and chum are released at the target depth. Fishing usually takes place by smaller vessels within 6.5 nm from shore and by larger vessels around fish aggregating device or around sea mounts and weather buoys (100 - 200 nm from shore). As soon as a fish is caught, the gear is brought back on board.

There have been no reported interactions between gear used in the handline fishery and sea turtles or listed marine mammals. Although there is the risk that sea turtles or listed marine mammals may become hooked or entangled in the fishing gear, any caught animal can be immediately dehooked or disentangled and released. Moreover, most turtles or listed marine mammals found in the area of the handline fisheries are not likely to prey on the baited hooks. For these reasons, NMFS concludes the handline fishery, as managed under the Pelagics FMP is not likely to adversely affect listed sea turtle or marine mammal populations.

(4) Longline fisheries

Longline fishing is a passive fishing method that consists of suspending a monofilament line (main line) in the water column, by using floats, and attaching baited hooks along the line to attract fish. While the main line is deployed over the stern of the vessel, floats and hooks are attached to the main line using clips. Each float is attached to a float line and each hook is attached to a "branch line." The branch line is sometimes called a "gangion" or "dropper" line. For the most part, the branch lines are evenly spaced along the main line, except between floats where the placement of the float on the main line may lengthen the distance between the branch lines. The lengths of the branch lines and the float lines affect how deep the gear (hook) will fish and the type of species that might be caught. The depth that hooks actually fish is also determined by the vessel speed, drum speed, and shooter speed. The faster the main line is set (more line set in a shorter distance), the deeper the line will sink because of the line sag between the floats. In addition to the speed that the main line is set, the number of hooks and the size of the weight on each branch line can affect the depth and rate that the gear will sink. The type of species that are caught is also affected by the time of day the gear is set and the type of bait that is used.

American Samoa longline fishery. The longline fleet based in the island of Tutuila, American Samoa, has been, until recently, dominated by twin-hulled boats of aluminum or wood/fiberglass, called *alia*, most of which are about 30 feet long and powered by 40 horsepower outboard engines. The gear on the *alias* is stored on deck attached to a hand crank reel which can hold as much as 10 miles of monofilament mainline. These vessels, on which navigation is generally limited to visual methods, typically make only single-day trips, so most of their fishing effort occurs within 25 nautical miles of shore. Participants set between 100 and 300 hooks on a typical eight-hour trip. The gear is set by spooling the mainline off the reel and retrieved by hand cranking back onto the reel. Generally, gear setting begins in early morning; with retrieval in the mid-morning to afternoon. The longline fishery grew fairly steadily through the late 1990s, but after 2000 it expanded rapidly with the entry of a number of large vessels. The fleet is currently composed of about 40 of the relatively small (< 40 feet) *alia*, about five mid-sized (40-50 feet) monohull vessels, and about 30 large (> 50 feet) monohull vessels (WPRFMC 2002a). These large vessels, which have hydraulically powered reels and electronic navigation equipment and substantially greater gear and storage capacities than the small *alia*, tend to conduct multi-day fishing trips and can range throughout the EEZ (WPRFMC 2002a and WPRFMC 2002b). The rapid influx of the large domestic longliners during just the last two years has resulted in both a dramatic increase in longline fishing effort in the EEZ around American Samoa (from about 1.4 million hooks set in 2000 to about 5.8 million in 2001; WPRFMC 2002b) and a shift in the spatial distribution of longline effort towards waters more distant from shore.

(1) Past listed marine mammal take in the American Samoa-based longline fishery

For the American Samoa-based longline fishery, the federal logbooks from 1992 through 2001 indicate zero interactions with listed marine mammals. Although logbooks may not be the most reliable source of information on protected species interactions, the infrequent nature of interactions between listed marine mammals and the Hawaii-based longline fishery may indicate that this gear type incidentally captures very few marine mammals, particularly large whales. For this reason, NMFS concludes the American Samoa longline fishery, as managed under the Pelagics FMP is not likely to adversely affect listed marine mammal populations.

(2) Past sea turtle take in the American Samoa-based longline fishery

For the American Samoa-based longline fishery, the federal logbooks from 1992 through 1999 indicate six interactions with sea turtles (i.e. hooking/entanglement). In 1992, one vessel interacted with a green turtle. In 1998, one vessel interacted with an unidentified sea turtle; it was released alive. In 1999, one vessel reported interactions with four sea turtles. Three turtles released alive were recorded as a hawksbill, a leatherback, and an olive ridley. One turtle, identified as a green, was reported to have died from its interaction with this vessel. None of the species' identification were validated by NMFS' Southwest Fisheries Science Center; and NMFS cannot attest to the local knowledge of fishermen regarding the identity of various turtle species, particularly hard-shelled turtles. However, all four species of sea turtles reportedly caught by the fishery do occur in the fishing grounds of this longline fishery. In addition, as discussed below, logbook data may not be a reliable method to measure sea turtle interaction in the fisheries. From 2000 through October 2002, there have been no reported interactions with sea turtles in this fishery (S. Pooley, NMFS, personal communication, October 2002).

Hawaii-based longline fishery. 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 is about 1,690 hooks per set with about 27 hooks set between each float. There are approximately 66 floats used during each set. Deep set vessels use saury (sanma) as bait and the hook type used are "tuna" hooks. The average target depth is 167 meters. The gear is allowed to soak during the day and the total fishing time typically lasts about 19 hours, including setting and hauling of gear. This type of set is referred to below as "deep set."

(1) Past estimates of listed marine mammal captures and mortalities in the Hawaii-based longline fishery

Humpback whale. One humpback was reported by an observer entangled in the mainline of a Hawaii-based longline vessel in 1991. This interaction occurred inside what is now the protected species zone (50 nautical miles) of the islands and atolls of the Northwestern Hawaiian Islands. Another humpback whale was reported entangled in longline gear off Lanai by Nitta and Henderson (1993) and by whalewatch operators off Maui in 1993 (Hill and DeMaster, 1999). Confirmation was not made as to whether the gear type was pelagic longline gear, and the reports were believed to be for the same whale. In 2001, NMFS observer recorded a humpback whale entangled in the mainline of the fishing gear on a set targeting bigeye tuna. The animal was released alive. In October 2002, NMFS observed another humpback whale entangled in a mainline. This animal was released alive, but may have had some trailing line attached (<30ft).

Based on this information, NMFS concludes that there is a likelihood that humpback whales may incidentally become entangled in longline fishing gear. However, based on observer data and logbook data, such an interaction is infrequent and more likely a random event. Moreover, based on observer data (earlier non-observer reports of humpback whales entangled and trailing longline gear are not confirmed and were during a time when longline fishing was allowed within 50 miles of the islands and atolls of the Northwestern Hawaiian Islands), animals that are entangled are likely to be released alive, but they may have some trailing gear. Therefore, at this time NMFS believes that humpback whale interactions with longline gear are infrequent occurrences and that humpback whales will not be seriously injured or killed.

Monk Seal. In the early 1990s, longline operations were adversely affecting monk seals, as indicated by the sighting of a few animals with hooks and other non-natural injuries. In 1991, Amendment 3 established a permanent 50-mile protected species zone around the NWHI that closed the area to longline fishing. This protected species zone has essentially eliminated monk seal interactions with the longline fleet, except in 1994, a Hawaiian monk seal was reported released alive and injured on a Daily Longline Fishing Log by an operator of a Hawaii-based longline vessel. The species identification was not confirmed by Honolulu Laboratory personnel. The set was reported to occur 125 miles north by northwest of Kaui and targeting swordfish, with 800 hooks set and lightsticks used.

Based on logbook data, NMFS concludes that there is a possibility that monk seals may incidentally become entangled or hooked in longline fishing gear. However, there have been no monk seal interactions observed by NMFS observers, suggesting that the likelihood of an interaction is small. Moreover, the single animal was reported taken in a shallow set; shallow sets are now prohibited under the fishery management plan. This further reduces the likelihood of an interaction. Therefore, at this time, based on the data, NMFS does not anticipate monk seal interactions with longline gear.

Sperm Whale. NMFS has observed one sperm whale interaction by the Hawaii-based longline fishery. The event occurred in May, 1999 inside the Northwestern Hawaiian Islands EEZ (about 140 nautical miles north of Raita Bank), and the vessel was targeting swordfish (gear was set at night, lightsticks were used, and no line shooter was used). According to the observer report, the sperm whale's pectoral fin was entangled in the mainline. The captain stopped the boat, let out more mainline, and then backed up until he could reach the other end of the mainline. At this point, both ends of the mainline, on each side of the sperm whale, were secured on the vessel. During this time, the whale broke the mainline and swam away without trailing gear. There have been no reported sperm whale interactions by fishers in their logbook submissions.

Based on this information, NMFS concludes that there is a likelihood that sperm whales may incidentally become entangled in longline fishing gear. However, based on observer data and logbook data, such an interaction is infrequent. Animals that are entangled are likely to be released alive, but they may have some trailing gear (a single observed interaction does not allow us to determine conclusively that sperm whales in future interactions will not have trailing gear). Therefore, at this time NMFS believes that sperm whale interactions with longline gear are infrequent occurrences and that sperm whales will not be seriously injured or killed.

(2) Sea Turtle Interaction Analysis

The following discussion of sea turtle presence and behavior in the action area stems from observer reports and other scientific information available on the foraging and diving behavior and natal origin of the sea turtles known to be affected by the fisheries. The information presented below is based on past observed interactions between the Hawaii-based longline fishery and sea turtles and spans the entire collection of data from observer reports. However, due to changes in the Hawaii-based longline fishery, specifically the prohibitions on shallow-set gear and swordfishing methods, the location, frequency, and intensity of interactions may have changed after April 2001. Nevertheless, we are presenting all of the available information to provide as complete a picture as possible of the known intersection between this fishery and sea turtles and the reductions in interactions due to the changes in the fishery. Information specific to interactions occurring before April 2001, are referred to as occurring under the "prior fishery." Interaction information after April 1, 2001, occurred under the "current fishery." A similar analysis for the marine mammals adversely affected by the Western Pacific Pelagics Fisheries was not done due to the extremely rare and random nature of interactions between the fisheries and marine mammals foraging and migrating through the action areas.

As discussed in the *Approach to the Assessment* section, NMFS' Honolulu Laboratory estimated the number of interactions between the current fishery and sea turtles. These estimates are based on the number of turtles that interacted with observed longline sets; these estimates were then expanded statistically to estimate the number of interactions that would be expected for the entire fishery (observed and unobserved sets).

Green Turtles. The current fishery is expected to interact with about 8 green turtles each year (95% confidence interval = 2 - 21). Based on past experience, most of these green turtles will probably be members of the Hawaiian (French Frigate Shoals) or Mexican (Pacific coast) nesting aggregations. Of fourteen green turtles observed taken in the Hawaii-based longline fishery from 1994 to 2002, genetic tests indicated that six represented the eastern Pacific (Mexico - both Revillagigedos and Michoacan; and Galapagos) nesting aggregations, two represented the Hawaiian nesting aggregations, five may have originated from either Hawaii or Mexico (Islas Revillagigedos), and one was of unknown origin (P. Dutton, NMFS, personal communication, October, 2002). Nevertheless, turtles from other nesting aggregations in the Pacific Ocean may also interact with these Hawaii-based longline fisheries.

Life history information collected by observers suggests that the Hawaii-based longline fisheries tend to capture juvenile, subadult and adult green turtles (straight carapace lengths ranged from 28.5 cm to 73.5 cm with an average of 51.5 cm). From those turtles for which genetic data were collected, turtles originating from Hawaiian nesting aggregations were represented by smaller animals (juvenile and sub-adult sizes); turtles from Mexican nesting aggregations were represented by larger animals (sizes that suggest they were probably adult turtles).

Green turtles have been captured in all months of the year except January and September in the prior fishery and only during March and August under the current fishery. Under the prior fishery, green turtles have been caught in the area bounded by 155°W and approximately 180°E longitude and between 5°N and 30°N latitude. Under the current fishery, green turtles have been caught in the area bounded approximately by 160°W and 170°W longitude and south of 5°N latitude (see Figure 1 and Figure 2 in Appendix C). Green turtles in these areas are likely foraging in shallow waters or at shallow depths, or transiting to foraging grounds. The non-breeding range of green turtles is generally tropical, and can extend thousands of miles from shore in some regions. Data from satellite transmitters on Hawaiian green turtles indicate that these turtles can travel more than 1,100 km from the nesting beach at French Frigate Shoals, south and southwest against prevailing currents to numerous distant foraging grounds within the Hawaiian archipelago. Green turtles outfitted with satellite tags on Rose Atoll (the easternmost island of the Samoan Archipelago) traveled on a southwesterly course to Fiji, approximately 1,500 km distant (Balazs, *et al.*, 1994). Tag returns and observations of eastern Pacific green turtles establish that these turtles also travel long distances between foraging and nesting grounds, sometimes more than 1,000 kilometers from nesting beaches. East Pacific green turtles are the second-most sighted turtle in the east Pacific during tuna fishing cruises; they appear to frequent a north-south band from 15°N to 5°S along 90°W, and between the Galapagos Islands and Central American Coast

(NMFS and USFWS, 1998a), an area well outside of the ocean fished under the Pelagics FMP. Green turtles appear to prefer waters that usually remain around 20°C in the coldest month. During warm spells (e.g., El Niño), green turtles may be found considerably north of their normal distribution.

Under the prior fishery, more green turtles were captured in shallow sets compared to deep sets. Thirteen of 17 turtles caught by the prior fishery were captured in sets with less than 10 hooks per float, indicative of shallow-set gear. Because subadult green turtles reportedly perform routine dives of 20 meters, with a maximum depth of approximately 110 meters (Brill, *et al*., 1995, *in* Lutcavage and Lutz, 1997), they are more likely to encounter shallow-set longlines than deep-set longlines which are often set below 100 meters. Based on the behavior of post-hatchlings and juvenile green turtles raised in captivity, wild green turtles in pelagic habitats probably live and feed at or near the ocean surface, and their routine dives probably do not exceed several meters in depth (NMFS and USFWS, 1998a) making these life stages also vulnerable to capture by either shallow-set longline gear, or deep-set gear that is being set or retrieved. The only mortalities (n=5, 3 under the prior fishery and 2 under the current fishery) observed were on deep sets; we assume that these turtles drowned as a result of their inability to reach the surface.

Hawksbill Turtles. Although hawksbill turtles are known to nest on the Main Hawaiian Islands (on Molokai, Maui and Hawaii), they are not known to interact with the Hawaii-based longline fishery, as there have been no reported or observed interactions between these pelagic longliners and hawksbills. As hawksbills become adults, evidence suggests that they switch foraging behaviors from shallow water habitat to a deep water habitat, feeding pelagically for the first years of life, and switching to benthic feeding as they mature. If Hawaiian hawksbills forage close to their known nesting sites, they are probably benefitting from the protected species zone instituted by the Council in 1991, where longliners are prohibited from fishing within 50 nm of the NWHI[34] and within 100 nm closed corridors connecting the non-contiguous closed circles. Further longline exclusion zones prohibit longline fishing in specific areas around the MHI (depending on the time of year and location, the exclusion zones around the MHI range from 25-75 nm). Because adult hawksbills are most likely foraging primarily in nearshore waters, the likelihood of an interaction with a longliner is very low.

Leatherback Turtles. The current fishery is expected to interact with about 8 leatherback turtles each year (95% confidence interval = 2 - 21). Based on genetic analysis, all of the leatherback turtles captured in the Hawaii-based longline fishery are from two nesting aggregations: the western Pacific region (Papua New Guinea, Indonesia, and Solomon Islands), and the eastern Pacific region (Mexico and Costa Rica). Of 17 leatherback turtles captured in the Hawaii-based longline fishery, 16 were from nesting aggregations in the southwestern Pacific, most likely Indonesia or the Solomon Islands; the remaining turtle, captured in the southern range of the Hawaii fishery, was from an eastern Pacific nesting aggregation (P. Dutton, NMFS, personal communication, October, 2002).

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[34] Note: there have been no known valid records of a hawksbill anywhere in the NWHI (G. Balazs, NMFS, April, 2002).

Straight carapace lengths taken from a subset of the leatherback turtles caught in the fishery suggest that subadults, representing both early and late pelagic stage, based on the stage structure for Malaysian turtles presented in Bolten, *et al.* (1996). However, it appears that young leatherback turtles (carapace length <100 cm) reside only in waters warmer than 26°C, which should generally place them outside of areas in which longline swordfish fleets operate (Eckert, 1999b; Eckert, 2002). If one of the measured leatherback turtles (130 cm) originated from the eastern Pacific, it could have been an adult; if it originated from the western Pacific, it would be a subadult (P. Dutton, NMFS, personal communication, January, 2001). Because the majority of the leatherback turtles caught in the fishery are probably of western Pacific origin, this individual was probably a sub-adult. Most of the leatherbacks caught in the fishery were not measured. Those leatherbacks that were not measured may have been too large to be safely brought on board; therefore they may have been adults.

The data on these interactions revealed clear spatial patterns between the prior and current fisheries and leatherback turtles. However, there is no obvious temporal pattern to those interactions: leatherback turtles have been captured in every month of the year, except August. Under the prior fishery, leatherback turtles were captured in the area bounded by 170°E and 133°W longitude and between 5°N and 41°N latitude.

Leatherback turtles within the action area of the Hawaii-based longline fishery are probably foraging (at the surface or at depth, including the deep scattering layer) or migrating between their nesting, mating, and foraging areas. Leatherbacks are able to dive quite deep, but appear to spend most of their time (up to 90%) diving to depths shallower than 80 meters. They are highly migratory, exploiting convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Morreale, *et al.*, 1994; Eckert, 1998; Eckert, 1999a).

Leatherback turtles caught in prior fishery sets above 20°N latitude (43 out of 52 leatherback turtles observed) were caught in sets with less than 10 hooks per float, indicative of shallow-set gear and also indicative of the general area in which shallow set fishing methods were used. Leatherback turtles were primarily captured in these sets in an area bounded by 165°W and 130°W longitude and 20°N and 40°N latitude.

The remaining leatherback turtles captured in the prior fishery (9 out of 52), were associated with sets with more than 10 hooks per float, suggesting deep-set gear. These interactions occurred between 153°W and 167°W longitude and 5°N and 26°N latitude (see Figure 3 in Appendix C). Sea surface temperatures, latitude, and the distance to the approximate 17°C and 19°C isotherms were associated with these interactions, but there was a high degree of collinearity between these variables (McCracken, 2000): when McCracken examined four latitude predictor categories for leatherback turtles[35], she found that the proportion of sets associated with leatherback captures was higher in the northernmost and southernmost categories, even though these areas had lower proportions of the observed sets than the middle two categories, which had high observed sets but fewer observed takes. These observations suggest that the risk of an interaction increases toward

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[35] These four categories were: less than 14.95°N, between 14.95°N and 24.84°N, between 24.84°N and 33.82°N, and greater than 33.82°N (McCracken 2000).

the northern and southern boundaries of the action area. Under the current fishery, two leatherback turtles have been observed taken between 160°W and 162°W longitude and 21°N and 26°N latitude (see Figure 4 in Appendix C).

Recent information on leatherbacks tagged off the west coast of the United States has revealed an important migratory corridor from central California, to south of the Hawaiian islands, leading to western Pacific nesting beaches (P. Dutton, NMFS, personal communication, October 2002). This corridor runs through the areas typically fished by the Hawaii-based longline fleet and supports genetic findings that most of the leatherback turtles caught in the fishery originate from western Pacific beaches. Eastern Pacific leatherback turtles appear to migrate primarily to the south, into the fishing grounds of South American fishing nations, supporting the low observed interaction rate between the Hawaii-based longline fishery and eastern Pacific leatherback turtles.

Loggerhead Turtles. The current fishery is expected to interact with about 14 loggerhead turtles each year (95% confidence interval = 3 - 26), although interactions are more likely north of 22°N latitude (12 interactions, with a 95% confidence interval = 3 - 26) than south of 22°N (2 interactions, with a 95% confidence interval = 0 - 8). Based on genetic analyses of 133 loggerheads, all of the loggerhead turtles captured in the Hawaii-based longline fishery originated from Japanese nesting aggregations (Dutton *et al.*, 1998, P. Dutton, NMFS, personal communication, October, 2002). Available data on the length of these turtles indicate that the fishery captures pelagic-stage juvenile loggerhead turtles. These data are supported by the available information on the foraging and migrating patterns of loggerhead turtles. The transition from hatchling to young juvenile occurs in the open sea, and evidence is accumulating that this part of the loggerhead life cycle may involve a trans-Pacific developmental migration (Bowen, *et al.*, 1995). As they age, some loggerheads begin to move into shallower waters, where, as adults, they forage over a variety of benthic hard- and soft-bottom habitats.

From 1994 through March 2001, observers recorded the incidental take of 175 loggerheads (see Figure 5 of Appendix C, which shows the location of loggerhead captures by the Hawaii-based longline fleet). The existing data on these interactions revealed clear spatial patterns between the prior fishery and loggerhead turtles. There are reports of loggerhead turtle captures in all months except May and June; most captures occurred during the fall and winter months, however, especially in January and February.

Statistical analyses of captures through 1999 to determine possible associations with several different variables like sea surface temperature, latitude, and the distance to the approximate 17°C and 19°C isotherms showed a high degree of collinearity between these variables. Degree of latitude appeared to be a primary determinant of the probability of loggerhead captures in the fisheries. For example, McCracken (2000) reported that, none of 1,263 sets that were observed south of 22°N captured loggerhead turtles. Kleiber (1998) also found latitude to be the primary determinant of interactions between the fisheries and loggerhead turtles. However, after March

2001, the current fishery caught two loggerhead turtles, including one turtle far south of the area in which loggerhead turtles were typically seen (13°N latitude; see Figure 6 in Appendix C)[36].

Of 70 trips in which loggerheads were captured, 39 had captured loggerheads in more than one set, and several trips had captured multiple loggerheads in the same set. This suggests that juvenile loggerhead turtles forage or migrate in groups, or longliners target swordfish and tuna in areas of high loggerhead concentration, or both. Other data also suggest that juvenile loggerhead turtles forage or migrate in groups. Off Baja California, thousands of juvenile loggerhead turtles have been observed feeding on pelagic crabs. In the Atlantic Ocean, 68.1% of the loggerhead turtles captured in longline gear were caught in sets with other loggerheads compared with 31.9% that were caught singly (Hoey, 1998).

The existing data also lead us to conclude that loggerheads tend to congregate in areas typically fished by longliners targeting swordfish, taking advantage of high productivity associated with particular oceanographic features. Recent satellite tracking by Polovina *et al.* (2000) indicates that all life stages of loggerhead turtles actively migrate, swimming against weak geostrophic currents along two convergent fronts as they travel from east to west across the Pacific. Of nine juvenile loggerheads tracked in the central North Pacific, six associated with a front characterized by 17°C sea surface temperature (SST; termed "cool group") and the other three associated with a front with a SST of 20°C ("warm group"). Seasonally, these 17°C and 20°C isotherms move north and south over 10 degrees of latitude, and as the turtles moved westward, they also appeared to move north and south coincident with these isotherms. Under the prior fishery, the distribution of shallow longline sets during the first quarter was largely between the 17°C and 20°C SST fronts used by loggerheads.

Swordfish are believed to move south through these fronts, perhaps following squid. For example, during the second quarter, the prior fishery tended to locate well to the south of the 17°C SST front but overlapped the 20°C SST front. Sea turtles tracked during the first quarter of the years 1997 and 1998 occupied waters with a mean of 17°C SST, with considerable overlap with the SST associated with the fishery in the northern portion of the fishing grounds. As the fishery moved south in the second quarter, those "warm group" turtles following the 20°C front would be well within the fishing ground, while the "cool group" would likely have been well north of the fishing ground (Polovina, *et al.*, 2000). Observer data shows that the interaction rate (turtles per longline set) was substantially greater at 17°C SST than at 20°C SST (P. Kleiber, NMFS, personal communication *in* Polovina, *et al.*, 2000).

Finally, all of the 175 loggerheads observed taken by the Hawaii-based longline fishery from 1994 through March, 2001, were captured by longliners using shallow sets (i.e. target depth less than 100 meters, using less than 10 hooks per float, fishing at night, using lightsticks).. 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).

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[36] Two other loggerhead turtles were reported taken in the northern portions of the action area. These turtles were captured on sets under suspicion of illegal activity (targeting swordfish) and therefore they have not been included in the interaction analysis. In addition, there are no photos or other information available to confirm that the turtle taken around 13° N was a loggerhead.

Loggerhead turtle maximum recorded dive depth is 128 meters. In general, loggerhead turtles tend to spend most (90%) of their time at the surface or diving to 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. However, in July 2002, a loggerhead turtle was caught in a deep set fishing at 13°N latitude, an interaction than diverged from NMFS' past observations of the overlap between this species' pelagic distribution and behavior and the deep-set portion of the longline fishery.

Olive Ridley Turtles. The current fishery is expected to interact with about 26 olive ridley turtles each year (95% confidence interval = 12 - 47). Genetic analyses suggest that the Hawaii-based longline fishery catches olive ridley turtles from nesting aggregations in the eastern and western Pacific Ocean and the Indian Ocean. Based on analyses of 39 olive ridleys captured by the Hawaii-based longline fishery, 26 % (n=10) were from the Indian Ocean or western Pacific Ocean and 74% (n=29) were from the eastern Pacific (P. Dutton, NMFS, personal communication, October, 2002). Some areas within the fishing grounds of the prior fishery had a high proportion of captured olive ridleys from both eastern and western Pacific beaches, signifying that ridleys from both sides of the Pacific converge in the north Pacific pelagic environment. Length information collected by observers indicates that the fishery interacts with sub-adult and adult olive ridley turtles. Olive ridley turtles generally have a tropical range, with a distribution from Baja California, Mexico to Chile (Silva-Batiz, *et al.*, 1996). Satellite studies of post-nesting olive ridley turtles indicated that the females traversed thousands of kilometers of deep oceanic waters, including more than 3,000 kilometers out into the central Pacific. Young olive ridley turtles tend to forage in large groups, or flotillas, in the open ocean environment. As they age, they begin to recruit to the benthic feeding grounds of the adults. Olive ridley turtles caught in the fishery may be transitioning between the open ocean and the shallower adult feeding areas, or migrating between foraging, mating, and nesting areas.

The existing data from the prior fishery on these interactions revealed clear spatial patterns but a weak temporal pattern: olive ridley turtles had been captured in every month of the year, except February, with most of the captures occurring during warmer months (May to August). In addition, the prior fishery interacted with olive ridleys throughout the fishing area, with captures reported from as far north as 33°N to as far south as 7°N latitude, and from longitudes 143°W, west to 175°W (see Figure 7 in Appendix C). Sea surface temperatures, latitude, and the distance to the approximate 17°C and 19°C isotherms were associated with the takes, but there was a high degree of collinearity between these variables. There was a clear distinction between the proportion of takes between the two categories of sea surface temperature, but over latitude, the pattern was less clear (McCracken, 2000). Observed interactions between olive ridley turtles and the current fishery follow similar patterns: olive ridleys have been captured in January, March, April, June, and July in an area between 10°N and 23°N latitude and 154°W and 168°W longitude (Figure 8 in Appendix C).

Olive ridley turtle maximum recorded dive depth is 238 meters, although the species spends a greater proportion of time at depths shallower than 40 meters (60% with 20% of total time spent at the surface), possibly making them more likely to encounter shallow set longlines than deep set longlines. Under the prior fishery, most olive ridley turtles were caught in shallow sets with less than 10 hooks per float (76% of observed interactions). All but one of the turtles killed during interactions with the prior or current fishery were caught in deep sets with more than 10 hooks per float; it is likely that these turtles died as a result of their inability to reach the surface.

(a) Past estimates of sea turtle captures and mortalities in the Hawaii-based longline fishery

Because the bycatch information provided in skipper logbooks was considered unreliable, and due to reasonable and prudent measures listed in prior biological opinions, an observer program was established in 1994 to monitor target species caught and bycatch in the Hawaii-based longline fishery. Through 1999, observer coverage ranged from 3.4% to 5.3% of annual trips (NMFS, 2000f). Since 1999, observer coverage in the fishery increased substantially due to both court-orders and changes in NMFS' regulations. In 2000, 2001, and 2002, observer coverage was approximately 10.4%, 22.5%, and 27.6% (first nine months), respectively.

In earlier biological opinions, NMFS defined "turtle take" as any interaction between a sea turtle, a fishing vessel, or its gear, particularly interactions that were likely to result in a turtle becoming entangled in fishing line or caught on a hook. Observers complete sea turtle life history forms for every turtle observed taken by a longline vessel. Turtles are either brought aboard or sampled alongside the vessel, and from such vantage points, the observer records biological characteristics as well as the fate of the turtle. Table IV-3 contains characteristics (definitions) used by observers to define the condition and fate of turtles interacting with longline gear.

Because a probability sample was not drawn on a yearly basis, a model-based predictor was used to estimate the total take of sea turtles by the fishery. In developing the prediction model, explanatory variables were considered in order to estimate takes accurately and precisely. Such variables included: latitude, longitude, distance to 17°C isotherm, distance to 19°C isotherm, year (1994-1999), month, day, hooks, hooks/float, temperature, catch of other species (e.g. tuna species, marlin, albatross, etc.), vessel length, and trip type (i.e. swordfish, tuna, mixed). Some of the variables considered and found to be associated with take were poorly represented in the logbooks during the time period of data gathering and were therefore not considered for prediction purposes. Table IV-4 shows the explanatory variables that were included in the prediction models for the various species of sea turtles.

Table IV-3 Definitions used to characterize the fate of sea turtles taken by Hawaii-based longlines

Fate	Definition	Codes
Alive [Released Unharmed]	An animal removed from the fishing gear that can swim normally. The animal is likely to have minor cuts and abrasions from being entangled. **This applies to entangled sea turtles only.**	EOK = entangled, okay

Injured	An animal released from the fishing gear with obvious physical injury or with gear attached. An injured animal may lie at the surface, breathing irregularly, or swim in an abnormal manner. **If an animal is impaled on a hook, it is considered injured.** "Internal" refers to the hook being ingested, "external" implies that the turtle was hooked in the head, beak, flipper, carapace, or plastron.	HII = hooked, internal, injured HEI = hooked, external, injured HUI = hooked, unknown, injured EI = entangled, injured
Dead	An animal removed from the fishing gear in a postmortem state (i.e. the animal died due to injuries incurred during fishing operations or was returned to the sea while comatose). Animals will show a lack of muscular activity and may float passively at or below the water's surface.	HID = hooked, internal, dead HED = hooked, external, dead HUD = hooked, unknown, dead ED = entangled, dead
Unknown	An animal lost, released, or escaped from the fishing gear whose condition was not determined.	HIU = hooked, internal, unknown; HEU = hooked, external, unknown; HUU = hooked, unknown, unknown; EU = entangled, unknown.

Table IV-4. Explanatory variables used in the prediction models

Species	Explanatory Variables	Categories
Green turtle	None	n/a
Leatherback	Latitude (4 categories)	lat ≤ 14.95°N; 14.95°N < lat ≤ 24.84°N 24.84°N lat ≤ 33.82°N lat > 33.82°N
Loggerhead	Month (3 categories) Latitude as a polynomial Sea surface temp. (2 categories)	[1,2], [5,6], [3,4,7-12] $lat + lat^2$ sst ≤ 23.77°C; sst>23.77°C
Olive ridley	Sea surface temp. (2 categories)	sst ≤ 24.22°C; sst>24.22°C

Source: McCracken, 2000.

b. *Factors contributing to the likelihood of an interaction with the longline fishery*

As discussed in the *Approach to the Assessment* discussion, this section of the biological opinion discusses attributes of the fisheries that represent hazards for threatened and endangered turtles that interact with the longline fisheries. In addition, this section of the opinion discusses environmental conditions that represent risk factors for sea turtles.

(1) Gear

Floats. 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). Floats typically used during swordfish-style sets are bright orange, bullet-shaped, and slightly submerged. Deep sets generally use larger cylindrical inflatable or rigid spherical buoys and floats, and these also are typically orange in color (L. Enriquez, NMFS, personal communication, January, 2001; e.g. www.lindgren-pitman.com/floats.htm).

Bait. 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). In addition, a leatherback has been documented ingesting squid (the bait typically used on the now prohibited gear targeting swordfish). The authors speculate that the lightsticks used on this gear type may initially have attracted the turtle, by simulating natural prey (Skillman and Balazs, 1992).

(2) 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). Swordfish are caught by longliners in association with frontal zones where ocean currents or water masses meet to create turbulence and sharp gradients of temperature and salinity. Swordfish also make vertical migrations through the water column, rising near to the surface at night from deep waters. Thus, while searching for concentrations of swordfish under the prior fishery, longliners set their gear across these temperature gradients ("breaks") indicative of intersecting water masses, and when sea turtles were associated with these fronts, interactions were more likely.

2. General effects of longline fishing on sea turtles

The most significant hazard of longline fisheries for sea turtles results from potential entanglement in or hooking by gear used in the fishery which can injure or kill turtles. Turtles that are entangled in or hooked by longline gear can drown after being prevented from surfacing for air; alternatively, turtles that are hooked, but 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 the Hawaii-based longline fishery, 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 following discussion summarizes the information on these potential effects.

a. Effects of forcible submergence

Sea turtles can be forcibly submerged by longline gear either through a hooking or entanglement event, where the turtle is unable to reach the surface to breathe. This can occur at any time during the set, including the setting and hauling of the gear, and generally occurs when the sea turtle encounters a line that is too short to reach the surface or is too heavy to be brought up to the surface by a swimming sea turtle. For example, a sea turtle that is hooked on a 3 meter branchline attached to a mainline set at depth by a 6 meter floatline will generally not be able to swim to the surface unless it has the strength to drag the mainline approximately 3 more meters (discussed further below).

Turtles hooked by longline gear will sometimes drag the clip, attached to the branch line, along the main line. If this happens, the potential exists for a turtle to become entangled in an adjacent branch line which may have another species hooked such as a shark, swordfish, or tuna. According to observer reports, most of the sharks and some of the larger tuna such as bigeye are still alive when they are retrieved aboard the vessel, whereas most of the swordfish are dead. If a turtle were to drag the branch line up against a branch line with a live shark or bigeye tuna attached, the likelihood of the turtle becoming entangled in the branch line is greater. If the turtle becomes entangled in the gear, then the turtle may be prevented from reaching the surface. The potential also exists, that if a turtle drags the dropper line next to a float line, the turtle may wrap itself around the float line and become entangled.

Sea turtles that are forcibly submerged by longline gear undergo respiratory and metabolic stress that can lead to severe disturbance of their acid-base balance. While most voluntary dives by sea turtles appear to be aerobic, showing little if any increases in blood lactate and only minor changes in acid-base status (pH level of the blood), sea turtles that are stressed as a result of being forcibly submerged through hooking or entanglement in a line rapidly consume oxygen stores, triggering an activation of anaerobic glycolysis, and subsequently disturbing their acid-base balance, sometimes to lethal levels. It is likely that the rapidity and extent of the physiological changes that occur during forced submergence are functions of the intensity of struggling as well as the length of submergence (Lutcavage and Lutz, 1997). In a field study examining the effects of shrimp trawl tow times and sea turtle deaths, there was a strong, positive correlation between the length of time of the tow and sea turtle deaths (Henwood and Stuntz, 1987, *in* Lutcavage and Lutz, 1997).

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). 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 the Hawaii-based longline fishery or other 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).

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 on a longline. 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. During the warmer months, routine metabolic rates are higher, so the impacts of the stress due to entanglement or hooking may be magnified. 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 (*in* 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.

Although a low percentage of turtles that are captured by longliners actually are reported dead, sea turtles can drown from being forcibly submerged. Such drowning may be either "wet" or "dry." In the case of dry drowning, a reflex spasm seals the lungs from both air and water. With wet drowning, water enters the lungs, causing damage to the organs and/or causing asphyxiation, leading to death. 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 of course 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).

b. *Effects of entanglement*

Sea turtles are particularly prone to entanglement as a result of their body configuration and behavior. Records of stranded or entangled sea turtles reveal that fishing debris can wrap around the neck or flipper, or body of a sea turtle and severely restrict swimming or feeding. Over time, if the sea turtle is entangled when young, 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 both 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).

c. Effects of hooking

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. When lightsticks were used on a shallow set at night to attract the target species, the turtles could have mistaken the lightsticks for their preferred prey and been 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).

d. Effects of trailing gear

Trailing line (i.e. line that is left on a turtle after it has been captured and released), particularly line trailing from an ingested hook, poses a serious risk to sea turtles. Line trailing from an ingested hook is likely to be swallowed, which may occlude the gastrointestinal tract, preventing or hampering foraging, leading to eventual death. Trailing line may also become snagged on a floating or fixed object, resulting in further entanglement, with potential loss of appendages, which may affect mobility, feeding, predator evasion, or reproduction. 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 observer or the vessel and its crew at risk. Turtles with most or all of the trailing gear removed are expected to have a better chance of surviving the interaction in the long term.

e. Post-hooking survival studies - (lightly hooked v. deeply hooked)

Research has been conducted in both the Atlantic and the Pacific to estimate post-hooking survival and behavior of sea turtles captured by longline. In the Pacific, from 1997 to late 2000, a total of 54 pelagic turtles hooked by the Hawaii-based longline fishery have had satellite transmitters attached to them in order to track their location and distance traveled following the interaction. Of these 54 turtles, 15 produced no transmissions, or their transmissions lasted less than a month - 11 had deeply ingested hooks (turtles had swallowed the hook, and it was not removed) and 4 were lightly hooked.(turtles had the hook lodged externally (beak or flipper), permitting easy removal) (D. Parker and G. Balazs, NMFS, personal communication, April, 2002). No assumptions were made by the researchers regarding the fate of these turtles that failed to transmit or only transmitted for a short period of time. Assuming that the satellite transmitter was working correctly, there are a number of possible explanations for few or no transmissions, any of which could be correct. Following the hooking incident, including the forced submergence, hauling of the longline and subsequent capture by the vessel, the released turtle may not have had time to recover from its experience. As discussed above, turtles that expend energy as a result of increased activity, need time at the surface to process lactic acid loads. Sea turtles often appear to be moving fairly well and then just collapse, while they rebuild their energy stores or repay their oxygen debt (E. Jacobsen, *in* Balazs, *et al.*, 1995). If a turtle does not have enough energy to remain afloat, it could submerge and die. In addition, injuries sustained as a result of the hooking incident, especially in incidents where the hook may have perforated an organ, may also result in death to the turtle. In both instances, the turtle sinks with the transmitter, and no signal is received. Whether or not these turtles remained submerged and therefore died, or the transmitters failed to transmit is a matter of speculation.

For the 34 turtles that did produce successful tracks for periods lasting more than a month, there were no significant differences (P>0.05) found for the duration of tracking (days) and the distance traveled between lightly hooked turtles (n=15) and turtles with deeply ingested hooks (n=19). Even when the 15 turtles that did not produce successful tracks were taken into account, no significant differences were found in terms of distance traveled and duration between the two groups (19 total lightly hooked, and 30 total deeply ingested). Furthermore, when species were analyzed individually for the two categories, no significant differences were found.

Polovina (NMFS, personal communication, September, 2000) used a contingency table approach to analyze the transmission duration in intervals of 1 month for 34 loggerheads (including those w/ few or no transmissions), comparing lightly hooked versus deeply hooked turtles. While 43% of the deeply hooked turtles transmitted less than one month compared to 27% of the lightly hooked turtles, the chi-squared test found no significant difference between the transmission distributions for these two categories. When the data for all hard shell turtles are combined (n=48), 22% (n=4) lightly hooked and 37% (n=11) deeply hooked turtles transmitted less than one month. Again, the difference was not statistically significant between hooking categories based on a chi-square test.

Data were also analyzed to determine whether the length of the turtle (in straight carapace length) played any role in determining differences between deeply hooked turtles and those that were lightly hooked. Only all satellite tagged loggerheads (both with successful tracks and without (n=35)) showed a significant difference (P=0.02) in size between deeply ingested (mean size = 62.0 ± 10.9 cm) and lightly hooked (mean size = 53.0 ± 6.6 cm) (D. Parker and G. Balazs, NMFS, personal communication, November, 2000).

In the eastern Atlantic, in the waters around the Azores, three juvenile loggerheads that had been lightly hooked by swordfish longline gear were instrumented with satellite-linked time-depth recorders in 1998. The number of dives performed by these hooked turtles was compared to five juvenile loggerheads that had been captured by dipnet and also instrumented. Turtles caught on longline fishing gear had significantly lower dive counts than turtle caught with dipnets during the normal (observed) period of most intense diving activity (from 9:00 am to 3:00 pm) (Bjorndal, *et al.*, 1999). During a similar study in the summer of 2000, in the same area of the Atlantic, 10 pelagic juvenile loggerheads were instrumented - four were captured with dipnets (control), and six had been deeply hooked. In all periods of the 24-hour day (separated by 6-hour increments), the hooked turtles appeared to make longer and shallower dives than control turtles, but overall, dive behavior appeared similar between hooked and non-hooked turtles, having a diurnal component (shallowest dives occurring during 21:00 and 03:00) and a seasonal component (dive depth generally increased for most turtles from summer into fall) (Riewald, *et al.*, 2000). Caution was given in interpreting both sets of data, as the studies were ongoing at the time of writing.

B. Estimation of the Risks the Pelagic Fisheries Pose to Sea Turtles

This section of the biological opinion evaluates the available evidence to assess the probable risks posed by the various fisheries managed under the Pelagics FMP based on the interaction analysis and susceptibilities of the turtles to reach conclusions about the potential effects of the fisheries on threatened and endangered sea turtles. Specifically, we evaluated the available evidence to determine if the fisheries were likely to kill or physically injure these turtles species in ways that would be expected to have chronic or acute effects on their population ecology. Although this section of our assessment included concerns for effects on individual animals, our assessment focused on the probable effects of the fisheries on populations and, through those populations, the viability of the species themselves.

The following discussion estimates the probability of injuries or death based on data extracted from interactions between these fisheries and sea turtles over time. It is important to note that much of the data presented below includes interactions between the turtles and the now-prohibited shallow-set component of the longline fishery. Past mortality estimates for turtles taken by the Hawaii-based longline fishery before 2001 were based on limited data from Aguilar, *et al.* (1995) and from information recorded by observers on the condition of the turtles when released (Kleiber, 1998). Aguilar, *et al.* (1995) estimated a 29% mortality rate for loggerheads ingesting a longline hook; therefore all turtles (hard-shelled and leatherback) that had been hooked internally were assigned a mortality rate of 29%. Turtles recorded as dead had a 100% mortality rate, and turtles recorded as okay (released uninjured) were assigned a 0% mortality rate. All species of turtles hooked externally were also assigned a 0% mortality rate (McCracken, 2000).

Observers occasionally were unable to identify a turtle to species, or to assess their condition accurately. Therefore, identified turtles hooked in an unknown location were assigned the average mortality of the turtles of their species with a known hook location. Turtles with an unknown condition (i.e. not recorded) were assigned the average within species of turtles with condition "okay," internally hooked, or externally hooked. For those turtles reported as hardshell with unknown hook location or unknown condition, the averaging was conducted over all turtles except leatherbacks (Kleiber, 1998), also taking into account temperature or latitude (McCracken, 2000). For example, there were 10 unidentified hardshell turtles observed taken from 1994 to 1999. The identity of these turtles was apportioned to loggerhead, olive ridley, or green turtle takes in the same proportion as observed takes of these species, and, except for green turtles, using the prediction models for each species. Based on the prediction models, olive ridley takes were higher at temperatures greater than 23.77°C, whereas loggerhead takes were higher at temperatures less than 24.22°C. If the sea surface temperature was not a clear indicator, the observed latitude was used to determine the species, since loggerhead takes were higher in the northern latitudes. In the two instances where the choice between the two species was most ambiguous, the identity was split fractionally among the three hardshelled species based on the proportions determined from observer data (McCracken, 2000).

Using the mortality rates assigned above for the condition of a turtle taken by the Hawaii-based longline fishery, the total number of turtles killed per year was estimated by averaging the mortality rates assigned to each condition class for the species, based on observed takes from 1994-1999. For example, of 147 loggerheads observed taken from 1994-1999, 83 were deeply hooked (29% mortality rate), 56 were externally hooked (0% mortality rate), 3 were hooked in an unknown location (17% mortality rate[37]), 1 was dead (100% mortality rate), 3 were entangled and released alive and uninjured (0% mortality rate), and 1 was of unknown condition (17% mortality rate). Averaging these, the resultant mortality rate for the 147 loggerheads observed taken by the Hawaii-based longline fishery was 17.5% (McCracken, 2000).

Given the potential for organ and tissue damage and subsequent infection (as discussed in *Post-hooking survival studies - (lightly hooked v. deeply hooked)* above), total mortalities may have been under estimated previously if lightly hooked animals were assigned a zero mortality rate. To estimate the probability of future mortalities, NMFS reviewed the results of several post-hooking survival studies from Hawaii, the eastern Atlantic, and the Mediterranean (i.e. Aguilar *et al.* 1995; Parker and Balazs pers. comm, 2000; Bjorndal, *et al.* 1999; Riewald, *et al*, 2000), as well as analyses of input from veterinarians and scientists with expertise in sea turtle biology and/or longline gear impacts (see January 4, 2001, memoranda from Don Knowles and Bruce Morehead to the Southeast Regional Office, the Office of Protected Resources).

After reviewing the available information, NMFS reached consensus on a method of estimating sea turtle mortalities (NMFS 2001b). NMFS' adopted approach apportions mortality in a manner consistent with the best scientific information in lieu of applying one standard across the board, while still providing the precautionary approach required for evaluating effects to listed species (NMFS 2001b). Table IV-5 details the estimated mortality rates for sea turtles captured on long line gear based on their condition.

Table IV-5. Sea turtle mortality rates based on level and type of interaction with longline fishing gear. Source: NMFS, 2001b

Interaction	**Response**	**Injury**	**Mortality Rate**
Entangled / no hook	Disentangled	No injury	0%
Entangled / external hook	Disentangled, no gear	Minor	27%
	Disentangled, trailing gear	Moderate	27%
	Dehooked, no gear	Minor	27%
Hooked in beak or mouth	Hook left, no gear	Moderate	27%
	Hook left, trailing gear	Serious	42%
	Dehooked, no gear	Moderate	27%
Hook swallowed	Hook left, no gear	Serious	42%
	Hook left, trailing gear	Serious	42%
Turtle Retrieved Dead	---	Lethal	100%

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[37] Turtles with an unknown condition were assigned the average within species of turtles with a known condition (Kleiber, 1998).

We should also note that very little of the available data contain information on leatherback survival post-interaction. In the absence of better data on this species, NMFS is using the best available scientific data as estimates of the mortality rates leatherbacks may experience while anticipating that more information is likely to become available in the future.

Based on these latter recommendations which take into account the best available scientific and commercial data, NMFS will assume that the mortality rates in Table IV-5 estimate the probability of injury and mortality for sea turtles captured by longline gear in the future. Uncertainty in these impact estimates as a result of differences in the handling of captured turtles or the small sample sizes upon which these mortality rates are drawn should be noted when drawing conclusions about the magnitude of the impacts of delayed mortality on sea turtle populations. NMFS will use these methods to estimate the probability of future mortalities only; estimates of the outcomes of past interactions, which were calculated prior to NMFS' recent review of sea turtle mortality rates, will remain unchanged.

Because the abundance and distribution, migration and foraging patterns, and physiology vary so significantly between the four species of sea turtles that may be encountered by Hawaii-based longliners fishing in the Pacific Ocean, their vulnerability to the Hawaii-based longline fishing operations also varies. The following sections review the past impacts that the Hawaii-based longline fishery has had on each of the sea turtle species.

a. *Green turtles*

The Hawaii-based longline fisheries rarely capture green turtles. As shown in Table IV-6, observers have recorded the incidental take of 17 green turtles by the prior fishery from 1994-March 2001. All but one of these turtles were hooked either externally (13), or internally (3), and three were observed dead, the rest injured. In addition, all green turtles observed prior to 2000 were taken from different trips; therefore, there was no evidence within the data that a green turtle in one set implies a higher probability of a green turtle take in another set from the same trip (McCracken, 2000). However, in 2000, two of the seven turtles observed taken that year were taken during the same trip, but different sets.

Table IV-6. Green turtles observed captured by the Hawaii-based longline fishery from 1994-3/01.

Year/Fate	Condition	1994	1995	1996	1997	1998	1999	2000	Total
Alive (Okay)	Entangled	0	0	0	0	0	0	0	0
Injured	Hooked, External	2	0	3	0	2	1	3	11
	Hooked, Internal	0	0	0	0	0	1	2	3
Dead	Entangled	0	0	0	0	0	0	1	1
	Hooked, External	0	0	0	0	0	1	1	2

	Hooked, Internal	0	0	0	0	0	0	0	0

Table IV-7 shows the observed incidental take of two green turtles by the fishery as it currently operates (April 2001 - July 2002 data). These turtles were hooked, one externally and one internally. Both of the turtles were released dead.

Table IV-7. Green turtles observed captured by the current Hawaii-based longline fishery (April 2001 - July 2002).

Year/Fate	Condition	2001	2002	Total
Alive (Okay)	Entangled	0	0	0
Injured	Hooked, External	0	0	0
	Hooked, Internal	0	0	0
Dead	Hooked, External	1	0	1
	Hooked, Internal	0	1	1
	Entangled	0	0	0

Based on observer data, green turtles appear to be more likely to be hooked externally than to be entangled or hooked internally. Therefore, it is likely that green turtles may not be attracted to the baited hooks. The principal food sources for the green turtle are benthic marine algae. These algae are restricted to shallow depths where sunlight, substrate, and nutrients are conducive to plant growth. As a consequence, the feeding pastures used by green turtles are usually less than 10 meters deep and frequently not more than 3 meters deep, often right up to the shoreline. Because of these foraging strategies and food preferences, interactions between green turtles and the Hawaii-based longline fishery are rare.

From observer data (1994 through 1999), and using a model-based predictor, McCracken (2000) estimated that between 37 and 45 green turtles (average 40) were taken each year by the Hawaii-based longline fishery, and of these, an average of 5 were killed (given a 13% mortality rate; Table IV-8).

Table IV-8. Estimated numbers of green turtles captured and killed in the longline fishery with 95% prediction intervals (PI).

Year		1994	1995	1996	1997	1998	1999	Annual Avg
Takes	Estimate	37	38	40	38	42	45	40
	95% PI	[15-65]	[15-70]	[19-70]	[14-73]	[18-76]	[18-76]	[18-71]
Kills	Estimate	5	5	5	5	5	6	5

	95% PI	[0-16]	[0-17]	[1-17]	[0-17]	[1-19]	[1-19]	

Source: McCracken, 2000 and McCracken, personal communication, March 2001

Recently, NMFS-Honolulu Laboratory (2002b) estimated the incidental take of green turtles under the current fishery (July 2001 through June 2002 data; Table IV-9). Comparisons between these estimates and the estimates in Table IV-8 indicate a reduction in the interaction rates between green turtles and the Hawaii-based longline fishery since the current regime took effect.

Table IV-9. Estimates of the incidental capture (hooking and entanglement) of green turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002.

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

Analysis by Kobayashi (2002) estimated that the change in the fishery to the current regime would reduce green turtle take by 93% (95% CI: 85-100%), but actual reductions based on July 2001 through June 2002 data were much lower than expected (69%).

b. Leatherback turtles

As shown in Table IV-10, from 1994- March 2001, observers recorded the incidental take of 52 leatherback turtles in the Hawaii-based longline fishery. Of these, 3 were entangled, released alive and uninjured (5.8%), 43 were injured (83.7% – comprised of 3 entanglements, 33 hooked externally, 3 hooked internally, and 4 hooked in an unknown location), 3 died as a result of the interaction (5.8% - comprised of 2 that were entangled, and 1 that was hooked externally), and for 3 leatherbacks taken, there was no information (i.e. the observer was unable to identify the fate or condition of the turtle). Two trips had more than one leatherback interaction during the trip. One trip had three leatherback interactions and the other trip had two leatherback interactions. There were no leatherback turtles taken in the same set.

Table IV-10. Leatherbacks observed captured by the Hawaii-based longline fishery from 1994-3/2001.

Year/Fate	Condition	1994	1995	1996	1997	1998	1999	2000	2001	Total
Alive (Okay)	Entangled	2	0	1	0	0	0	0	0	3
Injured	Entangled	0	0	2	0	1	0	0	0	3
	Hooked, External	3	3	4	10	2	1	8	2	33
	Hooked, Internal	1	0	0	0	0	0	2	0	3
	Hooked, Unknown	1	0	0	2	1	0	0	0	4
Dead	Entangled	0	0	1	0	1	0	0	0	2

	Hooked, External	0	0	0	0	0	1	0	0	1
No Record		1	1	1	0	0	0	0	0	3

Table IV-11 shows the observed incidental take of two leatherback turtles by the current fishery Between April 2001 and July 2002. One of these turtles was hooked externally and one was entangled. Both of the leatherback turtles were released injured.

Table IV-11. Leatherback turtles observed captured by the Hawaii-based longline fishery 4/2001 - 7/2002.

Year/Fate	Condition	2001	2002	Total
Alive (Okay)	Entangled	0	0	0
Injured	Entangled	0	1	1
	Hooked, External	0	1	1
	Hooked, Internal	0	0	0
Dead	Hooked, External	0	0	0
	Hooked, Internal	0	0	0

Based on observations of leatherback turtles taken by the Hawaii-based longline fishery, leatherback turtles primarily appear to be hooked externally or entangled, rather than ingesting the hook (only three leatherback turtles of 54 observed taken were hooked internally, or 5.5%). This is probably due to their foraging strategy as well as their physiology. Whereas some hard-shelled turtle species (e.g. loggerheads) are piscivores and will forage on the bait used on longlines and therefore become hooked internally, leatherbacks tend to target cnidarians (e.g. medusae and siphonophores), so they may have been attracted to the lightsticks once used on the longlines (but now prohibited) at night to attract squid and subsequently were hooked externally or entangled. Turtles could be captured while feeding or swimming at the surface when the longline is being set or hauled back, or when the longline is fishing at depth.

Leatherbacks appear to be very susceptible to entanglement in fishing gear. Of 11 sea turtles examined port-mortem after being captured by Hawaii-based longline fishers, the only two turtles with leaders around their body parts were leatherback turtles (Work 2000). This susceptibility is probably the result of long pectoral flippers and active swimming behavior that are probably risk factors for entanglement in fishing gear and ocean debris. Leatherback turtles appear to rest for a very small percentage of their daily activity (0-7%, S. Eckert, manuscript in prep. May, 2000). Leatherback hatchlings studied in captivity for almost 2 years swam persistently without ever recognizing the tank sides as a barrier (Deraniyagala, 1939, *in* Wyneken, 1997). As a result, leatherback turtles that become entangled with longlines will probably continue trying to swim (Rudloe, 1979, *in* Witzell, 1984), expending energy and oxygen while becoming more entangled in the process.

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

From observer data, and using a model-based predictor, McCracken (2000) estimated that between 88 and 132 leatherback turtles (average 112) were captured each year, during the period 1994-1999, by the Hawaii-based longline fishery, and of these, an average of 9 died (Table IV-12).

Table IV-12. Estimated numbers of leatherback turtle captured and killed in the longline fisheries (1994-1999) with 95% prediction intervals (PI).

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

Source: McCracken, 2000 and McCracken, personal communication, March 2001

Recently, NMFS-Honolulu Laboratory (2002b) estimated the incidental take of leatherback turtles under the current fishery (July 2001 through June 2002 data; Table IV-13). Comparisons between these estimates and the estimates in Table IV-12 indicate a reduction in the interaction rates between leatherback turtles and the Hawaii-based longline fishery since the current regime took effect.

Table IV-13. Estimates of the incidental capture (hooking and entanglement) of leatherback turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002.

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

Analysis by Kobayashi (2002) estimated that the change in the fishery to the current regime would reduce leatherback turtle take by 90% (95% CI: 83 - 98%), but actual reductions based on July 2001 through June 2002 data were higher than expected (96%).

c. Loggerhead turtles

Loggerhead turtles have been the species most often captured by the Hawaii-based longline fishery. From 1994 through March 2001, observers recorded the incidental take of 175 loggerheads. Of these, 3 were released alive and uninjured (1.7%), 166 were injured by hooking (94.8%) (65 hooked externally, 101 hooked internally), and 4 died as a result of the interaction (3%) (1 hooked internally and 3 hooked in an unknown location). For one loggerhead interaction, there is no information on its condition (Table IV-14). From life history data collected by observers, it appears that the Hawaii-based longline fishery primarily interacts with juvenile loggerheads. Straight carapace lengths (SCL) ranged from 38.4 cm to 90 cm (average 56.9 cm), however, approximately 75% of the captured loggerheads were less than 65 cm SCL (G. Balazs, NMFS, personal communication, January, 2001).

Table IV-14. Loggerheads observed captured in the Hawaii-based longline fisheries from 1994-3/2001.

Year/Fate	Condition	1994	1995	1996	1997	1998	1999	2000	2001	Total
Alive (Okay)	Entangled	1	1	0	1	0	0	0	0	3
Injured	Entangled	0	0	0	0	0	0	1	0	1
	Hooked, External	4	8	10	6	22	6	8	1	65
	Hooked, Internal	6	10	14	15	25	13	13	5	101
Dead	Hooked, Internal	0	0	0	0	1	0	0	0	1
	Hooked, Unknown	0	0	2	0	0	1	0	0	3
No Record		0	0	1	0	0	0	0	0	1

Table IV-15 shows the observed incidental take of four loggerhead turtles by the current fishery between April 2001 and July 2002. These turtles were hooked either externally (1) or internally (2), or entangled and released alive and uninjured (1). Two of the loggerhead turtles were released injured and one turtle, hooked internally, was released dead.

Table IV-15. Loggerhead turtles observed captured by the current Hawaii-based longline fishery 4/2001 - 7/2002.

Year/Fate	Condition	2001	2002	Total
Alive (Okay)	Entangled	0	1	1
Injured	Hooked, External	0	1	1
	Hooked, Internal	0	1	1
Dead	Hooked, External	0	0	0
	Hooked, Internal	0	1	1

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

Using mortality and take estimates described above, McCracken (2000) estimated the take and kill of loggerheads per year, as shown in Table IV-16. Of 2,505 loggerheads estimated taken by the fishery from 1994-1999, 438 were estimated killed (given a 17.5 % mortality rate).

Table IV-16. Estimates of the number of loggerhead turtles captured and killed in the longline fisheries, with 95% prediction intervals (PI).

Year		1994	1995	1996	1997	1998	1999	Annual Avg.
Takes	Estimate	501	412	445	371	407	369	418
	95% PI	[315-669]	[244-543]	[290-594]	[236-482]	[259-527]	[234-466]	[273-527]
Kills	Estimate	88	72	78	65	71	64	73
	95% PI	[36-141]	[31-115]	[34-127]	[28-102]	[32-112]	[28-102]	

Source: McCracken, 2000 and McCracken, personal communication, March 2001

Recently, NMFS-Honolulu Laboratory (2002b) estimated the incidental take of loggerhead turtles under the current fishery (July 2001 through June 2002 data; Table IV-17). Comparisons between these estimates and the estimates in Table IV-16 indicate a substantial reduction in the interaction rates between loggerhead turtles and the Hawaii-based longline fishery since the current regime took effect. During February 2002, (after the fishery was modified to eliminate the targeted swordfish fishery and the shallow sets associated with it), three loggerhead turtles were captured in the fishery. Two of those three turtles were captured on sets that are believed to have been illegally using shallow-set methods to target swordfish. As a result, the numbers presented below may overestimate the past incidental take of loggerheads under the current fishery, indicating that loggerhead interaction rates have significantly decreased.

Table IV-17. Estimates of the incidental capture (hooking and entanglement) of loggerhead turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002.

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

trips south of 22°N	2	[0-8]	0.26	[≈0 - 1.11]	na

Analysis by Kobayashi (2002) estimated that the change in the fishery to the current regime would reduce loggerhead turtle take by 99% (95% CI: 83 -100%); actual reductions based on July 2001 through June 2002 data were 98%.

d. Olive ridley turtles

As shown in Table IV-18, from 1994 through March 2001, observers recorded the incidental take of 50 olive ridleys by the Hawaii-based longline fishery. Of these, 38 were injured (76% – all hooking incidents, 15 hooked externally and 23 hooked internally) and 12 died as a result of the interaction (24% - comprised of 9 that were hooked externally, and 3 that were hooked internally). Based on life history data collected by observers, it appears that the fishery is interacting with both subadult and adult life stages of olive ridleys. For those olive ridleys brought on board and measured (n=29), straight carapace length ranged from 44.5 cm to 66.5 cm (average 55.43 cm).

None of the olive ridleys observed taken by the fishery were entangled, all were hooked; therefore, it is likely that the olive ridleys may have been attracted to the baited hook or to the lightsticks, which may be confused for pyrosomas by the turtle. While the habitat of juvenile olive ridleys is not well-known, adults use a wide range of foraging habitats, feeding pelagically in deep water as well as in shallow benthic waters. They feed on a wide variety of items, ranging from jellyfish, to crabs, molluscs and algae (*in* NMFS and USFWS, 1998d). Stomach contents of 7 olive ridleys captured by the fishery were found to contain salps, cowfish and pyrosomas. One animal had seabird feathers and pelagic snails, while another had large amounts of plastic, fishing line and cellophane. Four of the olive ridleys examined had bait in their esophagus. One of these four turtles was found with three fish used as longline bait, indicating that it had ingested bait from more than one hook (Work and Balazs, draft manuscript, January, 2001).

Table IV-18. Olive ridleys observed captured by the Hawaii-based longline fishery from 1994-3/2001.

Year/Fate	Condition	1994	1995	1996	1997	1998	1999	2000	2001	Total
Injured	Hooked, External	2	2	2	1	1	2	3	3	16
	Hooked, Internal	1	1	6	2	1	5	4	3	23
Dead	Hooked, External	0	0	1	0	2	1	2	4	10
	Hooked, Internal	0	1	0	0	1	0	1	0	3

Table IV-19 shows the observed incidental take of nine olive ridley turtles by the current fishery between April 2001 and July 2002. These turtles were hooked either externally (8) or internally (1). Eight of these turtles were released dead and one was released injured.

Table IV-19. Olive ridley turtles captured by the current Hawaii-based longline fishery between 4/2001 and 7/2002.

Year/Fate	Condition	2001	2002	Total
Alive (Okay)	Entangled	0	0	0
Injured	Hooked, External	1	0	1
	Hooked, Internal	0	0	0
Dead	Hooked, External	1	6	7
	Hooked, Internal	0	1	1

Based on observer data, olive ridleys had the highest mortality rate of all sea turtles captured in the Hawaii-based longline fisheries, probably because more olive ridleys were captured and killed in deep sets than any other species of sea turtle. As shown in Table IV-20, of 878 olive ridleys estimated to have been captured in the fisheries from 1994-1999, an estimated 292 died (assuming a 33.25% mortality rate). Although pathological lesions were noted in 5 olive ridleys necropsied after being taken and killed by the fishery, these were considered mild and incidental (i.e. the turtles were probably not predisposed to being taken as a result of the lesions) (Work, 2000). Therefore, the turtles that died as a result of the interaction probably drowned, suffocated, or died from injuries they suffered as a result of their being hooked. Of the 6 olive ridley turtles captured in deep sets, 5 died, probably because the turtles were unable to surface, because of the deep sets, and drowned.

Table IV-20. Estimates of the number of olive ridley turtles captured and killed in the longline fisheries with 95% prediction intervals (PI)

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

Source: McCracken, 2000 and McCracken, personal communication, March 2001

Recently, NMFS-Honolulu Laboratory (2002b) estimated the incidental take of olive ridley turtles under the current fishery (July 2001 through June 2002 data; Table IV-21). Comparisons between these estimates and the estimates in Table IV-20 indicate a reduction in the interaction rates between olive ridley turtles and the Hawaii-based longline fishery since the current regime took effect.

Table IV-21. Estimates of the incidental capture (hooking and entanglement) of olive ridley turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002.

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

Analysis by Kobayashi (2002) estimated that the change in the fishery to the current regime would reduce olive ridley turtle take by 56% (95% CI: 33-77%), but actual reductions based on July 2001 through June 2002 data were higher than expected (72%).

D. Future Effects of Pelagics FMP Fisheries on Sea Turtles

Under the proposed action, NMFS expects that fishing effort in all fisheries under the Pelagics FMP will continue as it has in previous years, including limitations placed on the number and size of vessels in the Hawaii-based and American Samoa longline fisheries. NMFS also anticipates that, due to the lack of measures to avoid or reduce the amount of bycatch and mortal bycatch of listed species, these interactions will continue with the same frequency and effect as they have in the past. In the case of the Hawaii-based longline fishery, this would be the pattern of interactions since the first implementation of the current fishery by emergency (and now, final) regulations.

1. Handline, Troll, and Pole and Line Fisheries

There have been no reported interactions with sea turtles in the fisheries of the Pelagics FMP other than the Hawaii-based longline fishery, the American Samoa-based longline fishery, and the central and western Pacific U.S. purse-seine fishery (discussed below). There is a chance, based on fishing methods including bait used and gear-type, that these other fisheries do interact with sea turtles although the information is not reported. Due to low effort and target-species selectivity of the gear, incidental take and mortality in these fisheries is likely minimal and has an insignificant effect on the survival and recovery of sea turtle populations.

2. Longline Fisheries

a. *American Samoa-based longline fishery*

Because NMFS does not have an observer program in place for the American-Samoa-based longline fishery, the only information available is from fisher logbooks. Based on logbooks from 1992 through 2001, it is apparent that this fishery takes sea turtles, but NMFS cannot quantitatively estimate the amount or extent of take of sea turtles by this fishery. In addition, all species of listed sea turtles considered in this Opinion occur within the fishing grounds of this fishery and therefore, all of these species may be taken. Effort has greatly increased in this fishery in the last few years, but if a limited entry program is established as proposed in FMP Amendment 11, effort is unlikely to substantially increase in the future. Increases in effort are likely to result in increased levels of incidental take of sea turtles; however since NMFS has no estimates of the amount of take in recent years, it is difficult to estimate take levels in the future. Required handling and resuscitation techniques and the use of line clippers to remove gear from captured sea turtles should reduce the severity of interactions that may occur.

b. Hawaii-based longline fishery

Based on past observer data and logbook data on the effort and distribution of the Hawaii-based longline fishery, NMFS has calculated the expected annual impact of the continued operation of this fishery (see Table IV-22 below). Uncertainty in these impact estimates as a result of differences in the handling of captured turtles or the small sample sizes upon which these mortality rates are drawn should be noted when drawing conclusions about the magnitude of the impacts of delayed mortality on sea turtle populations.

NMFS calculated expected annual mortality in Table IV-22 by applying the estimated mortality rates (described in NMFS (2001b) and presented in Table IV-5) to the observed and extrapolated information on turtles that were externally hooked, deeply hooked, or retrieved dead based on data from July 1, 2001 through June 30, 2002.

Table IV-22. Rough estimates of annual capture and mortality for sea turtles taken in the Hawaii-based longline fishery, based on past interactions between July 1, 2001 and June 30, 2002. (Source: NMFS-Honolulu Laboratory 2002b)

Species	Incidental Take	Incidental Mortality[1]
Green	8	7
Leatherback	8	3
Loggerhead	14	8
Olive Ridley	26	24

[1] The estimated incidental mortality is a subset of the estimated incidental take by hooking or entanglement.

These numbers provide a rough estimate of the numbers of turtles that may be taken by the Hawaii-based longline fishery during any given year depending on effort and natural variation in ocean conditions and turtle abundance and use of the action area. As mentioned above, these numbers do not include uncertainty associated with small sample size in the scientific studies or differences in handling of captured turtles between scientific studies and fishing operations. In addition, these numbers are based on the effort in the fishery between July 2001 and June 2002. During that year, the number of vessels participating in the fishery has decreased, trips in the shallow-set fishery have been eliminated, and the number of trips in the deep set segment has increased. NMFS' analysis of the future effects of the Hawaii-based longline component of the fisheries operating under the Pelagics FMP will use these estimates when assessing annual and aggregate effects on the species (see section V. *Species' Response to the Action* below.).

IV. EFFECTS OF THE ACTION

Pursuant to Section 7(a)(2) of the ESA (16 U.S.C. §1536), federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. As described above, the ESA defines a "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 biological opinion assesses the effects of NMFS' Pelagics FMP, as amended, and the fisheries managed under that FMP on threatened and endangered species and critical habitat that has been designated for these species. The fisheries authorized under the Pelagics FMP are likely to adversely affect listed species through gear interactions, primarily entanglement and hooking, which may injure or kill individual animals. In the *Description of the Action* section of this Opinion, NMFS provided an overview of the fisheries, particularly the distribution and timing of fisheries that use gear that has been a problem for threatened and endangered species. In the *Status of the Species* (which is also the *Environmental Baseline*) section of this Opinion, NMFS provided an overview of the threatened and endangered species that are likely to be adversely affected by fisheries authorized under the Pelagics FMP.

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of federal actions to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR 402.02). Section 7 of the ESA and its implementing regulations also require biological opinions to determine if federal actions would appreciably diminish the value of critical habitat for the survival and recovery of listed species (16 U.S.C. §1536; 50 CFR 402.02). Since the proposed action is not likely to affect designated critical habitat, this Opinion will focus only on the jeopardy analysis.

NMFS generally approaches "jeopardy" analyses for fisheries in a series of steps. First, we evaluate the available evidence to identify the direct and indirect physical, chemical, and biotic effects of proposed actions on individual members of listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species - such as entanglements in fishing gear; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering its nesting substrate, or altering its ambient temperature regimes - or adding something novel to a species' environment - such as introducing exotic competitors or a sound). Once we have identified the effects of an action, we evaluate the available evidence to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). We then use the evidence available to determine if these reductions, if there are any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

A. Approach to the Assessment

We assessed the effects of the Western Pacific Pelagic Fisheries on threatened and endangered species using a general risk assessment model patterned after the U.S. Environmental Protection Agency's *Guidelines for Risk Assessment* (U.S. EPA 1998) and models toxicologists and epidemiologists use to assess risks posed by terrestrial, aquatic, and atmospheric pollutants (Kapustka *et al.* 1996, Landis *et al.* 1994, Landis *et al.* 1997, Lipton *et al.* 1993, McCarty and Power 1997, Newman *et al.* 2000, Norton *et al.* 1992, Taub 1997, U.S. EPA 1998, Wentsell

1994). We chose this assessment approach for several reasons: it is a peer-reviewed assessment framework that has been applied to a wide variety of assessment situations that include assessments of the effect of various human activities on threatened and endangered species, it is one of the best-documented assessment approaches available, it accommodates qualitative as well as quantitative information, and it is not defeated by uncertainty.

The first step of our assessment approach examined a species' likelihood of interacting with the Western Pacific Pelagic Fisheries (in this instance, a marine mammal or turtle would have "interacted" with the fishery if it was entangled or hooked by fishing gear using in the fisheries), which included an assessment of the number and kind of interaction (for example, whether a turtle ingested a hook or was hooked in a flipper), the life stage of the marine mammals or turtles involved in the interactions, the frequency of interactions, and the pattern of interactions over time and space. We combined information on the biogeography of the different turtles with the spatial and temporal interaction patterns to make inferences about which populations of marine mammals or subpopulations of sea turtles were probably affected by the fisheries (in this opinion, sea turtles in the Pacific are treated as separate "populations" from sea turtles in the Atlantic and Indian Oceans; a sea turtle population in the Pacific is represented by subpopulations that comprise one or more nesting aggregation).

Our second step was to assess the probable responses of marine mammals and sea turtles that interacted with the fisheries. For example, this step assessed a turtle's likelihood of being injured or killed during an interaction with gear used in the Western Pacific Pelagic Fisheries. In this step, we also estimate rates of post-hooking mortality. In 2001, NMFS recommended assuming a 27% mortality rate for sea turtles that are hooked externally or entangled and 42% for turtles that are hooked internally (that is, if the hook penetrates the turtle's mouth; see Appendix 4 of NMFS 2001 for a complete review and analysis of relevant research and recommendations). NMFS also recommended revising the scheme for classifying the injuries of, and assigning mortality rates to, sea turtles that have interacted with longline fishing gear. The new classification scheme is (1) non-serious injuries (2) minor or moderate injuries, and (3) serious injuries that may result in mortality or reduced ability to contribute to the population when released alive after the interaction.

The third step of our approach estimated the probable risks posed to marine mammals and sea turtles in the Pacific Ocean by the Western Pacific Pelagic Fisheries by integrating our interaction and response analyses. Specifically, we evaluated the available evidence to determine if interactions with gear used in the Western Pacific Pelagic Fisheries are likely to reduce the reproduction, numbers, or distribution of marine mammals and sea turtle populations in the Pacific Ocean by (1) killing individual marine mammals or sea turtles; (2) physically injuring marine mammals or sea turtles in ways that would have acute or chronic effects on their behavioral ecology; or (3) eliciting behavioral responses that would have longer-term, chronic effects on the viability of populations of a species. Although this section of our assessment included concerns for effects on individual animals, our assessment focused on the probable effects of the Western Pacific Pelagic Fisheries on populations and, through populations, listed species.

The final step in our analyses — relating reductions in a species' reproduction, numbers, or distribution to reductions in the species' likelihood of surviving and recovering in the wild — is the most difficult step because (a) the relationship is not linear; (b) to persist over geologic time, most species' have evolved adaptations that allow them to withstand some level of variation in their birth and death rates without a corresponding change in their likelihood of surviving and recovering in the wild; and (c) our knowledge of the population dynamics of other species and their response to human perturbation is usually too limited to support anything more than rough estimates. Nevertheless, we conducted this step of our analyses by estimating the number of marine mammals or sea turtles that would be killed or injured by interacting with the fishery, identifying the populations that would be affected by these interactions, and estimating the effects of those deaths of injuries on those populations' likelihood of surviving and recovering in the wild (for example, we considered the effect of killing a certain number of adult or sub-adult female turtles on nesting aggregations, given the probable size of the aggregation).

Jeopardy analyses must look into the future to encompass any delays between the effects of an action and the population responses of threatened and endangered species. Some human activities appear to have "delayed" effects on plant and animal populations, which can occur for two primary reasons. First, a disease, toxic chemical, or other stressor may take time to accumulate and individual animals may respond only after particular threshold doses. The classic example of this kind of "delayed effects" is the bald eagle's response to DDT: the effect of DDT on bald eagles was delayed until individual eagles received threshold doses of DDT that caused the shells of their eggs to thin. Second, a human stressor may have immediate effects on individuals or populations, but the ecology of the species may mask our ability to detect the effect. In the previous example, the bald eagle populations had declined for several years before humans were able to detect it. This kind of "delayed" effect probably reflects limitations in our ability to detect effects below certain thresholds or our inability to identify abnormal population declines given background rates of population variability.

With sea turtles, we expect the second kind of "delayed" effect. We monitor the abundance of sea turtles by counting the number of adult females on nesting beaches, and as a result, we generally would not detect changes in these populations until the adult, female population changed. The long lives and high, adult survival rates of sea turtles would mask changes in all non-adult age classes: we would not detect changes, even dramatic changes, in non-adult age classes until the adult population changed. Because of these delayed effects, assessments in the Services' biological opinions must look far enough into the future to (1) be certain of detecting a population's response to an effect, (2) be certain of detecting changes in a species' reproduction, numbers, and distribution, and (3) be certain of detecting changes in a species' likelihood of surviving and recovering in the wild (Crouse 1999b). If we do not look far enough into the future, we increase the risk of failing to detect a population's response to a human activities and we are more likely to falsely conclude there was no effect when, in fact, an effect occurred (which, in the case of fisheries, means that adult and subadult turtles will have been captured and killed for a period of years). If we look too far into the future, the passage of time can mask short-term collapses in a population and, again, we increase our likelihood of falsely concluding there was no effect when, in fact, an effect occurred.

In earlier Opinions, we responded to this challenge by basing our projections on the time it would take individuals born in the current year (2001) to enter the adult population and breed (using an approach that was consistent with approaches population biologists normally use when addressing life tables, which follow a cohort's patterns of survival and fecundity from birth to death — for age-based models — or from eggs to adults, for stage-based approaches). In the past, logbooks and observer reports collected over several years provided us with the data we needed to project the effects of the fisheries over time. Since the fisheries, particularly the Hawaii-based longline fishery, were changed in March 2001, we could not use those earlier data to estimate the probable effects of the fishery. We only have one year of monitoring data from the current fishery; in terms of a time series, these data represent a single point that limits our ability to project into the future. For the purposes of this consultation, we assume that current rates of interaction and mortality would continue into the future, although with time, we may discover that the number and rate of interactions and mortalities associated with the fishery is much different than the data that are currently available would suggest.

Information Available for the Assessment

To conduct this assessment, NMFS examined an extensive amount of evidence from a variety of sources. Detailed background information on the status of these species and critical habitat has been published in a number of documents including recent the marine mammal stock assessment reports (Hill et al. 1997, Hill and DeMaster, 1999) and a status report on six whale species that was prepared by Perry et al. (1999), status reviews of sea turtles (NMFS and USFWS, 1995; USFWS, 1997); recovery plans for the recovery plans for the blue whale (NMFS 1998a), humpback whale (NMFS 1991a), right whale (NMFS 1991b), Steller sea lion (NMFS 1992), eastern Pacific green turtle (NMFS and USFWS, 1998a), U.S. Pacific populations of hawksbill sea turtles (NMFS and USFWS, 1998b), loggerhead sea turtle (NMFS and USFWS, 1991), leatherback sea turtle (NMFS and USFWS, 1992), and U.S. Pacific populations of olive-ridley sea turtles (NMFS and USFWS, 1998c); and reports on interactions between sea turtles and gear used in pelagic fisheries (Bolten *et al.*, 1996). In April 2002, Turtle Island Restoration Network convened a meeting of experts to discuss the status of leatherback turtle populations in the Pacific Ocean. In addition, Caswell (2001), Crouse *et al.* (1987), Crowder *et al.* (1994), Ebert (1999), Heppell (1998), and Heppell *et al.* (1996, 1999, and 2000) published results from population models, sensitivity analyses, and elasticity analyses for various species of marine turtles, although most of these models are based on data on loggerhead sea turtles in the Atlantic Ocean. We supplemented these sources using online literature searches (using the search engines available through Library of Congress's website).

In the past few years, our ability to describe the biology and ecology of sea turtles has improved dramatically. Sea turtles that have been fitted with satellite tags have increased our knowledge of the migratory patterns of sea turtles in the Pacific Ocean, genetic analyses have provided essential information on the structure of sea turtles populations in the Pacific Ocean, monitoring efforts at turtle nesting beaches allow us to update our understanding of trends of different nesting aggregations, and numerous investigators continue to publish new insights into the population ecology of sea turtles produced by computer models. Despite these advances, we must still confront large gaps in our understanding of the biology and ecology of sea turtles and much of the information we have is surrounded by uncertainty. For example, our knowledge of the distribution and abundance of male sea turtles and their role on the ecology of sea turtles is still rudimentary. As another example, our ability to quantify many of the phenomena we can describe also remains very limited: we still must make assumptions about a wide array of variables, including age at reproductive maturity, age-specific rates of survivorship and fecundity, and population sizes based largely on information from loggerhead sea turtles in the Atlantic Ocean. These gaps and uncertainties limit our ability to conduct quantitative risk assessments for sea turtles in the Pacific.

In early 2002, Dr. Milani Chaloupka developed a series of simulation models that were designed to help us overcome the limits in our knowledge of the population ecology of sea turtles in the Pacific Ocean (Chaloupka 2002a, 2002b, 2002c). These models use differential equations (running in Berkeley Madonna software) to simulate time-varying demographic processes that can be subject to environmental and demographic stochasticity; the models were designed to allow managers and other interested parties to quickly consider the effects of small changes in some variables on a population's trajectory over time. After carefully reviewing these models, NMFS concluded that, without much more information on the biology and ecology of sea turtles in the Pacific Ocean, it would be inappropriate to use the models as the basis for biological opinions or other, specific management purposes. In particular, comprehensive models like the ones developed by Dr. Chaloupka require detailed information on the biology and ecology of sea turtles and the environmental relationships that, as we discussed in the preceding paragraphs, is not available for sea turtles in the Pacific Ocean. Using this kind of model under those circumstances would give the appearance of numerical precision without the reality of it (Burgman *et al.* 1993, Cortes 1999, Morris and Doak 2002, Reed *et al.* 1998).

Given these limits in our understanding, we relied on conceptual life history and population models to assess the probable responses of the turtle species to the Western Pacific Pelagic Fisheries. Although this approach produced generalizable, qualitative results and more transparent reasoning and assumptions, we sacrificed numerical precision. Nevertheless, general, transparent results were preferable to precise numerical results that were not transparent and could not be verified with existing knowledge.

Assumptions Underlying This Assessment

In the absence of definitive data or conclusive evidence, NMFS made a series of assumptions to overcome limits in our understanding (the information supporting these assumptions is presented after the assumptions). First, we continued to assume that we could assess the status and trends of sea turtle populations by considering only female turtles and ignoring male turtles, despite recent work that argues that ecologists cannot assume that only a minimum threshold number of males is needed to maintain a population and that any additional males are superfluous (Wilson 2002). Nevertheless, our knowledge of the population biology and ecology of male sea turtles is even more limited than our knowledge of female turtles; with few exceptions, we cannot even speculate on their marine distribution, status, and trends. As a result, our analyses probably underestimate the significance of male sea turtles on their species' population ecology.

To assess the potential effects of reductions in sea turtle reproduction, numbers, or distribution on the turtles' likelihood of surviving and recovering in the wild, we used a conceptual model of sea turtle life history. To compensate for a high mortality rate of eggs, hatchlings, and small juveniles each year, sea turtles have evolved a life history strategy that requires adults to produce large numbers of eggs each year, live for many years, and breed repeatedly (National Research Council 1990). Through this life history strategy, the long lives of adult turtles buffer the turtles from dramatic fluctuations caused by large fluctuations in egg, hatchling, and juvenile survival (Crouse 1999b). Now that these species of sea turtles are endangered, however, we assume that the long lives of adult turtles *mask* the effect of previous losses of eggs, hatchlings, and juveniles on the turtle populations (see Crouse 1999b). As a result, we assume that sea turtles probably face a higher risk of extinction than our knowledge allows us to recognize and allow that our assessment probably underestimates the effects of the fisheries on turtles (see Ludwig *et al.* 1993).

All of the affected turtle species and two of the marine mammal species are represented by populations that occur within the Pacific and Atlantic Oceans. For the purposes of section 7 consultations, we treat populations of threatened and endangered species in the Pacific Ocean and the Atlantic Ocean as distinct. We believe this approach is consistent with interagency policy on the recognition of distinct vertebrate populations (Federal Register 61: 4722-4725), although our final jeopardy determination will be made at the scale of the listing for the affected turtles rather than at the distinct population scale. To address specific criteria outlined in that policy, populations of marine mammals and sea turtle in the Atlantic basin are geographically discrete from populations in the Pacific basin, with limited genetic exchange (see NMFS and USFWS 1998a). This approach is also consistent with traditional jeopardy analyses: the loss of marine mammals and sea turtle populations in the Pacific basin would result in a significant gap in the distribution of each turtle species, which makes these populations biologically significant. Finally, the loss of populations of marine mammals and sea turtle in the Pacific basin would dramatically reduce the distribution and abundance of these species and would, by itself, appreciably reduce the entire species' likelihood of surviving and recovering in the wild.

These analyses are based on an implicit understanding that the marine mammals and sea turtles considered in this Opinion are threatened with global extinction by a wide array of human activities and natural phenomena; we have outlined many of those activities in the *Status of the Species* section of this Opinion. NMFS also recognizes that some of these other human activities and natural phenomena pose a much larger and more serious threat to the survival and recovery of sea turtles and whales (and other flora and fauna) than the proposed fisheries. Further, NMFS recognizes that sea turtles will not recover without addressing the full range of human activities and natural phenomena — for turtles, patterns of beach erosion, predation on turtle eggs, and turtle captures, injuries, and deaths in international fisheries and other State, federal, and private activities, for whales, other commercial fisheries and shipping — that could cause these animals to become extinct in the foreseeable future (USFWS and NMFS 1997).

Nevertheless, this Opinion focuses solely on whether the direct and indirect effects of the Western Pacific Pelagic Fisheries can be expected to appreciably reduce the listed marine mammals and sea turtles' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution. NMFS will consider the effects of other actions on threatened and endangered marine mammals and sea turtles as a separate issue. As stated previously, jeopardy analyses in biological opinion distinguish between the effects of a specific action on a species' likelihood of surviving and recovering in the wild and a species' background likelihood of surviving and recovering given the full set of human actions and natural phenomena that threaten a species.

To conduct our jeopardy analyses, we evaluate the information available on the numbers of marine mammals and sea turtles captured, injured, or killed in the U.S. Pacific pelagic fisheries to determine if these injuries or deaths can be expected to reduce the Pacific Ocean population's reproduction, numbers, or distribution. As part of these analyses, we made assumptions about the number, sex, and life stage of marine mammals and sea turtles that might be captured, injured, or killed in the pelagic fisheries.

We consider these reductions within the context of the Pacific Ocean population's status and trend. We estimate the relative abundance of sea turtle populations based on the numbers of adult females, usually as they return to their nesting beaches. As a result, our population estimates will generally change only in response to changes in (1) the death rate of adult females, (2) the recruitment rate of sub-adult females, (3) the interval between a female's return to nesting beaches, and (4) migration patterns that might cause females to nest on other, uncensused, beaches (given the strong tendency of female turtles to return to the beach of their birth, we discount this latter phenomenon as having minimal effect on population trends). Over any five-ten year interval, the size of sea turtle populations will only change in response to changes in death rates and changes in recruitment rates (this time interval should be long enough to mask differences in re-nesting intervals). Therefore, if a turtle population is increasing, we can infer that the average number of females that recruit into the adult population is greater than the average number of adults that die in the population. If a turtle population is stable, we can infer that the average number of females that recruit into the adult population equals the average number of adults that die in the population. If a turtle population is decreasing, we can infer that the average number of females that recruit into the adult population is less than the average number of adults that die in the population.

B. Conservation and Management of Listed Species under the Magnuson-Stevens Act and the Pelagics Fishery Management Plan

Two of the ten national standards set out by the MSA are relevant to the effects the Pelagics FMP are expected to have on the listed species. As further discussed in the next section, the primary effect of the Pelagics FMP and the fisheries authorized under that FMP is the incidental capture, injury, and mortality of listed species by fishing gear. National standards 1 and 9, as seen in Table IV-1 below, guide the amount of effort and associated bycatch that shall be permitted under an FMP.

Table IV-1: **MSA National Standards** (16 U.S.C. 1851, Sec. 301(a)).

(a) IN GENERAL. – Any fishery management plan prepared, and any regulation promulgated to implement any such plan, pursuant to this title shall be consistent with the following national standards for fishery conservation and management:	
(1)	Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.
(9)	Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.

The Pelagics FMP currently has a non-numerical definition of optimum yield (OY) which is as follows: "OY is the amount of each management unit species or species complex that can be harvested by domestic and foreign fishing vessels in the EEZ and adjacent waters to the extent regulated by the FMP without causing 'local overfishing' or 'economic overfishing' within the EEZ of each island area, and without causing or significantly contributing to 'growth overfishing' or 'recruitment overfishing' on a stock-wide basis" (WPRFMC 1998b). Given that little is known about the status of most of the PMUS, this definition of OY could equate to unrestricted fishing effort under the FMP.

There are several regulations and proposed FMP amendments which limit fishing effort under the FMP in longline fisheries and which institute various conservation measures designed to avoid or reduce protected species interactions with FMP fisheries and the consequences of any remaining interactions. The limited entry program and maximum boat-length limit for the Hawaii based longline fishery limit the amount of effort in that fishery. A proposed limited entry program for the American Samoa longline fishery would do the same there. The 25 to 75 nm longline exclusion zone around the Hawaiian Islands, 100 nm wide protected species zone around the Northwestern Hawaiian Islands, to protect Hawaiian monk seals and to eliminate gear conflicts between fisheries, and new Northwestern Hawaiian Islands Coral Reef Reserve, also serve to limit fishing effort in certain areas by prohibiting longline fishing, while still allowing other gear types. Requirements on turtle handling, including line clippers, dip nets, and use of resuscitation techniques reduce the adverse effects of a gear interaction. Finally, prohibitions on the use of shallow-set gear and other swordfish-targeting techniques, and the time and area closure south of the Hawaiian Islands in April and May reduce the likelihood of interactions between turtles and longline fishing gear.

This assessment is based on the assumption that fishing effort in all the fisheries under the Pelagics FMP, with the exception of the American Samoa-based longline fishery, will continue at the same levels as they have since implementation of the June 12, 2001 emergency regulations and that sea turtle and marine mammal interactions will continue with the same frequency and effect as they have since that date.

C. Effects of Fisheries Authorized Under the Pelagics FMP

As discussed in the Action Area (see *Description of the Action)*, the fisheries authorized under the Pelagics FMP occur throughout the central, western, eastern and northern Pacific Ocean, including waters around the Northwestern Hawaiian Islands, the main Hawaiian Islands, American Samoa, Guam, Commonwealth of the Northern Mariana Islands (Saipan, Rota, and

Tinian), and the U.S. possessions of Johnston Atoll, Kingman Reef, and Palmyra, Jarvis, Howland, Baker, Midway, and Wake Islands (see Figure II-8).

The Hawaii longline fishery generally operates around the main and northwestern Hawaiian islands except for prohibited areas described above in the *Description of the Action* section. The other fisheries authorized under the Pelagics FMP generally occur closer to shore. Most of the vessels associated with the pelagic longline fishery based out of American Samoa fish within 25 nautical miles of shore, although newer, larger vessels are capable of fishing out to and beyond 50 nautical miles – a closed area around American Samoa, instituted in March, 2002, prohibits vessels longer than 50 feet from fishing within 50 nautical miles of the shore, with some exceptions. Similarly, the pole-and-line fishery based in Hawaii, the recreational fisheries that target pelagic species around Hawaii, the Hawaiian charter boat fishery, the American Samoa, Guam, Hawaii, and Commonwealth of Northern Mariana Island-based troll fisheries all generally occur within 25 miles of shore (NMFS, 2000). For each of these fisheries some fishing vessels range as far as 100 nautical miles from land.

1. Marine Mammal and Sea Turtle Interaction Analysis

This section of the Opinion evaluates the available information to determine the likelihood of a listed sea turtle or marine mammal interacting (in this instance, an "interaction" consists of an animal that is entangled in or hooked by gear associated with the fisheries) with one or more of the fisheries authorized by the Pelagics FMP. Interaction analyses also evaluate the intensity, duration, and frequency of interactions between sea turtle species and gear associated with the various Pelagic fisheries. These analyses assume that sea turtles or marine mammals are not likely to be adversely affected by a fishery if they do not interact with the fishery; these analyses also assume that the potential effects of the fisheries would be proportional to the number of interactions between the fisheries and sea turtles or marine mammals.

The only source of information available for these interaction analyses are reports of actual interactions between some of the fisheries and sea turtles and marine mammals that have been derived from observer programs and logbooks. These sources do not allow us to determine the abundance of sea turtles from different nesting aggregations that *could* interact with the Pelagics fisheries (that is, the total number and origin of turtles that are susceptible to interactions with the fisheries). As a result, we cannot estimate potential interactions or the probability of interactions that remain unreported and, as with other studies confronting these data limitations, we use our estimates with caution (Kinas 2002). Nevertheless, our analysis assumes that the spatial and temporal patterns derived from reported interactions between the fisheries and turtles represents the actual spatial and temporal distribution of the sea turtle populations in the action area. Given the information available on sea turtle biology and behavior in the pelagic environment, turtles probably occur throughout the entire fishing area but probably within certain zones based on water temperatures, currents, seasonality, and prey abundance.

a. Likelihood of Interactions By Gear Type

In general, five different fishing gear types are used under the Pelagics FMP: troll, handline, pole-and-line, and longline gear. The type of fishing gear used and the area fished will affect the likelihood of an interaction with a sea turtle or marine mammal. The following section discusses the likelihood of interactions between these gear types and sea turtles and marine mammals.

(1) Troll fishing gear

Trolling is conducted by towing lures or baited hooks from a moving vessel, using big-game-type rods and reels as well as hydraulic haulers, outriggers, and other gear. Up to six lines rigged with artificial lures or live bait may be trolled when outrigger poles are used to keep gear from tangling. When using live bait, trollers move at slower speeds to permit the bait to swim naturally (WPRFMC, 1995). Freshly caught small yellowfin tuna or skipjack tuna may be used as live bait to attract marlin. Once a fish is hooked, the gear is immediately retrieved.

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

(2) Pole-and-line

A small pole-and-line fishery operates from Hawaii that targets skipjack tuna. It is sometimes referred to as the aku (skipjack tuna) fishery or baitboat fishery. The pole-and-line fishery uses live bait thrown from a fishing vessel (ranging from 65 to 80 feet) to stimulate a surface tuna school into a feeding frenzy. The pole and line used are of equal length (3 meters). Fishing is conducted using a barbless hook with feather skirts slapped against the water until a fish strikes. The hooked fish is then yanked into the vessel in one motion. The fish unhooks when the line is slacked so that the process can be repeated. The bait most often used is anchovy.

Although the distribution of the pole-and-line fishery overlaps with the distribution of sea turtles and listed marine mammals, there is a very low likelihood of an interaction with a sea turtle or listed marine mammal because the turtle or marine mammal would need to be in the vicinity and the fisher would need to hook the animal or the animal would need to strike the hook. This type of an event is unlikely to occur because sea turtles and listed marine mammals are not likely to prey on anchovy, and the activity of the fish feeding frenzy would deter turtles from remaining in the area. For these reasons, NMFS concludes that the pole-and-line fishery is not likely to adversely affect sea turtle or listed marine mammal populations.

(3) Handline fishery

Two types of pelagic handline fishing methods are practiced in Hawaii, the *ika-shibi* method, and the *palu-ahi* method. The *ika-shibi* or night handline fishery developed from a squid (*ika*) fishery that switched to target the incidental catch of tuna (*shibi*). Lights and chum are used to attract small prey species and larger target tunas to handlines baited with squid. The vessels typically fish between 5 and 6.5 nm from shore. The night-time fishery is mostly conducted off Hilo and off Keahou, both on the island of Hawaii (Hamilton, 1996 *in* NMFS, 2000a).

The *palu-ahi* or day-handline fishery also targets tuna but fishing occurs during the day. A baited hook on the end of a handline is laid against a stone and the line wound around it. Additional pieces of chum are wound into the bundle which is then tied in a slip knot (Rizzuto, 1983 *in* NMFS, 2000a). The bundle is lowered to the preferred depth (commonly 20-30 meters) where the line is jerked to untie the knot so the baited hook and chum are released at the target depth. Fishing usually takes place by smaller vessels within 6.5 nm from shore and by larger vessels around fish aggregating device or around sea mounts and weather buoys (100 - 200 nm from shore). As soon as a fish is caught, the gear is brought back on board.

There have been no reported interactions between gear used in the handline fishery and sea turtles or listed marine mammals. Although there is the risk that sea turtles or listed marine mammals may become hooked or entangled in the fishing gear, any caught animal can be immediately dehooked or disentangled and released. Moreover, most turtles or listed marine mammals found in the area of the handline fisheries are not likely to prey on the baited hooks. For these reasons, NMFS concludes the handline fishery, as managed under the Pelagics FMP is not likely to adversely affect listed sea turtle or marine mammal populations.

(4) Longline fisheries

Longline fishing is a passive fishing method that consists of suspending a monofilament line (main line) in the water column, by using floats, and attaching baited hooks along the line to attract fish. While the main line is deployed over the stern of the vessel, floats and hooks are attached to the main line using clips. Each float is attached to a float line and each hook is attached to a "branch line." The branch line is sometimes called a "gangion" or "dropper" line. For the most part, the branch lines are evenly spaced along the main line, except between floats where the placement of the float on the main line may lengthen the distance between the branch lines. The lengths of the branch lines and the float lines affect how deep the gear (hook) will fish and the type of species that might be caught. The depth that hooks actually fish is also determined by the vessel speed, drum speed, and shooter speed. The faster the main line is set (more line set in a shorter distance), the deeper the line will sink because of the line sag between the floats. In addition to the speed that the main line is set, the number of hooks and the size of the weight on each branch line can affect the depth and rate that the gear will sink. The type of species that are caught is also affected by the time of day the gear is set and the type of bait that is used.

American Samoa longline fishery. The longline fleet based in the island of Tutuila, American Samoa, has been, until recently, dominated by twin-hulled boats of aluminum or wood/fiberglass, called *alia*, most of which are about 30 feet long and powered by 40 horsepower outboard engines. The gear on the *alias* is stored on deck attached to a hand crank reel which can hold as much as 10 miles of monofilament mainline. These vessels, on which navigation is generally limited to visual methods, typically make only single-day trips, so most of their fishing effort occurs within 25 nautical miles of shore. Participants set between 100 and 300 hooks on a typical eight-hour trip. The gear is set by spooling the mainline off the reel and retrieved by hand cranking back onto the reel. Generally, gear setting begins in early morning; with retrieval in the mid-morning to afternoon. The longline fishery grew fairly steadily through the late 1990s, but after 2000 it expanded rapidly with the entry of a number of large vessels. The fleet is currently composed of about 40 of the relatively small (< 40 feet) *alia*, about five mid-sized (40-50 feet) monohull vessels, and about 30 large (> 50 feet) monohull vessels (WPRFMC 2002a). These large vessels, which have hydraulically powered reels and electronic navigation equipment and substantially greater gear and storage capacities than the small *alia*, tend to conduct multi-day fishing trips and can range throughout the EEZ (WPRFMC 2002a and WPRFMC 2002b). The rapid influx of the large domestic longliners during just the last two years has resulted in both a dramatic increase in longline fishing effort in the EEZ around American Samoa (from about 1.4 million hooks set in 2000 to about 5.8 million in 2001; WPRFMC 2002b) and a shift in the spatial distribution of longline effort towards waters more distant from shore.

(1) Past listed marine mammal take in the American Samoa-based longline fishery

For the American Samoa-based longline fishery, the federal logbooks from 1992 through 2001 indicate zero interactions with listed marine mammals. Although logbooks may not be the most reliable source of information on protected species interactions, the infrequent nature of interactions between listed marine mammals and the Hawaii-based longline fishery may indicate that this gear type incidentally captures very few marine mammals, particularly large whales. For this reason, NMFS concludes the American Samoa longline fishery, as managed under the Pelagics FMP is not likely to adversely affect listed marine mammal populations.

(2) Past sea turtle take in the American Samoa-based longline fishery

For the American Samoa-based longline fishery, the federal logbooks from 1992 through 1999 indicate six interactions with sea turtles (i.e. hooking/entanglement). In 1992, one vessel interacted with a green turtle. In 1998, one vessel interacted with an unidentified sea turtle; it was released alive. In 1999, one vessel reported interactions with four sea turtles. Three turtles released alive were recorded as a hawksbill, a leatherback, and an olive ridley. One turtle, identified as a green, was reported to have died from its interaction with this vessel. None of the species' identification were validated by NMFS' Southwest Fisheries Science Center; and NMFS cannot attest to the local knowledge of fishermen regarding the identity of various turtle species, particularly hard-shelled turtles. However, all four species of sea turtles reportedly caught by the fishery do occur in the fishing grounds of this longline fishery. In addition, as discussed below, logbook data may not be a reliable method to measure sea turtle interaction in the fisheries. From

2000 through October 2002, there have been no reported interactions with sea turtles in this fishery (S. Pooley, NMFS, personal communication, October 2002).

Hawaii-based longline fishery. 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 is about 1,690 hooks per set with about 27 hooks set between each float. There are approximately 66 floats used during each set. Deep set vessels use saury (sanma) as bait and the hook type used are "tuna" hooks. The average target depth is 167 meters. The gear is allowed to soak during the day and the total fishing time typically lasts about 19 hours, including setting and hauling of gear. This type of set is referred to below as "deep set."

(1) Past estimates of listed marine mammal captures and mortalities in the Hawaii-based longline fishery

Humpback whale. One humpback was reported by an observer entangled in the mainline of a Hawaii-based longline vessel in 1991. This interaction occurred inside what is now the protected species zone (50 nautical miles) of the islands and atolls of the Northwestern Hawaiian Islands. Another humpback whale was reported entangled in longline gear off Lanai by Nitta and Henderson (1993) and by whalewatch operators off Maui in 1993 (Hill and DeMaster, 1999). Confirmation was not made as to whether the gear type was pelagic longline gear, and the reports were believed to be for the same whale. In 2001, NMFS observer recorded a humpback whale entangled in the mainline of the fishing gear on a set targeting bigeye tuna. The animal was released alive. In October 2002, NMFS observed another humpback whale entangled in a mainline. This animal was released alive, but may have had some trailing line attached (<30ft).

Based on this information, NMFS concludes that there is a likelihood that humpback whales may incidentally become entangled in longline fishing gear. However, based on observer data and logbook data, such an interaction is infrequent and more likely a random event. Moreover, based on observer data (earlier non-observer reports of humpback whales entangled and trailing longline gear are not confirmed and were during a time when longline fishing was allowed within 50 miles of the islands and atolls of the Northwestern Hawaiian Islands), animals that are entangled are likely to be released alive, but they may have some trailing gear. Therefore, at this time NMFS believes that humpback whale interactions with longline gear are infrequent occurrences and that humpback whales will not be seriously injured or killed.

Monk Seal. In the early 1990s, longline operations were adversely affecting monk seals, as indicated by the sighting of a few animals with hooks and other non-natural injuries. In 1991, Amendment 3 established a permanent 50-mile protected species zone around the NWHI that closed the area to longline fishing. This protected species zone has essentially eliminated monk seal interactions with the longline fleet, except in 1994, a Hawaiian monk seal was reported released alive and injured on a Daily Longline Fishing Log by an operator of a Hawaii-based longline vessel. The species identification was not confirmed by Honolulu Laboratory personnel. The set was reported to occur 125 miles north by northwest of Kaui and targeting swordfish, with 800 hooks set and lightsticks used.

Based on logbook data, NMFS concludes that there is a possibility that monk seals may incidentally become entangled or hooked in longline fishing gear. However, there have been no monk seal interactions observed by NMFS observers, suggesting that the likelihood of an interaction is small. Moreover, the single animal was reported taken in a shallow set; shallow sets are now prohibited under the fishery management plan. This further reduces the likelihood of an interaction. Therefore, at this time, based on the data, NMFS does not anticipate monk seal interactions with longline gear.

Sperm Whale. NMFS has observed one sperm whale interaction by the Hawaii-based longline fishery. The event occurred in May, 1999 inside the Northwestern Hawaiian Islands EEZ (about 140 nautical miles north of Raita Bank), and the vessel was targeting swordfish (gear was set at night, lightsticks were used, and no line shooter was used). According to the observer report, the sperm whale's pectoral fin was entangled in the mainline. The captain stopped the boat, let out more mainline, and then backed up until he could reach the other end of the mainline. At this point, both ends of the mainline, on each side of the sperm whale, were secured on the vessel. During this time, the whale broke the mainline and swam away without trailing gear. There have been no reported sperm whale interactions by fishers in their logbook submissions.

Based on this information, NMFS concludes that there is a likelihood that sperm whales may incidentally become entangled in longline fishing gear. However, based on observer data and logbook data, such an interaction is infrequent. Animals that are entangled are likely to be released alive, but they may have some trailing gear (a single observed interaction does not allow us to determine conclusively that sperm whales in future interactions will not have trailing gear). Therefore, at this time NMFS believes that sperm whale interactions with longline gear are infrequent occurrences and that sperm whales will not be seriously injured or killed.

(2) Sea Turtle Interaction Analysis

The following discussion of sea turtle presence and behavior in the action area stems from observer reports and other scientific information available on the foraging and diving behavior and natal origin of the sea turtles known to be affected by the fisheries. The information presented below is based on past observed interactions between the Hawaii-based longline fishery and sea turtles and spans the entire collection of data from observer reports. However, due to changes in the Hawaii-based longline fishery, specifically the prohibitions on shallow-set gear and swordfishing methods, the location, frequency, and intensity of interactions may have changed after April 2001. Nevertheless, we are presenting all of the available information to provide as complete a picture as possible of the known intersection between this fishery and sea turtles and the reductions in interactions due to the changes in the fishery. Information specific to interactions occurring before April 2001, are referred to as occurring under the "prior fishery." Interaction information after April 1, 2001, occurred under the "current fishery." A similar analysis for the marine mammals adversely affected by the Western Pacific Pelagics Fisheries was not done due to the extremely rare and random nature of interactions between the fisheries and marine mammals foraging and migrating through the action areas.

As discussed in the *Approach to the Assessment* section, NMFS' Honolulu Laboratory estimated the number of interactions between the current fishery and sea turtles. These estimates are based on the number of turtles that interacted with observed longline sets; these estimates were then expanded statistically to estimate the number of interactions that would be expected for the entire fishery (observed and unobserved sets).

Green Turtles. The current fishery is expected to interact with about 8 green turtles each year (95% confidence interval = 2 - 21). Based on past experience, most of these green turtles will probably be members of the Hawaiian (French Frigate Shoals) or Mexican (Pacific coast) nesting aggregations. Of fourteen green turtles observed taken in the Hawaii-based longline fishery from 1994 to 2002, genetic tests indicated that six represented the eastern Pacific (Mexico - both Revillagigedos and Michoacan; and Galapagos) nesting aggregations, two represented the Hawaiian nesting aggregations, five may have originated from either Hawaii or Mexico (Islas Revillagigedos), and one was of unknown origin (P. Dutton, NMFS, personal communication, October, 2002). Nevertheless, turtles from other nesting aggregations in the Pacific Ocean may also interact with these Hawaii-based longline fisheries.

Life history information collected by observers suggests that the Hawaii-based longline fisheries tend to capture juvenile, subadult and adult green turtles (straight carapace lengths ranged from 28.5 cm to 73.5 cm with an average of 51.5 cm). From those turtles for which genetic data were collected, turtles originating from Hawaiian nesting aggregations were represented by smaller animals (juvenile and sub-adult sizes); turtles from Mexican nesting aggregations were represented by larger animals (sizes that suggest they were probably adult turtles).

Green turtles have been captured in all months of the year except January and September in the prior fishery and only during March and August under the current fishery. Under the prior fishery, green turtles have been caught in the area bounded by 155°W and approximately 180°E longitude and between 5°N and 30°N latitude. Under the current fishery, green turtles have been caught in the area bounded approximately by 160°W and 170°W longitude and south of 5°N latitude (see Figure 1 and Figure 2 in Appendix C). Green turtles in these areas are likely foraging in shallow waters or at shallow depths, or transiting to foraging grounds. The non-breeding range of green turtles is generally tropical, and can extend thousands of miles from shore in some regions. Data from satellite transmitters on Hawaiian green turtles indicate that these turtles can travel more than 1,100 km from the nesting beach at French Frigate Shoals, south and southwest against prevailing currents to numerous distant foraging grounds within the Hawaiian archipelago. Green turtles outfitted with satellite tags on Rose Atoll (the easternmost island of the Samoan Archipelago) traveled on a southwesterly course to Fiji, approximately 1,500 km distant (Balazs, *et al.*, 1994). Tag returns and observations of eastern Pacific green turtles establish that these turtles also travel long distances between foraging and nesting grounds, sometimes more than 1,000 kilometers from nesting beaches. East Pacific green turtles are the second-most sighted turtle in the east Pacific during tuna fishing cruises; they appear to frequent a north-south band from 15°N to 5°S along 90°W, and between the Galapagos Islands and Central American Coast (NMFS and USFWS, 1998a), an area well outside of the ocean fished under the Pelagics FMP. Green turtles appear to prefer waters that usually remain around 20°C in the coldest month. During warm spells (e.g., El Niño), green turtles may be found considerably north of their normal distribution.

Under the prior fishery, more green turtles were captured in shallow sets compared to deep sets. Thirteen of 17 turtles caught by the prior fishery were captured in sets with less than 10 hooks per float, indicative of shallow-set gear. Because subadult green turtles reportedly perform routine dives of 20 meters, with a maximum depth of approximately 110 meters (Brill, *et al.*, 1995, *in* Lutcavage and Lutz, 1997), they are more likely to encounter shallow-set longlines than deep-set longlines which are often set below 100 meters. Based on the behavior of post-hatchlings and juvenile green turtles raised in captivity, wild green turtles in pelagic habitats probably live and feed at or near the ocean surface, and their routine dives probably do not exceed several meters in depth (NMFS and USFWS, 1998a) making these life stages also vulnerable to capture by either shallow-set longline gear, or deep-set gear that is being set or retrieved. The only mortalities (n=5, 3 under the prior fishery and 2 under the current fishery) observed were on deep sets; we assume that these turtles drowned as a result of their inability to reach the surface.

Hawksbill Turtles. Although hawksbill turtles are known to nest on the Main Hawaiian Islands (on Molokai, Maui and Hawaii), they are not known to interact with the Hawaii-based longline fishery, as there have been no reported or observed interactions between these pelagic longliners and hawksbills. As hawksbills become adults, evidence suggests that they switch foraging behaviors from shallow water habitat to a deep water habitat, feeding pelagically for the first years of life, and switching to benthic feeding as they mature. If Hawaiian hawksbills forage close to their known nesting sites, they are probably benefitting from the protected species zone instituted by the Council in 1991, where longliners are prohibited from fishing within 50 nm of the NWHI[38] and within 100 nm closed corridors connecting the non-contiguous closed circles. Further longline exclusion zones prohibit longline fishing in specific areas around the MHI (depending on the time of year and location, the exclusion zones around the MHI range from 25-75 nm). Because adult hawksbills are most likely foraging primarily in nearshore waters, the likelihood of an interaction with a longliner is very low.

Leatherback Turtles. The current fishery is expected to interact with about 8 leatherback turtles each year (95% confidence interval = 2 - 21). Based on genetic analysis, all of the leatherback turtles captured in the Hawaii-based longline fishery are from two nesting aggregations: the western Pacific region (Papua New Guinea, Indonesia, and Solomon Islands), and the eastern Pacific region (Mexico and Costa Rica). Of 17 leatherback turtles captured in the Hawaii-based longline fishery, 16 were from nesting aggregations in the southwestern Pacific, most likely Indonesia or the Solomon Islands; the remaining turtle, captured in the southern range of the Hawaii fishery, was from an eastern Pacific nesting aggregation (P. Dutton, NMFS, personal communication, October, 2002).

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[38] Note: there have been no known valid records of a hawksbill anywhere in the NWHI (G. Balazs, NMFS, April, 2002).

Straight carapace lengths taken from a subset of the leatherback turtles caught in the fishery suggest that subadults, representing both early and late pelagic stage, based on the stage structure for Malaysian turtles presented in Bolten, *et al.* (1996). However, it appears that young leatherback turtles (carapace length <100 cm) reside only in waters warmer than 26°C, which should generally place them outside of areas in which longline swordfish fleets operate (Eckert, 1999b; Eckert, 2002). If one of the measured leatherback turtles (130 cm) originated from the eastern Pacific, it could have been an adult; if it originated from the western Pacific, it would be a subadult (P. Dutton, NMFS, personal communication, January, 2001). Because the majority of the leatherback turtles caught in the fishery are probably of western Pacific origin, this individual was probably a sub-adult. Most of the leatherbacks caught in the fishery were not measured. Those leatherbacks that were not measured may have been too large to be safely brought on board; therefore they may have been adults.

The data on these interactions revealed clear spatial patterns between the prior and current fisheries and leatherback turtles. However, there is no obvious temporal pattern to those interactions: leatherback turtles have been captured in every month of the year, except August. Under the prior fishery, leatherback turtles were captured in the area bounded by 170°E and 133°W longitude and between 5°N and 41°N latitude.

Leatherback turtles within the action area of the Hawaii-based longline fishery are probably foraging (at the surface or at depth, including the deep scattering layer) or migrating between their nesting, mating, and foraging areas. Leatherbacks are able to dive quite deep, but appear to spend most of their time (up to 90%) diving to depths shallower than 80 meters. They are highly migratory, exploiting convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Morreale, *et al.*, 1994; Eckert, 1998; Eckert, 1999a).

Leatherback turtles caught in prior fishery sets above 20°N latitude (43 out of 52 leatherback turtles observed) were caught in sets with less than 10 hooks per float, indicative of shallow-set gear and also indicative of the general area in which shallow set fishing methods were used. Leatherback turtles were primarily captured in these sets in an area bounded by 165°W and 130°W longitude and 20°N and 40°N latitude.

The remaining leatherback turtles captured in the prior fishery (9 out of 52), were associated with sets with more than 10 hooks per float, suggesting deep-set gear. These interactions occurred between 153°W and 167°W longitude and 5°N and 26°N latitude (see Figure 3 in Appendix C). Sea surface temperatures, latitude, and the distance to the approximate 17°C and 19°C isotherms were associated with these interactions, but there was a high degree of collinearity between these variables (McCracken, 2000): when McCracken examined four latitude predictor categories for leatherback turtles[39], she found that the proportion of sets associated with leatherback captures was higher in the northernmost and southernmost categories, even though these areas had lower proportions of the observed sets than the middle two categories, which had high observed sets but fewer observed takes. These observations suggest that the risk of an interaction increases toward

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[39] These four categories were: less than 14.95°N, between 14.95°N and 24.84°N, between 24.84°N and 33.82°N, and greater than 33.82°N (McCracken 2000).

the northern and southern boundaries of the action area. Under the current fishery, two leatherback turtles have been observed taken between 160°W and 162°W longitude and 21°N and 26°N latitude (see Figure 4 in Appendix C).

Recent information on leatherbacks tagged off the west coast of the United States has revealed an important migratory corridor from central California, to south of the Hawaiian islands, leading to western Pacific nesting beaches (P. Dutton, NMFS, personal communication, October 2002). This corridor runs through the areas typically fished by the Hawaii-based longline fleet and supports genetic findings that most of the leatherback turtles caught in the fishery originate from western Pacific beaches. Eastern Pacific leatherback turtles appear to migrate primarily to the south, into the fishing grounds of South American fishing nations, supporting the low observed interaction rate between the Hawaii-based longline fishery and eastern Pacific leatherback turtles.

Loggerhead Turtles. The current fishery is expected to interact with about 14 loggerhead turtles each year (95% confidence interval = 3 - 26), although interactions are more likely north of 22°N latitude (12 interactions, with a 95% confidence interval = 3 - 26) than south of 22°N (2 interactions, with a 95% confidence interval = 0 - 8). Based on genetic analyses of 133 loggerheads, all of the loggerhead turtles captured in the Hawaii-based longline fishery originated from Japanese nesting aggregations (Dutton *et al.*, 1998; P. Dutton, NMFS, personal communication, October, 2002). Available data on the length of these turtles indicate that the fishery captures pelagic-stage juvenile loggerhead turtles. These data are supported by the available information on the foraging and migrating patterns of loggerhead turtles. The transition from hatchling to young juvenile occurs in the open sea, and evidence is accumulating that this part of the loggerhead life cycle may involve a trans-Pacific developmental migration (Bowen, *et al.*, 1995). As they age, some loggerheads begin to move into shallower waters, where, as adults, they forage over a variety of benthic hard- and soft-bottom habitats.

From 1994 through March 2001, observers recorded the incidental take of 175 loggerheads (see Figure 5 of Appendix C, which shows the location of loggerhead captures by the Hawaii-based longline fleet). The existing data on these interactions revealed clear spatial patterns between the prior fishery and loggerhead turtles. There are reports of loggerhead turtle captures in all months except May and June; most captures occurred during the fall and winter months, however, especially in January and February.

Statistical analyses of captures through 1999 to determine possible associations with several different variables like sea surface temperature, latitude, and the distance to the approximate 17°C and 19°C isotherms showed a high degree of collinearity between these variables. Degree of latitude appeared to be a primary determinant of the probability of loggerhead captures in the fisheries. For example, McCracken (2000) reported that, none of 1,263 sets that were observed south of 22°N captured loggerhead turtles. Kleiber (1998) also found latitude to be the primary determinant of interactions between the fisheries and loggerhead turtles. However, after March

2001, the current fishery caught two loggerhead turtles, including one turtle far south of the area in which loggerhead turtles were typically seen (13°N latitude; see Figure 6 in Appendix C)[40].

Of 70 trips in which loggerheads were captured, 39 had captured loggerheads in more than one set, and several trips had captured multiple loggerheads in the same set. This suggests that juvenile loggerhead turtles forage or migrate in groups, or longliners target swordfish and tuna in areas of high loggerhead concentration, or both. Other data also suggest that juvenile loggerhead turtles forage or migrate in groups. Off Baja California, thousands of juvenile loggerhead turtles have been observed feeding on pelagic crabs. In the Atlantic Ocean, 68.1% of the loggerhead turtles captured in longline gear were caught in sets with other loggerheads compared with 31.9% that were caught singly (Hoey, 1998).

The existing data also lead us to conclude that loggerheads tend to congregate in areas typically fished by longliners targeting swordfish, taking advantage of high productivity associated with particular oceanographic features. Recent satellite tracking by Polovina *et al.* (2000) indicates that all life stages of loggerhead turtles actively migrate, swimming against weak geostrophic currents along two convergent fronts as they travel from east to west across the Pacific. Of nine juvenile loggerheads tracked in the central North Pacific, six associated with a front characterized by 17°C sea surface temperature (SST; termed "cool group") and the other three associated with a front with a SST of 20°C ("warm group"). Seasonally, these 17°C and 20°C isotherms move north and south over 10 degrees of latitude, and as the turtles moved westward, they also appeared to move north and south coincident with these isotherms. Under the prior fishery, the distribution of shallow longline sets during the first quarter was largely between the 17°C and 20°C SST fronts used by loggerheads.

Swordfish are believed to move south through these fronts, perhaps following squid. For example, during the second quarter, the prior fishery tended to locate well to the south of the 17°C SST front but overlapped the 20°C SST front. Sea turtles tracked during the first quarter of the years 1997 and 1998 occupied waters with a mean of 17°C SST, with considerable overlap with the SST associated with the fishery in the northern portion of the fishing grounds. As the fishery moved south in the second quarter, those "warm group" turtles following the 20°C front would be well within the fishing ground, while the "cool group" would likely have been well north of the fishing ground (Polovina, *et al.*, 2000). Observer data shows that the interaction rate (turtles per longline set) was substantially greater at 17°C SST than at 20°C SST (P. Kleiber, NMFS, personal communication *in* Polovina, *et al.*, 2000).

Finally, all of the 175 loggerheads observed taken by the Hawaii-based longline fishery from 1994 through March, 2001, were captured by longliners using shallow sets (i.e. target depth less than 100 meters, using less than 10 hooks per float, fishing at night, using lightsticks). Loggerheads in the north Pacific are opportunistic feeders that target items floating at or near the surface, and if

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[40] Two other loggerhead turtles were reported taken in the northern portions of the action area. These turtles were captured on sets under suspicion of illegal activity (targeting swordfish) and therefore they have not been included in the interaction analysis. In addition, there are no photos or other information available to confirm that the turtle taken around 13° N was a loggerhead.

high densities of prey are present, they will actively forage at depth (Parker, *et al.*, in press). Loggerhead turtle maximum recorded dive depth is 128 meters. In general, loggerhead turtles tend to spend most (90%) of their time at the surface or diving to 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. However, in July 2002, a loggerhead turtle was caught in a deep set fishing at 13°N latitude, an interaction than diverged from NMFS' past observations of the overlap between this species' pelagic distribution and behavior and the deep-set portion of the longline fishery.

Olive Ridley Turtles. The current fishery is expected to interact with about 26 olive ridley turtles each year (95% confidence interval = 12 - 47). Genetic analyses suggest that the Hawaii-based longline fishery catches olive ridley turtles from nesting aggregations in the eastern and western Pacific Ocean and the Indian Ocean. Based on analyses of 39 olive ridleys captured by the Hawaii-based longline fishery, 26 % (n=10) were from the Indian Ocean or western Pacific Ocean and 74% (n=29) were from the eastern Pacific (P. Dutton, NMFS, personal communication, October, 2002). Some areas within the fishing grounds of the prior fishery had a high proportion of captured olive ridleys from both eastern and western Pacific beaches, signifying that ridleys from both sides of the Pacific converge in the north Pacific pelagic environment. Length information collected by observers indicates that the fishery interacts with sub-adult and adult olive ridley turtles. Olive ridley turtles generally have a tropical range, with a distribution from Baja California, Mexico to Chile (Silva-Batiz, *et al.*, 1996). Satellite studies of post-nesting olive ridley turtles indicated that the females traversed thousands of kilometers of deep oceanic waters, including more than 3,000 kilometers out into the central Pacific. Young olive ridley turtles tend to forage in large groups, or flotillas, in the open ocean environment. As they age, they begin to recruit to the benthic feeding grounds of the adults. Olive ridley turtles caught in the fishery may be transitioning between the open ocean and the shallower adult feeding areas, or migrating between foraging, mating, and nesting areas.

The existing data from the prior fishery on these interactions revealed clear spatial patterns but a weak temporal pattern: olive ridley turtles had been captured in every month of the year, except February, with most of the captures occurring during warmer months (May to August). In addition, the prior fishery interacted with olive ridleys throughout the fishing area, with captures reported from as far north as 33°N to as far south as 7°N latitude, and from longitudes 143°W, west to 175°W (see Figure 7 in Appendix C). Sea surface temperatures, latitude, and the distance to the approximate 17°C and 19°C isotherms were associated with the takes, but there was a high degree of collinearity between these variables. There was a clear distinction between the proportion of takes between the two categories of sea surface temperature, but over latitude, the pattern was less clear (McCracken, 2000). Observed interactions between olive ridley turtles and the current fishery follow similar patterns: olive ridleys have been captured in January, March, April, June, and July in an area between 10°N and 23°N latitude and 154°W and 168°W longitude (Figure 8 in Appendix C).

Olive ridley turtle maximum recorded dive depth is 238 meters, although the species spends a greater proportion of time at depths shallower than 40 meters (60% with 20% of total time spent at the surface), possibly making them more likely to encounter shallow set longlines than deep set longlines. Under the prior fishery, most olive ridley turtles were caught in shallow sets with less than 10 hooks per float (76% of observed interactions). All but one of the turtles killed during interactions with the prior or current fishery were caught in deep sets with more than 10 hooks per float; it is likely that these turtles died as a result of their inability to reach the surface.

(a) Past estimates of sea turtle captures and mortalities in the Hawaii-based longline fishery

Because the bycatch information provided in skipper logbooks was considered unreliable, and due to reasonable and prudent measures listed in prior biological opinions, an observer program was established in 1994 to monitor target species caught and bycatch in the Hawaii-based longline fishery. Through 1999, observer coverage ranged from 3.4% to 5.3% of annual trips (NMFS, 2000f). Since 1999, observer coverage in the fishery increased substantially due to both court-orders and changes in NMFS' regulations. In 2000, 2001, and 2002, observer coverage was approximately 10.4%, 22.5%, and 27.6% (first nine months), respectively.

In earlier biological opinions, NMFS defined "turtle take" as any interaction between a sea turtle, a fishing vessel, or its gear, particularly interactions that were likely to result in a turtle becoming entangled in fishing line or caught on a hook. Observers complete sea turtle life history forms for every turtle observed taken by a longline vessel. Turtles are either brought aboard or sampled alongside the vessel, and from such vantage points, the observer records biological characteristics as well as the fate of the turtle. Table IV-3 contains characteristics (definitions) used by observers to define the condition and fate of turtles interacting with longline gear.

Because a probability sample was not drawn on a yearly basis, a model-based predictor was used to estimate the total take of sea turtles by the fishery. In developing the prediction model, explanatory variables were considered in order to estimate takes accurately and precisely. Such variables included: latitude, longitude, distance to 17°C isotherm, distance to 19°C isotherm, year (1994-1999), month, day, hooks, hooks/float, temperature, catch of other species (e.g. tuna species, marlin, albatross, etc.), vessel length, and trip type (i.e. swordfish, tuna, mixed). Some of the variables considered and found to be associated with take were poorly represented in the logbooks during the time period of data gathering and were therefore not considered for prediction purposes. Table IV-4 shows the explanatory variables that were included in the prediction models for the various species of sea turtles.

Table IV-3 Definitions used to characterize the fate of sea turtles taken by Hawaii-based longlines

Fate	Definition	Codes
Alive [Released Unharmed]	An animal removed from the fishing gear that can swim normally. The animal is likely to have minor cuts and abrasions from being entangled. **This applies to entangled sea turtles only.**	EOK = entangled, okay

Injured	An animal released from the fishing gear with obvious physical injury or with gear attached. An injured animal may lie at the surface, breathing irregularly, or swim in an abnormal manner. **If an animal is impaled on a hook, it is considered injured.** "Internal" refers to the hook being ingested, "external" implies that the turtle was hooked in the head, beak, flipper, carapace, or plastron.	HII = hooked, internal, injured HEI = hooked, external, injured HUI = hooked, unknown, injured EI = entangled, injured
Dead	An animal removed from the fishing gear in a postmortem state (i.e. the animal died due to injuries incurred during fishing operations or was returned to the sea while comatose). Animals will show a lack of muscular activity and may float passively at or below the water's surface.	HID = hooked, internal, dead HED = hooked, external, dead HUD = hooked, unknown, dead ED = entangled, dead
Unknown	An animal lost, released, or escaped from the fishing gear whose condition was not determined.	HIU = hooked, internal, unknown; HEU = hooked, external, unknown; HUU = hooked, unknown, unknown; EU = entangled, unknown.

Table IV-4. Explanatory variables used in the prediction models

Species	Explanatory Variables	Categories
Green turtle	None	n/a
Leatherback	Latitude (4 categories)	lat ≤ 14.95°N; 14.95°N < lat ≤ 24.84°N 24.84°N lat ≤ 33.82°N lat > 33.82°N
Loggerhead	Month (3 categories) Latitude as a polynomial Sea surface temp. (2 categories)	[1,2], [5,6], [3,4,7-12] lat + lat^2 sst ≤ 23.77°C; sst>23.77°C
Olive ridley	Sea surface temp. (2 categories)	sst ≤ 24.22°C; sst>24.22°C

Source: McCracken, 2000.

b. *Factors contributing to the likelihood of an interaction with the longline fishery*

As discussed in the *Approach to the Assessment* discussion, this section of the biological opinion discusses attributes of the fisheries that represent hazards for threatened and endangered turtles that interact with the longline fisheries. In addition, this section of the opinion discusses environmental conditions that represent risk factors for sea turtles.

(1) Gear

Floats. 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). Floats typically used during swordfish-style sets are bright orange, bullet-shaped, and slightly submerged. Deep sets generally use larger cylindrical inflatable or rigid spherical buoys and floats, and these also are typically orange in color (L. Enriquez, NMFS, personal communication, January, 2001; e.g. www.lindgren-pitman.com/floats.htm).

Bait. 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). In addition, a leatherback has been documented ingesting squid (the bait typically used on the now prohibited gear targeting swordfish). The authors speculate that the lightsticks used on this gear type may initially have attracted the turtle, by simulating natural prey (Skillman and Balazs, 1992).

(2) 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). Swordfish are caught by longliners in association with frontal zones where ocean currents or water masses meet to create turbulence and sharp gradients of temperature and salinity. Swordfish also make vertical migrations through the water column, rising near to the surface at night from deep waters. Thus, while searching for concentrations of swordfish under the prior fishery, longliners set their gear across these temperature gradients ("breaks") indicative of intersecting water masses, and when sea turtles were associated with these fronts, interactions were more likely.

2. General effects of longline fishing on sea turtles

The most significant hazard of longline fisheries for sea turtles results from potential entanglement in or hooking by gear used in the fishery which can injure or kill turtles. Turtles that are entangled in or hooked by longline gear can drown after being prevented from surfacing for air; alternatively, turtles that are hooked, but 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 the Hawaii-based longline fishery, 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 following discussion summarizes the information on these potential effects.

a. Effects of forcible submergence

Sea turtles can be forcibly submerged by longline gear either through a hooking or entanglement event, where the turtle is unable to reach the surface to breathe. This can occur at any time during the set, including the setting and hauling of the gear, and generally occurs when the sea turtle encounters a line that is too short to reach the surface or is too heavy to be brought up to the surface by a swimming sea turtle. For example, a sea turtle that is hooked on a 3 meter branchline attached to a mainline set at depth by a 6 meter floatline will generally not be able to swim to the surface unless it has the strength to drag the mainline approximately 3 more meters (discussed further below).

Turtles hooked by longline gear will sometimes drag the clip, attached to the branch line, along the main line. If this happens, the potential exists for a turtle to become entangled in an adjacent branch line which may have another species hooked such as a shark, swordfish, or tuna. According to observer reports, most of the sharks and some of the larger tuna such as bigeye are still alive when they are retrieved aboard the vessel, whereas most of the swordfish are dead. If a turtle were to drag the branch line up against a branch line with a live shark or bigeye tuna attached, the likelihood of the turtle becoming entangled in the branch line is greater. If the turtle becomes entangled in the gear, then the turtle may be prevented from reaching the surface. The potential also exists, that if a turtle drags the dropper line next to a float line, the turtle may wrap itself around the float line and become entangled.

Sea turtles that are forcibly submerged by longline gear undergo respiratory and metabolic stress that can lead to severe disturbance of their acid-base balance. While most voluntary dives by sea turtles appear to be aerobic, showing little if any increases in blood lactate and only minor changes in acid-base status (pH level of the blood), sea turtles that are stressed as a result of being forcibly submerged through hooking or entanglement in a line rapidly consume oxygen stores, triggering an activation of anaerobic glycolysis, and subsequently disturbing their acid-base balance, sometimes to lethal levels. It is likely that the rapidity and extent of the physiological changes that occur during forced submergence are functions of the intensity of struggling as well as the length of submergence (Lutcavage and Lutz, 1997). In a field study examining the effects of shrimp trawl tow times and sea turtle deaths, there was a strong, positive correlation between the length of time of the tow and sea turtle deaths (Henwood and Stuntz, 1987, *in* Lutcavage and Lutz, 1997).

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). 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 the Hawaii-based longline fishery or other 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).

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 on a longline. 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. During the warmer months, routine metabolic rates are higher, so the impacts of the stress due to entanglement or hooking may be magnified. 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 (*in* 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.

Although a low percentage of turtles that are captured by longliners actually are reported dead, sea turtles can drown from being forcibly submerged. Such drowning may be either "wet" or "dry." In the case of dry drowning, a reflex spasm seals the lungs from both air and water. With wet drowning, water enters the lungs, causing damage to the organs and/or causing asphyxiation, leading to death. 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 of course 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).

b. *Effects of entanglement*

Sea turtles are particularly prone to entanglement as a result of their body configuration and behavior. Records of stranded or entangled sea turtles reveal that fishing debris can wrap around the neck or flipper, or body of a sea turtle and severely restrict swimming or feeding. Over time, if the sea turtle is entangled when young, 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 both 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).

c. Effects of hooking

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. When lightsticks were used on a shallow set at night to attract the target species, the turtles could have mistaken the lightsticks for their preferred prey and been 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).

d. Effects of trailing gear

Trailing line (i.e. line that is left on a turtle after it has been captured and released), particularly line trailing from an ingested hook, poses a serious risk to sea turtles. Line trailing from an ingested hook is likely to be swallowed, which may occlude the gastrointestinal tract, preventing or hampering foraging, leading to eventual death. Trailing line may also become snagged on a floating or fixed object, resulting in further entanglement, with potential loss of appendages, which may affect mobility, feeding, predator evasion, or reproduction. 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 observer or the vessel and its crew at risk. Turtles with most or all of the trailing gear removed are expected to have a better chance of surviving the interaction in the long term.

e. Post-hooking survival studies - (lightly hooked v. deeply hooked)

Research has been conducted in both the Atlantic and the Pacific to estimate post-hooking survival and behavior of sea turtles captured by longline. In the Pacific, from 1997 to late 2000, a total of 54 pelagic turtles hooked by the Hawaii-based longline fishery have had satellite transmitters attached to them in order to track their location and distance traveled following the interaction. Of these 54 turtles, 15 produced no transmissions, or their transmissions lasted less than a month - 11 had deeply ingested hooks (turtles had swallowed the hook, and it was not removed) and 4 were lightly hooked.(turtles had the hook lodged externally (beak or flipper), permitting easy removal) (D. Parker and G. Balazs, NMFS, personal communication, April, 2002). No assumptions were made by the researchers regarding the fate of these turtles that failed to transmit or only transmitted for a short period of time. Assuming that the satellite transmitter was working correctly, there are a number of possible explanations for few or no transmissions, any of which could be correct. Following the hooking incident, including the forced submergence, hauling of the longline and subsequent capture by the vessel, the released turtle may not have had time to recover from its experience. As discussed above, turtles that expend energy as a result of increased activity, need time at the surface to process lactic acid loads. Sea turtles often appear to be moving fairly well and then just collapse, while they rebuild their energy stores or repay their oxygen debt (E. Jacobsen, *in* Balazs, *et al.*, 1995). If a turtle does not have enough energy to remain afloat, it could submerge and die. In addition, injuries sustained as a result of the hooking incident, especially in incidents where the hook may have perforated an organ, may also result in death to the turtle. In both instances, the turtle sinks with the transmitter, and no signal is received. Whether or not these turtles remained submerged and therefore died, or the transmitters failed to transmit is a matter of speculation.

For the 34 turtles that did produce successful tracks for periods lasting more than a month, there were no significant differences (P>0.05) found for the duration of tracking (days) and the distance traveled between lightly hooked turtles (n=15) and turtles with deeply ingested hooks (n=19). Even when the 15 turtles that did not produce successful tracks were taken into account, no significant differences were found in terms of distance traveled and duration between the two groups (19 total lightly hooked, and 30 total deeply ingested). Furthermore, when species were analyzed individually for the two categories, no significant differences were found.

Polovina (NMFS, personal communication, September, 2000) used a contingency table approach to analyze the transmission duration in intervals of 1 month for 34 loggerheads (including those w/ few or no transmissions), comparing lightly hooked versus deeply hooked turtles. While 43% of the deeply hooked turtles transmitted less than one month compared to 27% of the lightly hooked turtles, the chi-squared test found no significant difference between the transmission distributions for these two categories. When the data for all hard shell turtles are combined (n=48), 22% (n=4) lightly hooked and 37% (n=11) deeply hooked turtles transmitted less than one month. Again, the difference was not statistically significant between hooking categories based on a chi-square test.

Data were also analyzed to determine whether the length of the turtle (in straight carapace length) played any role in determining differences between deeply hooked turtles and those that were lightly hooked. Only all satellite tagged loggerheads (both with successful tracks and without (n=35)) showed a significant difference (P=0.02) in size between deeply ingested (mean size = 62.0 ± 10.9 cm) and lightly hooked (mean size = 53.0 ± 6.6 cm) (D. Parker and G. Balazs, NMFS, personal communication, November, 2000).

In the eastern Atlantic, in the waters around the Azores, three juvenile loggerheads that had been lightly hooked by swordfish longline gear were instrumented with satellite-linked time-depth recorders in 1998. The number of dives performed by these hooked turtles was compared to five juvenile loggerheads that had been captured by dipnet and also instrumented. Turtles caught on longline fishing gear had significantly lower dive counts than turtle caught with dipnets during the normal (observed) period of most intense diving activity (from 9:00 am to 3:00 pm) (Bjorndal, *et al.*, 1999). During a similar study in the summer of 2000, in the same area of the Atlantic, 10 pelagic juvenile loggerheads were instrumented - four were captured with dipnets (control), and six had been deeply hooked. In all periods of the 24-hour day (separated by 6-hour increments), the hooked turtles appeared to make longer and shallower dives than control turtles, but overall, dive behavior appeared similar between hooked and non-hooked turtles, having a diurnal component (shallowest dives occurring during 21:00 and 03:00) and a seasonal component (dive depth generally increased for most turtles from summer into fall) (Riewald, *et al.*, 2000). Caution was given in interpreting both sets of data, as the studies were ongoing at the time of writing.

B. Estimation of the Risks the Pelagic Fisheries Pose to Sea Turtles

This section of the biological opinion evaluates the available evidence to assess the probable risks posed by the various fisheries managed under the Pelagics FMP based on the interaction analysis and susceptibilities of the turtles to reach conclusions about the potential effects of the fisheries on threatened and endangered sea turtles. Specifically, we evaluated the available evidence to determine if the fisheries were likely to kill or physically injure these turtles species in ways that would be expected to have chronic or acute effects on their population ecology. Although this section of our assessment included concerns for effects on individual animals, our assessment focused on the probable effects of the fisheries on populations and, through those populations, the viability of the species themselves.

The following discussion estimates the probability of injuries or death based on data extracted from interactions between these fisheries and sea turtles over time. It is important to note that much of the data presented below includes interactions between the turtles and the now-prohibited shallow-set component of the longline fishery. Past mortality estimates for turtles taken by the Hawaii-based longline fishery before 2001 were based on limited data from Aguilar, *et al.* (1995) and from information recorded by observers on the condition of the turtles when released (Kleiber, 1998). Aguilar, *et al.* (1995) estimated a 29% mortality rate for loggerheads ingesting a longline hook; therefore all turtles (hard-shelled and leatherback) that had been hooked internally were assigned a mortality rate of 29%. Turtles recorded as dead had a 100% mortality rate, and turtles recorded as okay (released uninjured) were assigned a 0% mortality rate. All species of turtles hooked externally were also assigned a 0% mortality rate (McCracken, 2000).

Observers occasionally were unable to identify a turtle to species, or to assess their condition accurately. Therefore, identified turtles hooked in an unknown location were assigned the average mortality of the turtles of their species with a known hook location. Turtles with an unknown condition (i.e. not recorded) were assigned the average within species of turtles with condition "okay," internally hooked, or externally hooked. For those turtles reported as hardshell with unknown hook location or unknown condition, the averaging was conducted over all turtles except leatherbacks (Kleiber, 1998), also taking into account temperature or latitude (McCracken, 2000). For example, there were 10 unidentified hardshell turtles observed taken from 1994 to 1999. The identity of these turtles was apportioned to loggerhead, olive ridley, or green turtle takes in the same proportion as observed takes of these species, and, except for green turtles, using the prediction models for each species. Based on the prediction models, olive ridley takes were higher at temperatures greater than 23.77°C, whereas loggerhead takes were higher at temperatures less than 24.22°C. If the sea surface temperature was not a clear indicator, the observed latitude was used to determine the species, since loggerhead takes were higher in the northern latitudes. In the two instances where the choice between the two species was most ambiguous, the identity was split fractionally among the three hardshelled species based on the proportions determined from observer data (McCracken, 2000).

Using the mortality rates assigned above for the condition of a turtle taken by the Hawaii-based longline fishery, the total number of turtles killed per year was estimated by averaging the mortality rates assigned to each condition class for the species, based on observed takes from 1994-1999. For example, of 147 loggerheads observed taken from 1994-1999, 83 were deeply hooked (29% mortality rate), 56 were externally hooked (0% mortality rate), 3 were hooked in an unknown location (17% mortality rate[41]), 1 was dead (100% mortality rate), 3 were entangled and released alive and uninjured (0% mortality rate), and 1 was of unknown condition (17% mortality rate). Averaging these, the resultant mortality rate for the 147 loggerheads observed taken by the Hawaii-based longline fishery was 17.5% (McCracken, 2000).

Given the potential for organ and tissue damage and subsequent infection (as discussed in *Post-hooking survival studies - (lightly hooked v. deeply hooked)* above), total mortalities may have been under estimated previously if lightly hooked animals were assigned a zero mortality rate. To estimate the probability of future mortalities, NMFS reviewed the results of several post-hooking survival studies from Hawaii, the eastern Atlantic, and the Mediterranean (i.e. Aguilar *et al.* 1995; Parker and Balazs pers. comm, 2000; Bjorndal, *et al.* 1999; Riewald, *et al*, 2000), as well as analyses of input from veterinarians and scientists with expertise in sea turtle biology and/or longline gear impacts (see January 4, 2001, memoranda from Don Knowles and Bruce Morehead to the Southeast Regional Office, the Office of Protected Resources).

After reviewing the available information, NMFS reached consensus on a method of estimating sea turtle mortalities (NMFS 2001b). NMFS' adopted approach apportions mortality in a manner consistent with the best scientific information in lieu of applying one standard across the board, while still providing the precautionary approach required for evaluating effects to listed species (NMFS 2001b). Table IV-5 details the estimated mortality rates for sea turtles captured on long line gear based on their condition.

Table IV-5. Sea turtle mortality rates based on level and type of interaction with longline fishing gear.
Source: NMFS, 2001b

Interaction	Response	Injury	Mortality Rate
Entangled / no hook	Disentangled	No injury	0%
Entangled / external hook	Disentangled, no gear	Minor	27%
	Disentangled, trailing gear	Moderate	27%
	Dehooked, no gear	Minor	27%
Hooked in beak or mouth	Hook left, no gear	Moderate	27%
	Hook left, trailing gear	Serious	42%
	Dehooked, no gear	Moderate	27%
Hook swallowed	Hook left, no gear	Serious	42%
	Hook left, trailing gear	Serious	42%
Turtle Retrieved Dead	---	Lethal	100%

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[41] Turtles with an unknown condition were assigned the average within species of turtles with a known condition (Kleiber, 1998).

We should also note that very little of the available data contain information on leatherback survival post-interaction. In the absence of better data on this species, NMFS is using the best available scientific data as estimates of the mortality rates leatherbacks may experience while anticipating that more information is likely to become available in the future.

Based on these latter recommendations which take into account the best available scientific and commercial data, NMFS will assume that the mortality rates in Table IV-5 estimate the probability of injury and mortality for sea turtles captured by longline gear in the future. Uncertainty in these impact estimates as a result of differences in the handling of captured turtles or the small sample sizes upon which these mortality rates are drawn should be noted when drawing conclusions about the magnitude of the impacts of delayed mortality on sea turtle populations. NMFS will use these methods to estimate the probability of future mortalities only; estimates of the outcomes of past interactions, which were calculated prior to NMFS' recent review of sea turtle mortality rates, will remain unchanged.

Because the abundance and distribution, migration and foraging patterns, and physiology vary so significantly between the four species of sea turtles that may be encountered by Hawaii-based longliners fishing in the Pacific Ocean, their vulnerability to the Hawaii-based longline fishing operations also varies. The following sections review the past impacts that the Hawaii-based longline fishery has had on each of the sea turtle species.

a. Green turtles

The Hawaii-based longline fisheries rarely capture green turtles. As shown in Table IV-6, observers have recorded the incidental take of 17 green turtles by the prior fishery from 1994-March 2001. All but one of these turtles were hooked either externally (13), or internally (3), and three were observed dead, the rest injured. In addition, all green turtles observed prior to 2000 were taken from different trips; therefore, there was no evidence within the data that a green turtle in one set implies a higher probability of a green turtle take in another set from the same trip (McCracken, 2000). However, in 2000, two of the seven turtles observed taken that year were taken during the same trip, but different sets.

Table IV-6. Green turtles observed captured by the Hawaii-based longline fishery from 1994-3/01.

Year/Fate	Condition	1994	1995	1996	1997	1998	1999	2000	Total
Alive (Okay)	Entangled	0	0	0	0	0	0	0	0
Injured	Hooked, External	2	0	3	0	2	1	3	11
	Hooked, Internal	0	0	0	0	0	1	2	3
Dead	Entangled	0	0	0	0	0	0	1	1
	Hooked, External	0	0	0	0	0	1	1	2

	Hooked, Internal	0	0	0	0	0	0	0	0

Table IV-7 shows the observed incidental take of two green turtles by the fishery as it currently operates (April 2001 - July 2002 data). These turtles were hooked, one externally and one internally. Both of the turtles were released dead.

Table IV-7. Green turtles observed captured by the current Hawaii-based longline fishery (April 2001 - July 2002).

Year/Fate	Condition	2001	2002	Total
Alive (Okay)	Entangled	0	0	0
Injured	Hooked, External	0	0	0
	Hooked, Internal	0	0	0
Dead	Hooked, External	1	0	1
	Hooked, Internal	0	1	1
	Entangled	0	0	0

Based on observer data, green turtles appear to be more likely to be hooked externally than to be entangled or hooked internally. Therefore, it is likely that green turtles may not be attracted to the baited hooks. The principal food sources for the green turtle are benthic marine algae. These algae are restricted to shallow depths where sunlight, substrate, and nutrients are conducive to plant growth. As a consequence, the feeding pastures used by green turtles are usually less than 10 meters deep and frequently not more than 3 meters deep, often right up to the shoreline. Because of these foraging strategies and food preferences, interactions between green turtles and the Hawaii-based longline fishery are rare.

From observer data (1994 through 1999), and using a model-based predictor, McCracken (2000) estimated that between 37 and 45 green turtles (average 40) were taken each year by the Hawaii-based longline fishery, and of these, an average of 5 were killed (given a 13% mortality rate; Table IV-8).

Table IV-8. Estimated numbers of green turtles captured and killed in the longline fishery with 95% prediction intervals (PI).

Year		1994	1995	1996	1997	1998	1999	Annual Avg.
Takes	Estimate	37	38	40	38	42	45	40

	95% PI	[15-65]	[15-70]	[19-70]	[14-73]	[18-76]	[18-76]	[18-71]
Kills	Estimate	5	5	5	5	5	6	5
	95% PI	[0-16]	[0-17]	[1-17]	[0-17]	[1-19]	[1-19]	

Source: McCracken, 2000 and McCracken, personal communication, March 2001

Recently, NMFS-Honolulu Laboratory (2002b) estimated the incidental take of green turtles under the current fishery (July 2001 through June 2002 data; Table IV-9). Comparisons between these estimates and the estimates in Table IV-8 indicate a reduction in the interaction rates between green turtles and the Hawaii-based longline fishery since the current regime took effect.

Table IV-9. Estimates of the incidental capture (hooking and entanglement) of green turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002.

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

Analysis by Kobayashi (2002) estimated that the change in the fishery to the current regime would reduce green turtle take by 93% (95% CI: 85-100%), but actual reductions based on July 2001 through June 2002 data were much lower than expected (69%).

b. Leatherback turtles

As shown in Table IV-10, from 1994- March 2001, observers recorded the incidental take of 52 leatherback turtles in the Hawaii-based longline fishery. Of these, 3 were entangled, released alive and uninjured (5.8%), 43 were injured (83.7% – comprised of 3 entanglements, 33 hooked externally, 3 hooked internally, and 4 hooked in an unknown location), 3 died as a result of the interaction (5.8% - comprised of 2 that were entangled, and 1 that was hooked externally), and for 3 leatherbacks taken, there was no information (i.e. the observer was unable to identify the fate or condition of the turtle). Two trips had more than one leatherback interaction during the trip. One trip had three leatherback interactions and the other trip had two leatherback interactions. There were no leatherback turtles taken in the same set.

Table IV-10. Leatherbacks observed captured by the Hawaii-based longline fishery from 1994-3/2001.

Year/Fate	Condition	1994	1995	1996	1997	1998	1999	2000	2001	Total
Alive (Okay)	Entangled	2	0	1	0	0	0	0	0	3
Injured	Entangled	0	0	2	0	1	0	0	0	3
	Hooked, External	3	3	4	10	2	1	8	2	33
	Hooked, Internal	1	0	0	0	0	0	2	0	3

	Hooked, Unknown	1	0	0	2	1	0	0	0	4
Dead	Entangled	0	0	1	0	1	0	0	0	2
	Hooked, External	0	0	0	0	0	1	0	0	1
No Record		1	1	1	0	0	0	0	0	3

Table IV-11 shows the observed incidental take of two leatherback turtles by the current fishery Between April 2001 and July 2002. One of these turtles was hooked externally and one was entangled. Both of the leatherback turtles were released injured.

Table IV-11. Leatherback turtles observed captured by the Hawaii-based longline fishery 4/2001 - 7/2002.

Year/Fate	Condition	2001	2002	Total
Alive (Okay)	Entangled	0	0	0
Injured	Entangled	0	1	1
	Hooked, External	0	1	1
	Hooked, Internal	0	0	0
Dead	Hooked, External	0	0	0
	Hooked, Internal	0	0	0

Based on observations of leatherback turtles taken by the Hawaii-based longline fishery, leatherback turtles primarily appear to be hooked externally or entangled, rather than ingesting the hook (only three leatherback turtles of 54 observed taken were hooked internally, or 5.5%) . This is probably due to their foraging strategy as well as their physiology. Whereas some hard-shelled turtle species (e.g. loggerheads) are piscivores and will forage on the bait used on longlines and therefore become hooked internally, leatherbacks tend to target cnidarians (e.g. medusae and siphonophores), so they may have been attracted to the lightsticks once used on the longlines (but now prohibited) at night to attract squid and subsequently were hooked externally or entangled. Turtles could be captured while feeding or swimming at the surface when the longline is being set or hauled back, or when the longline is fishing at depth.

Leatherbacks appear to be very susceptible to entanglement in fishing gear. Of 11 sea turtles examined port-mortem after being captured by Hawaii-based longline fishers, the only two turtles with leaders around their body parts were leatherback turtles (Work 2000). This susceptibility is probably the result of long pectoral flippers and active swimming behavior that are probably risk factors for entanglement in fishing gear and ocean debris. Leatherback turtles appear to rest for a very small percentage of their daily activity (0-7%, S. Eckert, manuscript in prep. May, 2000). Leatherback hatchlings studied in captivity for almost 2 years swam persistently without ever recognizing the tank sides as a barrier (Deraniyagala, 1939, *in* Wyneken, 1997). As a result, leatherback turtles that become entangled with longlines will probably continue trying to swim (Rudloe, 1979, *in* Witzell, 1984), expending energy and oxygen while becoming more entangled in the process.

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

From observer data, and using a model-based predictor, McCracken (2000) estimated that between 88 and 132 leatherback turtles (average 112) were captured each year, during the period 1994-1999, by the Hawaii-based longline fishery, and of these, an average of 9 died (Table IV-12).

Table IV-12. Estimated numbers of leatherback turtle captured and killed in the longline fisheries (1994-1999) with 95% prediction intervals (PI).

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

Source: McCracken, 2000 and McCracken, personal communication, March 2001

Recently, NMFS-Honolulu Laboratory (2002b) estimated the incidental take of leatherback turtles under the current fishery (July 2001 through June 2002 data; Table IV-13). Comparisons between these estimates and the estimates in Table IV-12 indicate a reduction in the interaction rates between leatherback turtles and the Hawaii-based longline fishery since the current regime took effect.

Table IV-13. Estimates of the incidental capture (hooking and entanglement) of leatherback turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002.

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

Analysis by Kobayashi (2002) estimated that the change in the fishery to the current regime would reduce leatherback turtle take by 90% (95% CI: 83 - 98%), but actual reductions based on July 2001 through June 2002 data were higher than expected (96%).

c. Loggerhead turtles

Loggerhead turtles have been the species most often captured by the Hawaii-based longline fishery. From 1994 through March 2001, observers recorded the incidental take of 175 loggerheads. Of these, 3 were released alive and uninjured (1.7%), 166 were injured by hooking (94.8%) (65 hooked externally, 101 hooked internally), and 4 died as a result of the interaction (3%) (1 hooked internally and 3 hooked in an unknown location). For one loggerhead interaction, there is no information on its condition (Table IV-14). From life history data collected by observers, it appears that the Hawaii-based longline fishery primarily interacts with juvenile loggerheads. Straight carapace lengths (SCL) ranged from 38.4 cm to 90 cm (average 56.9 cm), however, approximately 75% of the captured loggerheads were less than 65 cm SCL (G. Balazs, NMFS, personal communication, January, 2001).

Table IV-14. Loggerheads observed captured in the Hawaii-based longline fisheries from 1994-3/2001.

Year/Fate	Condition	1994	1995	1996	1997	1998	1999	2000	2001	Total
Alive (Okay)	Entangled	1	1	0	1	0	0	0	0	3
Injured	Entangled	0	0	0	0	0	0	1	0	1
	Hooked, External	4	8	10	6	22	6	8	1	65
	Hooked, Internal	6	10	14	15	25	13	13	5	101
Dead	Hooked, Internal	0	0	0	0	1	0	0	0	1
	Hooked, Unknown	0	0	2	0	0	1	0	0	3
No Record		0	0	1	0	0	0	0	0	1

Table IV-15 shows the observed incidental take of four loggerhead turtles by the current fishery between April 2001 and July 2002. These turtles were hooked either externally (1) or internally (2), or entangled and released alive and uninjured (1). Two of the loggerhead turtles were released injured and one turtle, hooked internally, was released dead.

Table IV-15. Loggerhead turtles observed captured by the current Hawaii-based longline fishery 4/2001 - 7/2002.

Year/Fate	Condition	2001	2002	Total
Alive (Okay)	Entangled	0	1	1
Injured	Hooked, External	0	1	1
	Hooked, Internal	0	1	1
Dead	Hooked, External	0	0	0
	Hooked, Internal	0	1	1

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

Using mortality and take estimates described above, McCracken (2000) estimated the take and kill of loggerheads per year, as shown in Table IV-16. Of 2,505 loggerheads estimated taken by the fishery from 1994-1999, 438 were estimated killed (given a 17.5 % mortality rate).

Table IV-16. Estimates of the number of loggerhead turtles captured and killed in the longline fisheries, with 95% prediction intervals (PI).

Year		1994	1995	1996	1997	1998	1999	Annual Avg
Takes	Estimate	501	412	445	371	407	369	418
	95% PI	[315-669]	[244-543]	[290-594]	[236-482]	[259-527]	[234-466]	[273-527]
Kills	Estimate	88	72	78	65	71	64	73
	95% PI	[36-141]	[31-115]	[34-127]	[28-102]	[32-112]	[28-102]	

Source: McCracken, 2000 and McCracken, personal communication, March 2001

Recently, NMFS-Honolulu Laboratory (2002b) estimated the incidental take of loggerhead turtles under the current fishery (July 2001 through June 2002 data; Table IV-17). Comparisons between these estimates and the estimates in Table IV-16 indicate a substantial reduction in the interaction rates between loggerhead turtles and the Hawaii-based longline fishery since the current regime took effect. During February 2002, (after the fishery was modified to eliminate the targeted swordfish fishery and the shallow sets associated with it), three loggerhead turtles were captured in the fishery. Two of those three turtles were captured on sets that are believed to have been illegally using shallow-set methods to target swordfish. As a result, the numbers presented below may overestimate the past incidental take of loggerheads under the current fishery, indicating that loggerhead interaction rates have significantly decreased.

Table IV-17. Estimates of the incidental capture (hooking and entanglement) of loggerhead turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002.

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

Analysis by Kobayashi (2002) estimated that the change in the fishery to the current regime would reduce loggerhead turtle take by 99% (95% CI: 83 -100%); actual reductions based on July 2001 through June 2002 data were 98%.

d. Olive ridley turtles

As shown in Table IV-18, from 1994 through March 2001, observers recorded the incidental take of 50 olive ridleys by the Hawaii-based longline fishery. Of these, 38 were injured (76% – all hooking incidents, 15 hooked externally and 23 hooked internally) and 12 died as a result of the interaction (24% - comprised of 9 that were hooked externally, and 3 that were hooked internally). Based on life history data collected by observers, it appears that the fishery is interacting with both subadult and adult life stages of olive ridleys. For those olive ridleys brought on board and measured (n=29), straight carapace length ranged from 44.5 cm to 66.5 cm (average 55.43 cm).

None of the olive ridleys observed taken by the fishery were entangled, all were hooked; therefore, it is likely that the olive ridleys may have been attracted to the baited hook or to the lightsticks, which may be confused for pyrosomas by the turtle. While the habitat of juvenile olive ridleys is not well-known, adults use a wide range of foraging habitats, feeding pelagically in deep water as well as in shallow benthic waters. They feed on a wide variety of items, ranging from jellyfish, to crabs, molluscs and algae (*in* NMFS and USFWS, 1998d). Stomach contents of 7 olive ridleys captured by the fishery were found to contain salps, cowfish and pyrosomas. One animal had seabird feathers and pelagic snails, while another had large amounts of plastic, fishing line and cellophane. Four of the olive ridleys examined had bait in their esophagus. One of these four turtles was found with three fish used as longline bait, indicating that it had ingested bait from more than one hook (Work and Balazs, draft manuscript, January, 2001).

Table IV-18. Olive ridleys observed captured by the Hawaii-based longline fishery from 1994-3/2001.

Year/Fate	Condition	1994	1995	1996	1997	1998	1999	2000	2001	Total
Injured	Hooked, External	2	2	2	1	1	2	3	3	16
	Hooked, Internal	1	1	6	2	1	5	4	3	23
Dead	Hooked, External	0	0	1	0	2	1	2	4	10
	Hooked, Internal	0	1	0	0	1	0	1	0	3

Table IV-19 shows the observed incidental take of nine olive ridley turtles by the current fishery between April 2001 and July 2002. These turtles were hooked either externally (8) or internally (1). Eight of these turtles were released dead and one was released injured.

Table IV-19. Olive ridley turtles captured by the current Hawaii-based longline fishery between 4/2001 and 7/2002.

Year/Fate	Condition	2001	2002	Total
Alive (Okay)	Entangled	0	0	0
Injured	Hooked, External	1	0	1
	Hooked, Internal	0	0	0
Dead	Hooked, External	1	6	7
	Hooked, Internal	0	1	1

Based on observer data, olive ridleys had the highest mortality rate of all sea turtles captured in the Hawaii-based longline fisheries, probably because more olive ridleys were captured and killed in deep sets than any other species of sea turtle. As shown in Table IV-20, of 878 olive ridleys estimated to have been captured in the fisheries from 1994-1999, an estimated 292 died (assuming a 33.25% mortality rate). Although pathological lesions were noted in 5 olive ridleys necropsied after being taken and killed by the fishery, these were considered mild and incidental (i.e. the turtles were probably not predisposed to being taken as a result of the lesions) (Work, 2000). Therefore, the turtles that died as a result of the interaction probably drowned, suffocated, or died from injuries they suffered as a result of their being hooked. Of the 6 olive ridley turtles captured in deep sets, 5 died, probably because the turtles were unable to surface, because of the deep sets, and drowned.

Table IV-20. Estimates of the number of olive ridley turtles captured and killed in the longline fisheries with 95% prediction intervals (PI)

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

Source: McCracken, 2000 and McCracken, personal communication, March 2001

Recently, NMFS-Honolulu Laboratory (2002b) estimated the incidental take of olive ridley turtles under the current fishery (July 2001 through June 2002 data; Table IV-21). Comparisons between these estimates and the estimates in Table IV-20 indicate a reduction in the interaction rates between olive ridley turtles and the Hawaii-based longline fishery since the current regime took effect.

Table IV-21. Estimates of the incidental capture (hooking and entanglement) of olive ridley turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002.

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

Analysis by Kobayashi (2002) estimated that the change in the fishery to the current regime would reduce olive ridley turtle take by 56% (95% CI: 33-77%), but actual reductions based on July 2001 through June 2002 data were higher than expected (72%).

D. Future Effects of Pelagics FMP Fisheries on Sea Turtles

Under the proposed action, NMFS expects that fishing effort in all fisheries under the Pelagics FMP will continue as it has in previous years, including limitations placed on the number and size of vessels in the Hawaii-based and American Samoa longline fisheries. NMFS also anticipates that, due to the lack of measures to avoid or reduce the amount of bycatch and mortal bycatch of listed species, these interactions will continue with the same frequency and effect as they have in the past. In the case of the Hawaii-based longline fishery, this would be the pattern of interactions since the first implementation of the current fishery by emergency (and now, final) regulations.

1. Handline, Troll, and Pole and Line Fisheries

There have been no reported interactions with sea turtles in the fisheries of the Pelagics FMP other than the Hawaii-based longline fishery, the American Samoa-based longline fishery, and the central and western Pacific U.S. purse-seine fishery (discussed below). There is a chance, based on fishing methods including bait used and gear-type, that these other fisheries do interact with sea turtles although the information is not reported. Due to low effort and target-species selectivity of the gear, incidental take and mortality in these fisheries is likely minimal and has an insignificant effect on the survival and recovery of sea turtle populations.

2. Longline Fisheries

a. American Samoa-based longline fishery

Because NMFS does not have an observer program in place for the American-Samoa-based longline fishery, the only information available is from fisher logbooks. Based on logbooks from 1992 through 2001, it is apparent that this fishery takes sea turtles, but NMFS cannot quantitatively estimate the amount or extent of take of sea turtles by this fishery. In addition, all species of listed sea turtles considered in this Opinion occur within the fishing grounds of this fishery and therefore, all of these species may be taken. Effort has greatly increased in this fishery in the last few years, but if a limited entry program is established as proposed in FMP Amendment 11, effort is unlikely to substantially increase in the future. Increases in effort are likely to result in increased levels of incidental take of sea turtles; however since NMFS has no estimates of the amount of take in recent years, it is difficult to estimate take levels in the future. Required handling and resuscitation techniques and the use of line clippers to remove gear from captured sea turtles should reduce the severity of interactions that may occur.

b. Hawaii-based longline fishery

Based on past observer data and logbook data on the effort and distribution of the Hawaii-based longline fishery, NMFS has calculated the expected annual impact of the continued operation of this fishery (see Table IV-22 below). Uncertainty in these impact estimates as a result of differences in the handling of captured turtles or the small sample sizes upon which these mortality rates are drawn should be noted when drawing conclusions about the magnitude of the impacts of delayed mortality on sea turtle populations.

NMFS calculated expected annual mortality in Table IV-22 by applying the estimated mortality rates (described in NMFS (2001b) and presented in Table IV-5) to the observed and extrapolated information on turtles that were externally hooked, deeply hooked, or retrieved dead based on data from July 1, 2001 through June 30, 2002.

Table IV-22. Rough estimates of annual capture and mortality for sea turtles taken in the Hawaii-based longline fishery, based on past interactions between July 1, 2001 and June 30, 2002. (Source: NMFS-Honolulu Laboratory 2002b)

Species	Incidental Take	Incidental Mortality[1]
Green	8	7
Leatherback	8	3
Loggerhead	14	8
Olive Ridley	26	24

[1] The estimated incidental mortality is a subset of the estimated incidental take by hooking or entanglement.

These numbers provide a rough estimate of the numbers of turtles that may be taken by the Hawaii-based longline fishery during any given year depending on effort and natural variation in ocean conditions and turtle abundance and use of the action area. As mentioned above, these numbers do not include uncertainty associated with small sample size in the scientific studies or differences in handling of captured turtles between scientific studies and fishing operations. In addition, these numbers are based on the effort in the fishery between July 2001 and June 2002. During that year, the number of vessels participating in the fishery has decreased, trips in the shallow-set fishery have been eliminated, and the number of trips in the deep set segment has increased. NMFS' analysis of the future effects of the Hawaii-based longline component of the fisheries operating under the Pelagics FMP will use these estimates when assessing annual and aggregate effects on the species (see section V. *Species' Response to the Action* below.).

V. SPECIES' RESPONSE TO THE ACTION

The *Approach to the Assessment* section of this Opinion stated that we approach jeopardy analyses in a series of steps. First, we identify the probable direct and indirect effects of an action on the physical, chemical, and biotic environment of the action area. Next, we analyze the available information to determine if we would reasonably expect threatened or endangered species to experience reductions in reproduction, numbers, or distribution in response to these effects (since the proposed fisheries are not likely to adversely affect designated critical habitat, this Opinion did not conduct "destruction and adverse modification analyses). In the final step of our analyses, we determine if any reductions in a species' reproduction, numbers, or distribution (identified in the second step of our analysis) can be expected to appreciably reduce a listed species' likelihood of surviving and recovering in the wild.

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 fisheries associated with the Pelagics FMP 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.

For the purposes of this analysis, we will assume that anything that places sea turtle populations in the Pacific Ocean at greater risk of extinction, also places the entire species at a greater risk of extinction; or, in other words, reduces the species' likelihood of survival and recovery. This assumption 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.

A. Humpback Whale

Based on the available information on interactions between humpback whales and the longline fisheries, humpback whales have been entangled in longline fishing gear. However, based on the information available on these previous interactions, the interactions appear to be rare occurrences and, when they have occurred, the humpback whales do not appear to have been injured or killed by the interaction. Because the Western Pacific Pelagic Fisheries have a small probability of interacting with endangered humpback whales and, when they occur, they do not appear to kill or injure the whales, those interactions are not likely to reduce the reproduction, numbers, or distribution of humpback whales. As a result, they are not likely to reduce the humpback whales' likelihood of surviving and recovering in the wild.

B. Hawaiian Monk Seal

Based on unconfirmed logbook data, monk seals may become entangled or hooked in longline fishing gear. However, no interactions between monk seals and the fisheries have been observed (by personnel in NMFS' Observer Program), which we interpret to indicate that the likelihood of interactions between the fisheries and monk seals is small. Further, the single report of an interaction indicated that the seal was entangled in a shallow set which are now prohibited under the Pelagics FMP. Based on these data, NMFS does not anticipate future interactions between monk seals and longline gear.

As a result, the Western Pacific Pelagic Fisheries are not likely to reduce the reproduction, numbers, or distribution of monk seals. As a result, they are not likely to reduce the monk seals' likelihood of surviving and recovering in the wild.

C. Sperm Whale

Based on the available information on interactions between sperm whales and the longline fisheries, sperm whales have been entangled in longline fishing gear. However, based on the information available on these previous interactions, the interactions appear to be rare occurrences and, when they have occurred, the sperm whales did not appear to have been injured or killed by the interaction. Because the Western Pacific Pelagic Fisheries have a small probability of interacting with endangered sperm whales and, when they occur, they do not appear to kill or injure the whales, those interactions are not likely to reduce the reproduction, numbers, or distribution of sperm whales. As a result, they are not likely to reduce the sperm whales' likelihood of surviving and recovering in the wild.

D. Green Turtles

The current fishery is expected to interact with about 8 green turtles each year (95% confidence interval = 2 - 21[42]). Because of their tendency to make relatively shallow dives, sub-adult green turtles have been more likely to encounter shallow-set longlines than deep-set longlines (which are often set below 100 meters). Similarly the routine dives of post-hatchling and juvenile green turtles made them more vulnerable to capture by either shallow-set longline gear or deep-set gear that is being set or retrieved. The only mortalities (n=5, 3 under the prior fishery and 2 under the current fishery) observed were on deep sets; we assume that these turtles drowned. In the past, shallow set gear had a higher interaction rate with green turtles (0.0044 green turtles per set) and subsequent injuries and deaths of green turtles than deep set gear (0.0014 turtles per set); now that shallow set gear has been eliminated, we expect this interaction rate to decrease (0.00057 turtles per set).

Green turtles encountered by U.S. vessels fishing managed under the Pelagics FMP may originate from a number of known breeding colonies in the Pacific Ocean. Genetic sampling of green turtles taken by the Hawaii-based longline fishery on observed trips indicates that green turtles in the action area represent turtles from nesting beaches in Hawaii (French Frigate Shoals) and the eastern Pacific (both Revillagigedos and Michoacan in Mexico and the Galapagos Islands). If the Hawaii- based longline fishery affects green turtle populations proportional to their relative abundance in the action area, about half of the green turtles that interact with the fisheries would come from the endangered eastern Pacific subpopulation, another 35 percent of the affected turtles would represent either the endangered eastern Pacific subpopulation or the Hawaiian subpopulation of threatened green turtles, and the remaining 14 percent would represent the Hawaiian subpopulation of threatened green turtles. Using this assumption, we would expect the pelagic fisheries to interact with about 4 to 7 adult or sub-adult green turtles from the endangered eastern Pacific population and between 1 and 4 adult or sub- adult green turtles from the Hawaiian subpopulation of threatened green turtles each year.

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 seemed to result from their diet: because green turtles primarily feed on benthic, marine algae, they seemed less likely to be attracted to the baited hooks used in the longline fishery. As a result they were 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 turtles were more likely to interact with shallow-set gear than deep-set gear.

Nevertheless, based on past patterns of the condition of green turtles that have been observed in the fishery and expected mortality rates for turtles given their condition when they were observed, about 7 adult or sub-adult green turtles would be expected to die each year as a result of their interactions with the current fisheries. Killing about 7 adult or sub-adult green turtles each year

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[42] In the past, these confidence intervals have been based on statistical analyses of data derived from observer reports and logbooks over time. Because the fishery, as currently configured, has only been operating for a single year, this confidence interval had to be generated through bootstrap methods. As we collect additional data on interactions between this fishery and sea turtles over time, these confidence intervals will reflect patterns contained in the data.

would reduce the numbers of individuals in the species, particularly since population estimates for this species are based on estimated numbers of adult turtles. Assuming that some of these turtles would be female, we would also conclude that these deaths would reduce the species' reproduction in addition to reducing their numbers. Assuming that turtles that interact with the fishery are proportional to their relative abundance in the action area, the endangered eastern Pacific population of green turtles would experience the larger reduction in reproduction and numbers.

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 having increased extinction risk. 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), Heppell (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. This conclusion is based on the number of green 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. We will discuss the status and trend of the two aggregations separately, then summarize our conclusions for both.

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. On Colola, an estimated 500-1,000 females nested nightly in the late 1960s. In the 1990s, that number dropped to 60-100 per night, or about 800-1,000 turtles per year (Eckert, 1993). During the 1998-99 season, based on a comparison of nest counts and egg collection data, an estimated 600 green turtles nested at Colola.

In 1990, the 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 - only residents are allowed to harvest turtles for subsistence, and egg poaching occurs only occasionally. An annual average of 1,400 nesting females was estimated for the period 1976- 1982 in the Galapagos Islands (NMFS and USFWS, 1998a). More current estimates of the status and trend of this population are not available.

The additional loss of between 4 and 7 adult or sub-adult, green turtles from this subpopulation each year would reduce the number of animals in the subpopulation. If we assume that some 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.

Hawaiian Green Turtle Population. The green turtles in Hawaii are genetically-distinct and geographically isolated from other green turtle populations; therefore, we treat them as a discrete subpopulation. 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 small size and geographic isolation of this population makes it vulnerable to changes caused by reduced birth rates, increased death rates, or both. 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 the green turtles in Hawaii were first protected in the early 1970s, ending years of exploitation, the nesting population of green turtles in Hawaii has shown a definite increase (Balazs, 1996). For example, the number of green turtles nesting at an index study site at East Island has tripled since systematic monitoring began in 1973 (NMFS and USFWS, 1998a).

Killing 1 to 4 of these green turtles each year 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, then the fishery would also reduce the reproduction of this nesting aggregation.

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 some of the adult turtles that are killed in interactions with the Hawaii-based longline fisheries are females, then 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 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 Western Pacific Pelagic Fisheries 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, as discussed in the introduction to the *Effects of the Action* section, 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.

In the past, we have concluded that the additional mortalities caused by the Hawaii-based longline fishery appreciably contributed to the green turtle's risk of extinction. In the past, the Hawaii-based longline fishery interacted with an average of 40 green turtles each year; we estimated that as many as 23 of these turtles died as a result of these interactions (McCracken, 2000). Most of those interactions and deaths were associated with the shallow-set component of the Hawaii-based fishery, so we now assume the primary threat to green turtles was eliminated with the shallow-set component of the fishery.[43]

Nevertheless, we estimate that killing about 4 to 7 adult or sub-adult female green turtles from the eastern Pacific nesting aggregations and 1 to 4 from the Hawaiian nesting aggregations could still be killed in the remaining fishery. Killing this number of green turtles would represent a small, proportional change in the survival rates of female turtles in those life history stages. However, based on our analyses (see Box 1), although we might be able to detect a small effect of these additional deaths on the annual survival rate of adult or sub-adult turtles in these nesting aggregations, which we would be offset by the number of younger turtles recruiting into the adult of sub-adult population (that is, the number of younger sea turtles maturing into the adult or sub-adult life stages would exceed the number of adult or sub-adult turtles that would be killed during interactions with the fisheries, particularly in the Hawaii subpopulation of green turtles, which has been increasing slightly). As a result, we would not expect the additional mortalities associated with these fisheries to appreciably reduce the either subpopulation's likelihood surviving and recovering in the wild (or, conversely, increase the subpopulations' likelihood of becoming extinct in the wild).

We only have one year of monitoring data from the current fishery; with time, we may discover that the number and rate of interactions and mortalities associated with the fishery as it is currently configured is higher or lower than the data that are currently available would suggest (in the former instance, we would probably reinitiate formal consultation on the fisheries). However, based on the data available for this consultation, we conclude that the change in the survival rates of adult and sub-adult caused by the current fisheries would not be expected to *appreciably* reduce the western Pacific nesting aggregations' likelihood of surviving and recovering in the wild, As a result, it would not reduce appreciably the species' likelihood of surviving as recovering in the wild.

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[43] 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 result, our analyses group the endangered populations and the threatened populations and treat them both as endangered to make certain that we afford the endangered turtles the additional protection warranted by their classification.

Box 1. We explored several population models to determine whether the 7 or so green turtles the are estimated to be killed in interactions with the proposed fisheries would be expected to "appreciably reduce" the green turtle's likelihood of surviving and recovering in the wild (it is important to note that these simulations were not formal analyses of a population's viability, they focused only on the issue of "appreciable reductions" in a species' likelihood of surviving and recovering in the wild). Our final analyses relied on a deterministic model of a population's probability of reaching a quasi-extinction threshold (n = 200) at any time over a 50-year period using the following equation to integrate the Gaussian distribution from t = 0 to t = 50 to produce a cumulative distribution for time to quasi-extinction (see equation 3.5 of Morris, W.F. and D.F. Doak. 2002. Quantitative conservation biology. Theory and practice of population viability analysis. Sinauer Associates, Inc.; Sunderland, Massachusetts). The equation is represented as:

$$G(T|d,\mu,\sigma^2) = \varphi\left(\frac{-d-\mu T}{\sqrt{\sigma^2 T}}\right) + \exp\left(-2\mu d/\sigma^2\right)\varphi\left(\frac{-d+\mu T}{\sqrt{\sigma^2 T}}\right)$$

Where $G(T|d, \mu, \sigma^2)$ = the cumulative probability of reaching the quasi-extinction threshold at time T.
ϕ = is the standard normal cumulative distribution function (produced by the NORMDIST function in Excel)
d = log N_c - Log N_x or the difference between the log of the current population size (N_c) and the log of the quasi-extinction threshold (N_x)
μ = the mean of the log population growth rate
σ^2 = the variance of the log population growth rate

To simulate the possible response of the various turtle populations, we created a "population" of about 700 and 1,000 individuals (counting only adult females) with specific mean and variances and projected the population for 50 years. The we reduced the populations by 3 to 7 individuals each year, re-ran the simulations for 50 years and compared the changes using paired Student's t-tests.

E. Hawksbill Sea Turtle

Hawksbill turtles occur in the water around the Hawaiian Islands (on Molokai, Maui and 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 an unconfirmed logbook report of an interaction between a hawksbill turtle and longline gear in American Samoa, there is a possibility of hawksbill turtles becoming incidentally entangled or hooked in longline fishing gear. However, no hawksbill turtles have been observed to interact with the longline fisheries, which indicates that the likelihood of an interaction is small. Moreover, the single report in vessel logbooks of an interaction indicated that the animal was taken in a shallow set and shallow sets are now prohibited under the Pelagics FMP. Based on the available data and the distribution of hawksbill turtles relative to the distribution of the pelagic fisheries, NMFS does not anticipate future interactions between hawksbill turtles and longline gear. Consequently, the Western Pacific Pelagic Fisheries are not likely to reduce the reproduction, numbers, or distribution of hawksbill turtles. As a result, they are not likely to reduce the turtles' likelihood of surviving and recovering in the wild.

F. Leatherback Turtles

The current fishery is expected to interact with about 8 leatherback turtles each year (95% confidence interval = 2 - 23). Most leatherback turtles will hooked externally rather than internally, although leatherback turtles also appear to be susceptible to entanglement in fishing gear. Virtually all of the leatherback turtles that would interact with the longline component of the Western Pacific Pelagic Fisheries (the number of leatherback turtles adversely affected by other fisheries included in this FMP is expected to be small). Based on the size of the leatherback turtles caught in the fishery in the past, we expect the fishery to capture either sub-adult or adult leatherback turtles.

Based on genetic analyses, most of the leatherback turtles captured in the Hawaii-based longline fishery are from two nesting aggregations: the western Pacific region (Indonesia, Papua New Guinea, and Solomon Islands), and the eastern Pacific region (Mexico and Costa Rica). The limited genetic sampling from the area indicates that about 94% of the leatherback turtles sampled in the action area originated from western Pacific nesting beaches (P. Dutton *et al.*, 2000; P. Dutton, NMFS, personal communication, January, 2001). If the current longline fisheries affect leatherback turtle populations proportional to their relative abundance in the action area, about 94 percent of the leatherback turtles that interact with the longline fisheries would come from the western Pacific populations. The remaining 6 percent would represent the eastern Pacific population. Assuming proportionality, almost all of the leatherback turtles that interact with the fishery would originate in the western Pacific population, although leatherback turtles from the eastern Pacific have a small, but distinct risk of interacting with the fishery as well.

Based on past patterns of the condition of sea turtles that have been observed in the fishery and expected mortality rates for turtles given their condition when they were observed, about 3 of the 8 leatherback turtles can be expected to die each year as a result of their interactions with the fisheries. Killing about 3 adult or sub-adult leatherback turtles each year would reduce the numbers of individuals in the species, particularly since population estimates for this species are based on estimated numbers of adult, female turtles. Assuming that some of the leatherback turtles captured and killed in the fishery would be females, we would also conclude that these deaths would reduce the species' reproduction in addition to reducing their numbers.

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 had 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 colonies 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 III,. *Status of the Species and Environmental Baseline*).

Leatherback turtles, like green turtles discussed previously, are long-lived, have high adult survival rates, and delayed maturity; 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, 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 3 adult or sub-adult leatherback turtles) would 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, and the Solomon Islands. 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 Terengganu - 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). The size of the current nesting assemblage represents less than 2 percent of the size of the assemblage reported from the 1950s; with one or two females nesting in this area each year (P. Dutton, personal communication, 2000). 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, Australia, and Papua-New Guinea (East Papua), leatherback turtles have only been known to nest in low densities and scattered colonies.

Only an Indonesian nesting assemblage has remained relatively abundant in the Pacific basin. The largest, extant leatherback nesting assemblage in the Indo-Pacific lies on the north coast of Irian Jaya (West Papua), Indonesia. The western Pacific nesting aggregation consists of about 1,000 adult females (about 500 in Indonesia, about 150 in the Solomon Islands, and about 400 in Papua New Guinea). Killing three of these adult leatherback turtles each year would reduce the abundance of this nesting aggregation. If we assume that all of the adult turtles that are killed in interactions with the Hawaii-based longline fisheries are females (an incorrect assumption since at least some of the turtles captured in the fishery have been male), then the fishery would also 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.

In the eastern Pacific Ocean, nesting populations of leatherback turtles 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 colony 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.

Given the population ecology of sea turtles in general, and leatherback turtles in particular, these mortalities would be expected to have significant, adverse effects on the population ecology of leatherback turtles in the western Pacific Ocean. Although the additional mortalities associated with Western Pacific Pelagic Fisheries would clearly reduce the numbers and may reduce the reproduction of the western Pacific subpopulation of leatherback sea turtles, the "jeopardy" standard requires us to consider those effects on a species' survival and recovery in the wild. Specifically, as discussed in the introduction to the *Effects of the Action* section, 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 green turtle narrative, 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.

In the past, NMFS has concluded that the additional mortalities caused by the Hawaii-based longline fisheries and other domestic fisheries appreciably contributed to the leatherback turtles risk of extinction. Although the number of leatherback turtles killed in these fisheries were relatively small, the status of leatherback turtles in the Pacific Ocean and prior experience with other threatened and endangered species suggested that the population could not withstand the additional threat these fisheries posed to the survival and recovery of leatherback turtles. 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*). Fujiwara and Caswell (2001) demonstrated that preventing the death of one or two female northern right whales per year could increase that population's growth rate to replacement levels. More recently, reports from the U.S. Pacific Northwest and British Columbia suggest small, incremental losses of northern spotted owls may have caused the owl to decline by as much as half in portions of its range (Dawdy 2002).

We distinguish the threat posed by the Western Pacific Pelagic Fisheries from those other circumstances primarily because these fisheries have been modified in ways that virtually eliminate the risk they pose to leatherback turtles. In the past, the U.S. Pacific pelagic fisheries interacted with an average of 112 (95% confidence interval 75-157) leatherback turtles and caused the death of between 24 to 49 of these turtles each year. The remaining mortality of about 3 adult or sub-adult leatherback turtles from the western Pacific nesting aggregations would represent a small proportional change in the survival rates of female turtles in those life history stages (0.003 percent). However, based on our analyses (see Box 1), although this might represent a reduction in the survival rate of a particular group of turtles in this subpopulation, we would not expect that reduced survival rate to represent an appreciable reduction in the subpopulation's likelihood of persisting in the wild (or an increase in the subpopulation's likelihood of becoming extinct in the wild).

Only a few published studies either calculated or reported the variance in vital rates (or lambda), so our ability to place this amount of change into perspective. 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, we would not be able to detect the effect of the remaining mortalities associated with the current fisheries on the survival rates of adult and sub-adult leatherback turtles in the western Pacific (assuming that we had the data necessary to reliably estimate survival rates). We believe the number of leatherback turtles that would be expected to interact with the current pelagic fisheries and die as a result of those interactions is so small that it would be masked by background variance, even considering the effects of the other sources of mortality that were discussed in the *Environmental Baseline.*

We only have one year of monitoring data from the current fishery; with time, we may discover that the number and rate of interactions and mortalities associated with the fishery as it is currently configured is higher or lower than the data that are currently available would suggest (in the former circumstance, we would probably reinitiate formal consultation on the fisheries). However, based on the data available for this consultation, we conclude that the change in the survival rates of adult and sub-adult caused by the current fisheries would not be expected to *appreciably* reduce the likelihood of surviving and recovering in the wild of the Pacific Ocean populations of leatherback turtles. As a result, it would not reduce the species' likelihood of surviving as recovering in the wild.

G. Loggerhead Turtles

The current fishery is expected to interact with about 14 loggerhead turtles each year (95% confidence interval = 3 - 26), although interactions are more likely north of 22°N latitude (12 interactions, with a 95% confidence interval = 3 - 29) than south of 22°N (2 interactions, with a

95% confidence interval = 0 - 8). Degree of latitude appeared to be a primary determinant of the probability of loggerhead captures in the fisheries. For example, McCracken (2000) reported that, none of 1,263 sets that were observed south of 22%N captured loggerhead turtles. Kleiber (1998) also found latitude to be the primary determinant of interactions between the fisheries and loggerhead turtles. However, after March 2001, the current fishery caught two loggerhead turtles, including one turtle far south of the area in which loggerhead turtles were typically seen (13°N latitude).

Based on genetic analyses, all of the loggerhead turtles captured in the Hawaii-based longline fishery originate from Japanese nesting aggregations (Dutton *et al.*, 1998, P. Dutton, NMFS, personal communication, October, 2002). Available data on the length of these turtles, supported by information on their foraging and migrating patterns, indicates that the fishery captures pelagic-stage juvenile loggerhead turtles.

Historically, most of the loggerhead turtles that interact with the fishery were either hooked internally or externally. The tendency to be hooked internally probably resulted from their diet: Loggerhead turtles in north Pacific pelagic habitats are opportunistic, omnivorous predators of the surface layer, feeding both by swallowing floating prey whole, biting off prey items from larger floating objects, or both. Based on past patterns of the condition of sea turtles that have been observed in the fishery and expected mortality rates for turtles given their condition when they were observed, we have estimated that about 8 of the 14 loggerhead turtles would be expected to die each year as a result of their interactions with the fisheries.

However, it is important to place these numbers into perspective: between July 2001 and June 2002 (when the fishery was modified to eliminate the targeted swordfish fishery and the shallow sets associated with it), three loggerhead turtles were captured in the fishery, two of those three turtles were captured by vessels that are believed to have been illegally using shallow sets to target swordfish. All of the 175 loggerheads that interacted with the Hawaii-based longline fishery from 1994 through March, 2001, were captured by longliners using shallow sets (i.e. target depths less than 100 meters, using less than 10 hooks per float, fishing at night, using lightsticks). 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. Eliminating the targeted swordfish fishery is expected to virtually eliminate the likelihood of interactions between the current fishery and loggerhead turtles.

Placed in this perspective, the estimated number of interactions between the current fishery and loggerhead turtles was biased by vessels that were allegedly fishing illegally; the Council and NMFS have taken further action to reduce the likelihood of such illegal activity in the future. As a result, although we estimated that 14 loggerhead turtles would interaction with the fishery and 8 of those turtles would die as a result of their interaction, those estimates may overestimate the risk by more than 66%. In July 2002, a loggerhead turtle was caught in a deep set fishing at 13%N latitude, an interaction than diverged from NMFS' past observations of the overlap between this species' pelagic distribution and behavior and the deep-set portion of the longline fishery; this recent observation is evidence that the current fishery poses a risk to loggerhead turtles even if that risk is much smaller than our current estimates.

Killing between 3 and 8 pelagic juvenile loggerhead turtles each year would reduce the numbers of individuals in the species, particularly since population estimates for this species are based on estimated numbers of adult, female turtles. 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 (see Table 2 in Appendix C; 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 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 colonies throughout the Pacific basin has declined dramatically over the past 10 to 20 years. Loggerhead turtle colonies 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 Pelagic FMP fisheries added to the current status and trend of the Japanese loggerhead population would increase the Japanese loggerhead population's rate of decline.

Although the mortalities associated with the Western Pacific Pelagic Fisheries would clearly 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, as discussed in the introduction to the Effects of the Action section, 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.

In the past, we have concluded that the additional mortalities caused by the Hawaii-based longline fishery appreciably contributed to the green turtle's risk of extinction. In the past, the Hawaii-based longline fishery interacted with an average of 418 loggerhead turtles each year; we estimated that as many as 73 of these turtles died as a result of these interactions (McCracken 2000). Most of those interactions and deaths were associated with the shallow-set component of the Hawaii-based fishery, so we now assume the primary threat to loggerhead turtles was been eliminated with the elimination of the shallow-set component of the fishery. This change in the baseline conditions associated with this fishery should dramatically virtually eliminate the risk the fishery has historically posed to loggerhead turtles.

Nevertheless, we estimate that 3 and 8 pelagic juvenile loggerhead turtles from the Japanese nesting aggregation could still be killed in the remaining fishery. Killing this number of loggerhead turtles would represent a small proportional change in the survival rates of juvenile turtles in that life history stage. However, based on our analyses (see Box 1), although we might be able to detect a small effect of these additional deaths on the annual survival rate of adult or sub-adult turtles in these nesting aggregations, which we would be offset by the number of younger turtles recruiting into the adult of sub-adult population (that is, the number of younger sea turtles maturing into the adult or sub-adult life stages would exceed the number of adult or sub-adult turtles that would be killed during interactions with the fisheries). As a result, we would not expect the additional mortalities associated with these fisheries to appreciably reduce the either subpopulation's likelihood surviving and recovering in the wild (or, conversely, increase the subpopulations' likelihood of becoming extinct in the wild).

We only have one year of monitoring data from the current fishery; with time, we may discover that the number and rate of interactions and mortalities associated with the fishery as it is currently configured is higher or lower than the data that are currently available would suggest (in the former instance, we would probably reinitiate formal consultation on the fisheries). However, based on the data available for this consultation, we conclude that the change in the survival rates of adult and sub-adult caused by the current fisheries would not be expected to *appreciably* reduce the Japanese nesting aggregations' likelihood of surviving and recovering in the wild. As a result, it would not reduce the species' likelihood of surviving as recovering in the wild.

H. Olive Ridley Turtle

The U.S. pelagic fisheries in the western Pacific Ocean will capture, injure, or kill adult and sub-adult olive ridley sea turtles. Virtually all of the olive ridley turtles that would interact with these fisheries would be affected by the longline fisheries (the number of olive ridley turtles that would interact with other fisheries included in the Pelagics FMP are expected to be minimal – if any takes occur at all). Based on past patterns of olive ridley turtles captured in the Hawaii-based longline fishery, these turtles may interact throughout the year, with most of the interactions occurring during the warmer months (May-August); and concentrated in areas surrounding the Hawaiian Island chain.

The current fisheries are expected to annually and incidentally capture about 26 adult or sub- adult olive ridley turtles (95% confidence interval = 12 - 47). Most of these turtles will probably be hooked, rather than entangled, with slightly more of them being hooked internally; internal hooking is expected to kill more turtles than external hooking. Therefore, about 24 of the olive ridley turtles captured in this fishery would die each year as a result of the interaction. In the past, shallow set gear has had a higher interaction rate of captures (0.0144 olive ridley turtles per set) and subsequent injuries and deaths of olive ridley turtles than deep set gear (0.0042 turtles per set); with the reduction in shallow set gear under the current fisheries, we expect this interaction rate to decrease (0.002 turtles per set).

Recent genetic information analyzed from 39 olive ridleys taken in the Hawaii-based longline fishery indicate that 74 percent of the turtles originated from the eastern Pacific (Mexico and Costa Rica) and 26 percent of the turtles were from the Indian and western Pacific beaches (P. Dutton, NMFS, personal communication, October 2002), indicating the animals from both sides of the Pacific converge in the north Pacific pelagic environment and may be equally affected by the proposed action.

If the longline fisheries affect olive ridley turtle populations proportional to their relative abundance in the action area (as documented through observer data), about 74 percent of the olive ridley turtles that are captured, injured, or killed by the longline fisheries would come from eastern Pacific populations. The remaining 26 percent would represent western Pacific populations. Using this assumption, it is reasonable to expect about 18 sub-adult or adult olive ridley turtles from the eastern Pacific population and another 6 sub-adult or adult olive ridley turtles from the western Pacific population would be killed each year in the Hawaii-based longline fishery. Further, it would be reasonable to expect that more of these olive ridley turtles would be taken by the shallow set component of the fishery based on that component's higher interaction rates.

We believe it is reasonable to expect that killing about 24 adult or sub-adult olive ridley turtles each year would reduce the numbers of individuals in the species, particularly since population estimates for this species are based on estimated numbers of adult turtles. Assuming that some of these turtles would be female, we would also conclude that these deaths would reduce the species' reproduction in addition to reducing their numbers. Assuming that turtles captured and killed in the fishery are proportional to their relative abundance in the action area, the western Pacific population of olive ridley turtles would experience the larger reduction in reproduction and numbers.

We do not believe these mortalities will 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.*, in press).

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 Terengganu, Malaysia, and at one time yielded 240,000 eggs (2,400 nests, with approximately 100 eggs per nest) (Siow and Moll, 1982, *in* Eckert, 1993)), while only 187 nests were reported from the area in 1990 (Eckert, 1993).

In 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.

Given initial population sizes and increases in the Mexican and Costa Rican populations in recent year, the mortalities associated with the U.S. pelagics fisheries are not likely to halt or reverse the increasing trend of those populations. Removing adult or sub-adult turtles from the eastern Pacific population could slow the recovery of the population that is occurring, although it is not clear if that reduction would be measurable given the size of the nesting population.

Population trends in the western Pacific are more difficult to discern, although it is clear that there are still large populations of olive ridleys nesting in India. Killing adult and sub-adult turtles in the western Pacific population could have more serious consequences, since 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. By removing reproductive adults and pre-reproductive sub-adults from this declining population, the Hawaii- based longline fisheries could 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 recruiting into the adult population, we believe this population can withstand the mortalities and reduced reproductive rates associated with the current fisheries without appreciable reductions in the olive ridley turtle's likelihood of the surviving and recovering in the wild.[44]

VI. CUMULATIVE EFFECTS

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[44] 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. 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 result, our analyses group the endangered populations and the threatened populations and treat them both as endangered to make certain that we afford the endangered turtles the additional protection warranted by their classification.

Cumulative effects 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. 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.

Most of the fisheries described as occurring within the action area (Section III. *Status of the Species* and *Environmental Baseline*), are expected to continue as described into the foreseeable future. Therefore, NMFS is not aware of any proposed or anticipated changes in most of these fisheries that would substantially change the impacts each fishery has on the sea turtles covered by this Opinion.

In addition to fisheries, NMFS is not aware of any proposed or anticipated changes in other human-related actions (e.g. poaching, habitat degradation) or natural conditions (e.g. over-abundance of land or sea predators, changes in oceanic conditions, etc.) that would substantially change the impacts that each threat has on the sea turtles or marine mammals covered by this Opinion. Therefore, NMFS expects that the levels of take of sea turtles described for each of the fisheries, except the California longline fishery, and non-fisheries will continue at similar levels into the foreseeable future.

VII. CONCLUSION

After reviewing the available scientific and commercial data, current status of endangered and threatened green turtles, the environmental baseline for the action area, the effects of the current fisheries, the proposed Amendment 11, and the cumulative effects, it is NMFS' biological opinion that the continued authorization of pelagic fisheries in the Western Pacific Region under the Pelagics FMP is not likely to jeopardize the continued existence of green turtles.

After reviewing the available scientific and commercial data, current status of hawksbill turtles, the environmental baseline for the action area, the effects of the current fisheries, the proposed Amendment 11, and the cumulative effects, it is NMFS' biological opinion that the continued authorization of pelagic fisheries in the Western Pacific Region under the Pelagics FMP is not likely to jeopardize the continued existence of hawksbill 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 pelagic fisheries in the Western Pacific Region under the Pelagics FMP 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 pelagic fisheries in the Western Pacific Region under the Pelagics FMP 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 pelagic fisheries in the Western Pacific Region under the Pelagics FMP is not likely to jeopardize the continued existence of olive ridley turtles.

After reviewing the available scientific and commercial data, current status of endangered eastern Pacific 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 pelagic fisheries in the Western Pacific Region under the Pelagics FMP is not likely to jeopardize the continued existence of endangered eastern Pacific olive ridley turtles.

After reviewing the available scientific and commercial data, current status of humpback whales, 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 pelagic fisheries in the Western Pacific Region under the Pelagics FMP is not likely to jeopardize the continued existence of humpback whales.

After reviewing the available scientific and commercial data, current status of sperm whales, 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 pelagic fisheries in the Western Pacific Region under the Pelagics FMP is not likely to jeopardize the continued existence of sperm whales.

After reviewing the available scientific and commercial data, current status of Hawaiian monk seals, 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 pelagic fisheries in the Western Pacific Region under the Pelagics FMP is not likely to jeopardize the continued existence of Hawaiian monk seals.

IV. EFFECTS OF THE ACTION

Pursuant to Section 7(a)(2) of the ESA (16 U.S.C. §1536), federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. As described above, the ESA defines a "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 biological opinion assesses the effects of NMFS' Pelagics FMP, as amended, and the fisheries managed under that FMP on threatened and endangered species and critical habitat that has been designated for these species. The fisheries authorized under the Pelagics FMP are likely to adversely affect listed species through gear interactions, primarily entanglement and hooking, which may injure or kill individual animals. In the *Description of the Action* section of this Opinion, NMFS provided an overview of the fisheries, particularly the distribution and timing of fisheries that use gear that has been a problem for threatened and endangered species. In the *Status of the Species* (which is also the *Environmental Baseline*) section of this Opinion, NMFS provided an overview of the threatened and endangered species that are likely to be adversely affected by fisheries authorized under the Pelagics FMP.

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of federal actions to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR 402.02). Section 7 of the ESA and its implementing regulations also require biological opinions to determine if federal actions would appreciably diminish the value of critical habitat for the survival and recovery of listed species (16 U.S.C. §1536; 50 CFR 402.02). Since the proposed action is not likely to affect designated critical habitat, this Opinion will focus only on the jeopardy analysis.

NMFS generally approaches "jeopardy" analyses for fisheries in a series of steps. First, we evaluate the available evidence to identify the direct and indirect physical, chemical, and biotic effects of proposed actions on individual members of listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species - such as entanglements in fishing gear; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering its nesting substrate, or altering its ambient temperature regimes - or adding something novel to a species' environment - such as introducing exotic competitors or a sound). Once we have identified the effects of an action, we evaluate the available evidence to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). We then use the evidence available to determine if these reductions, if there are any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

A. Approach to the Assessment

We assessed the effects of the Western Pacific Pelagic Fisheries on threatened and endangered species using a general risk assessment model patterned after the U.S. Environmental Protection Agency's *Guidelines for Risk Assessment* (U.S. EPA 1998) and models toxicologists and epidemiologists use to assess risks posed by terrestrial, aquatic, and atmospheric pollutants (Kapustka *et al.* 1996, Landis *et al.* 1994, Landis *et al.* 1997, Lipton *et al.* 1993, McCarty and Power 1997, Newman *et al.* 2000, Norton *et al.* 1992, Taub 1997, U.S. EPA 1998, Wentsell 1994). We chose this assessment approach for several reasons: it is a peer-reviewed assessment framework that has been applied to a wide variety of assessment situations that include assessments of the effect of various human activities on threatened and endangered species, it is one of the best-documented assessment approaches available, it accommodates qualitative as well as quantitative information, and it is not defeated by uncertainty.

The first step of our assessment approach examined a species' likelihood of interacting with the Western Pacific Pelagic Fisheries (in this instance, a marine mammal or turtle would have "interacted" with the fishery if it was entangled or hooked by fishing gear using in the fisheries), which included an assessment of the number and kind of interaction (for example, whether a turtle ingested a hook or was hooked in a flipper), the life stage of the marine mammals or turtles involved in the interactions, the frequency of interactions, and the pattern of interactions over time and space. We combined information on the biogeography of the different turtles with the spatial and temporal interaction patterns to make inferences about which populations of marine mammals or subpopulations of sea turtles were probably affected by the fisheries (in this opinion, sea turtles in the Pacific are treated as separate "populations" from sea turtles in the Atlantic and Indian Oceans; a sea turtle population in the Pacific is represented by subpopulations that comprise one or more nesting aggregation).

Our second step was to assess the probable responses of marine mammals and sea turtles that interacted with the fisheries. For example, this step assessed a turtle's likelihood of being injured or killed during an interaction with gear used in the Western Pacific Pelagic Fisheries. In this step, we also estimate rates of post-hooking mortality. In 2001, NMFS recommended assuming a 27% mortality rate for sea turtles that are hooked externally or entangled and 42% for turtles that are hooked internally (that is, if the hook penetrates the turtle's mouth; see Appendix 4 of NMFS 2001 for a complete review and analysis of relevant research and recommendations). NMFS also recommended revising the scheme for classifying the injuries of, and assigning mortality rates to, sea turtles that have interacted with longline fishing gear. The new classification scheme is (1) non-serious injuries (2) minor or moderate injuries, and (3) serious injuries that may result in mortality or reduced ability to contribute to the population when released alive after the interaction.

The third step of our approach estimated the probable risks posed to marine mammals and sea turtles in the Pacific Ocean by the Western Pacific Pelagic Fisheries by integrating our interaction and response analyses. Specifically, we evaluated the available evidence to determine if interactions with gear used in the Western Pacific Pelagic Fisheries are likely to reduce the reproduction, numbers, or distribution of marine mammals and sea turtle populations in the Pacific Ocean by (1) killing individual marine mammals or sea turtles; (2) physically injuring marine mammals or sea turtles in ways that would have acute or chronic effects on their behavioral ecology; or (3) eliciting behavioral responses that would have longer-term, chronic effects on the viability of populations of a species. Although this section of our assessment included concerns for effects on individual animals, our assessment focused on the probable effects of the Western Pacific Pelagic Fisheries on populations and, through populations, listed species.

The final step in our analyses — relating reductions in a species' reproduction, numbers, or distribution to reductions in the species' likelihood of surviving and recovering in the wild — is the most difficult step because (a) the relationship is not linear; (b) to persist over geologic time, most species' have evolved adaptations that allow them to withstand some level of variation in their birth and death rates without a corresponding change in their likelihood of surviving and recovering in the wild; and (c) our knowledge of the population dynamics of other species and their response to human perturbation is usually too limited to support anything more than rough estimates. Nevertheless, we conducted this step of our analyses by estimating the number of marine mammals or sea turtles that would be killed or injured by interacting with the fishery, identifying the populations that would be affected by these interactions, and estimating the effects of those deaths of injuries on those populations' likelihood of surviving and recovering in the wild (for example, we considered the effect of killing a certain number of adult or sub-adult female turtles on nesting aggregations, given the probable size of the aggregation).

Jeopardy analyses must look into the future to encompass any delays between the effects of an action and the population responses of threatened and endangered species. Some human activities appear to have "delayed" effects on plant and animal populations, which can occur for two primary reasons. First, a disease, toxic chemical, or other stressor may take time to accumulate and individual animals may respond only after particular threshold doses. The classic example of this kind of "delayed effects" is the bald eagle's response to DDT: the effect of DDT on bald eagles was delayed until individual eagles received threshold doses of DDT that caused the shells of their eggs to thin. Second, a human stressor may have immediate effects on individuals or populations, but the ecology of the species may mask our ability to detect the effect. In the previous example, the bald eagle populations had declined for several years before humans were able to detect it. This kind of "delayed" effect probably reflects limitations in our ability to detect effects below certain thresholds or our inability to identify abnormal population declines given background rates of population variability.

With sea turtles, we expect the second kind of "delayed" effect. We monitor the abundance of sea turtles by counting the number of adult females on nesting beaches, and as a result, we generally would not detect changes in these populations until the adult, female population changed. The long lives and high, adult survival rates of sea turtles would mask changes in all non-adult age classes: we would not detect changes, even dramatic changes, in non-adult age classes until the adult population changed. Because of these delayed effects, assessments in the Services' biological opinions must look far enough into the future to (1) be certain of detecting a population's response to an effect, (2) be certain of detecting changes in a species' reproduction, numbers, and distribution, and (3) be certain of detecting changes in a species' likelihood of surviving and recovering in the wild (Crouse 1999b). If we do not look far enough into the future, we increase the risk of failing to detect a population's response to a human activities and we are more likely to falsely conclude there was no effect when, in fact, an effect occurred (which, in the case of fisheries, means that adult and subadult turtles will have been captured and killed for a period of years). If we look too far into the future, the passage of time can mask short-term collapses in a population and, again, we increase our likelihood of falsely concluding there was no effect when, in fact, an effect occurred.

In earlier Opinions, we responded to this challenge by basing our projections on the time it would take individuals born in the current year (2001) to enter the adult population and breed (using an approach that was consistent with approaches population biologists normally use when addressing life tables, which follow a cohort's patterns of survival and fecundity from birth to death — for age-based models — or from eggs to adults, for stage-based approaches). In the past, logbooks and observer reports collected over several years provided us with the data we needed to project the effects of the fisheries over time. Since the fisheries, particularly the Hawaii-based longline fishery, were changed in March 2001, we could not use those earlier data to estimate the probable effects of the fishery. We only have one year of monitoring data from the current fishery; in terms of a time series, these data represent a single point that limits our ability to project into the future. For the purposes of this consultation, we assume that current rates of interaction and mortality would continue into the future, although with time, we may discover that the number and rate of interactions and mortalities associated with the fishery is much different than the data that are currently available would suggest.

Information Available for the Assessment

To conduct this assessment, NMFS examined an extensive amount of evidence from a variety of sources. Detailed background information on the status of these species and critical habitat has been published in a number of documents including recent the marine mammal stock assessment reports (Hill et al. 1997, Hill and DeMaster, 1999) and a status report on six whale species that was prepared by Perry et al. (1999), status reviews of sea turtles (NMFS and USFWS, 1995; USFWS, 1997); recovery plans for the recovery plans for the blue whale (NMFS 1998a), humpback whale (NMFS 1991a), right whale (NMFS 1991b), Steller sea lion (NMFS 1992), eastern Pacific green turtle (NMFS and USFWS, 1998a), U.S. Pacific populations of hawksbill sea turtles (NMFS and USFWS, 1998b), loggerhead sea turtle (NMFS and USFWS, 1991), leatherback sea turtle (NMFS and USFWS, 1992), and U.S. Pacific populations of olive-ridley sea turtles (NMFS and USFWS, 1998c); and reports on interactions between sea turtles and gear used in pelagic fisheries (Bolten *et al*., 1996). In April 2002, Turtle Island Restoration Network convened a meeting of experts to discuss the status of leatherback turtle populations in the Pacific Ocean. In addition, Caswell (2001), Crouse *et al.* (1987), Crowder *et al.* (1994), Ebert (1999), Heppell (1998), and Heppell *et al.* (1996, 1999, and 2000) published results from population models, sensitivity analyses, and elasticity analyses for various species of marine turtles, although most of these models are based on data on loggerhead sea turtles in the Atlantic Ocean. We supplemented these sources using online literature searches (using the search engines available through Library of Congress's website).

In the past few years, our ability to describe the biology and ecology of sea turtles has improved dramatically. Sea turtles that have been fitted with satellite tags have increased our knowledge of the migratory patterns of sea turtles in the Pacific Ocean, genetic analyses have provided essential information on the structure of sea turtles populations in the Pacific Ocean, monitoring efforts at turtle nesting beaches allow us to update our understanding of trends of different nesting aggregations, and numerous investigators continue to publish new insights into the population ecology of sea turtles produced by computer models. Despite these advances, we must still confront large gaps in our understanding of the biology and ecology of sea turtles and much of the information we have is surrounded by uncertainty. For example, our knowledge of the distribution and abundance of male sea turtles and their role on the ecology of sea turtles is still rudimentary. As another example, our ability to quantify many of the phenomena we can describe also remains very limited: we still must make assumptions about a wide array of variables, including age at reproductive maturity, age-specific rates of survivorship and fecundity, and population sizes based largely on information from loggerhead sea turtles in the Atlantic Ocean. These gaps and uncertainties limit our ability to conduct quantitative risk assessments for sea turtles in the Pacific.

In early 2002, Dr. Milani Chaloupka developed a series of simulation models that were designed to help us overcome the limits in our knowledge of the population ecology of sea turtles in the Pacific Ocean (Chaloupka 2002a, 2002b, 2002c). These models use differential equations (running in Berkeley Madonna software) to simulate time-varying demographic processes that can be subject to environmental and demographic stochasticity; the models were designed to allow managers and other interested parties to quickly consider the effects of small changes in some variables on a population's trajectory over time. After carefully reviewing these models, NMFS concluded that, without much more information on the biology and ecology of sea turtles in the Pacific Ocean, it would be inappropriate to use the models as the basis for biological opinions or other, specific management purposes. In particular, comprehensive models like the ones developed by Dr. Chaloupka require detailed information on the biology and ecology of sea turtles and the environmental relationships that, as we discussed in the preceding paragraphs, is not available for sea turtles in the Pacific Ocean. Using this kind of model under those circumstances would give the appearance of numerical precision without the reality of it (Burgman *et al.* 1993, Cortes 1999, Morris and Doak 2002, Reed *et al.* 1998).

Given these limits in our understanding, we relied on conceptual life history and population models to assess the probable responses of the turtle species to the Western Pacific Pelagic Fisheries. Although this approach produced generalizable, qualitative results and more transparent reasoning and assumptions, we sacrificed numerical precision. Nevertheless, general, transparent results were preferable to precise numerical results that were not transparent and could not be verified with existing knowledge.

Assumptions Underlying This Assessment

In the absence of definitive data or conclusive evidence, NMFS made a series of assumptions to overcome limits in our understanding (the information supporting these assumptions is presented after the assumptions). First, we continued to assume that we could assess the status and trends of sea turtle populations by considering only female turtles and ignoring male turtles, despite recent work that argues that ecologists cannot assume that only a minimum threshold number of males is needed to maintain a population and that any additional males are superfluous (Wilson 2002). Nevertheless, our knowledge of the population biology and ecology of male sea turtles is even more limited than our knowledge of female turtles; with few exceptions, we cannot even speculate on their marine distribution, status, and trends. As a result, our analyses probably underestimate the significance of male sea turtles on their species' population ecology.

To assess the potential effects of reductions in sea turtle reproduction, numbers, or distribution on the turtles' likelihood of surviving and recovering in the wild, we used a conceptual model of sea turtle life history. To compensate for a high mortality rate of eggs, hatchlings, and small juveniles each year, sea turtles have evolved a life history strategy that requires adults to produce large numbers of eggs each year, live for many years, and breed repeatedly (National Research Council 1990). Through this life history strategy, the long lives of adult turtles buffer the turtles from dramatic fluctuations caused by large fluctuations in egg, hatchling, and juvenile survival (Crouse 1999b). Now that these species of sea turtles are endangered, however, we assume that the long lives of adult turtles *mask* the effect of previous losses of eggs, hatchlings, and juveniles on the turtle populations (see Crouse 1999b). As a result, we assume that sea turtles probably face a higher risk of extinction than our knowledge allows us to recognize and allow that our assessment probably underestimates the effects of the fisheries on turtles (see Ludwig *et al.* 1993).

All of the affected turtle species and two of the marine mammal species are represented by populations that occur within the Pacific and Atlantic Oceans. For the purposes of section 7 consultations, we treat populations of threatened and endangered species in the Pacific Ocean and the Atlantic Ocean as distinct. We believe this approach is consistent with interagency policy on the recognition of distinct vertebrate populations (Federal Register 61: 4722-4725), although our final jeopardy determination will be made at the scale of the listing for the affected turtles rather than at the distinct population scale. To address specific criteria outlined in that policy, populations of marine mammals and sea turtle in the Atlantic basin are geographically discrete from populations in the Pacific basin, with limited genetic exchange (see NMFS and USFWS 1998a). This approach is also consistent with traditional jeopardy analyses: the loss of marine mammals and sea turtle populations in the Pacific basin would result in a significant gap in the distribution of each turtle species, which makes these populations biologically significant. Finally, the loss of populations of marine mammals and sea turtle in the Pacific basin would dramatically reduce the distribution and abundance of these species and would, by itself, appreciably reduce the entire species' likelihood of surviving and recovering in the wild.

These analyses are based on an implicit understanding that the marine mammals and sea turtles considered in this Opinion are threatened with global extinction by a wide array of human activities and natural phenomena; we have outlined many of those activities in the *Status of the Species* section of this Opinion. NMFS also recognizes that some of these other human activities and natural phenomena pose a much larger and more serious threat to the survival and recovery of sea turtles and whales (and other flora and fauna) than the proposed fisheries. Further, NMFS recognizes that sea turtles will not recover without addressing the full range of human activities and natural phenomena — for turtles, patterns of beach erosion, predation on turtle eggs, and turtle captures, injuries, and deaths in international fisheries and other State, federal, and private activities, for whales, other commercial fisheries and shipping — that could cause these animals to become extinct in the foreseeable future (USFWS and NMFS 1997).

Nevertheless, this Opinion focuses solely on whether the direct and indirect effects of the Western Pacific Pelagic Fisheries can be expected to appreciably reduce the listed marine mammals and sea turtles' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution. NMFS will consider the effects of other actions on threatened and endangered marine mammals and sea turtles as a separate issue. As stated previously, jeopardy analyses in biological opinion distinguish between the effects of a specific action on a species' likelihood of surviving and recovering in the wild and a species' background likelihood of surviving and recovering given the full set of human actions and natural phenomena that threaten a species.

To conduct our jeopardy analyses, we evaluate the information available on the numbers of marine mammals and sea turtles captured, injured, or killed in the U.S. Pacific pelagic fisheries to determine if these injuries or deaths can be expected to reduce the Pacific Ocean population's reproduction, numbers, or distribution. As part of these analyses, we made assumptions about the number, sex, and life stage of marine mammals and sea turtles that might be captured, injured, or killed in the pelagic fisheries.

We consider these reductions within the context of the Pacific Ocean population's status and trend. We estimate the relative abundance of sea turtle populations based on the numbers of adult females, usually as they return to their nesting beaches. As a result, our population estimates will generally change only in response to changes in (1) the death rate of adult females, (2) the recruitment rate of sub-adult females, (3) the interval between a female's return to nesting beaches, and (4) migration patterns that might cause females to nest on other, uncensused, beaches (given the strong tendency of female turtles to return to the beach of their birth, we discount this latter phenomenon as having minimal effect on population trends). Over any five-ten year interval, the size of sea turtle populations will only change in response to changes in death rates and changes in recruitment rates (this time interval should be long enough to mask differences in re-nesting intervals). Therefore, if a turtle population is increasing, we can infer that the average number of females that recruit into the adult population is greater than the average number of adults that die in the population. If a turtle population is stable, we can infer that the average number of females that recruit into the adult population equals the average number of adults that die in the population. If a turtle population is decreasing, we can infer that the average number of females that recruit into the adult population is less than the average number of adults that die in the population.

B. Conservation and Management of Listed Species under the Magnuson-Stevens Act and the Pelagics Fishery Management Plan

Two of the ten national standards set out by the MSA are relevant to the effects the Pelagics FMP are expected to have on the listed species. As further discussed in the next section, the primary effect of the Pelagics FMP and the fisheries authorized under that FMP is the incidental capture, injury, and mortality of listed species by fishing gear. National standards 1 and 9, as seen in Table IV-1 below, guide the amount of effort and associated bycatch that shall be permitted under an FMP.

Table IV-1: **MSA National Standards** (16 U.S.C. 1851, Sec. 301(a)).

(a) IN GENERAL. – Any fishery management plan prepared, and any regulation promulgated to implement any such plan, pursuant to this title shall be consistent with the following national standards for fishery conservation and management:	
(1)	Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.
(9)	Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.

The Pelagics FMP currently has a non-numerical definition of optimum yield (OY) which is as follows: "OY is the amount of each management unit species or species complex that can be harvested by domestic and foreign fishing vessels in the EEZ and adjacent waters to the extent regulated by the FMP without causing 'local overfishing' or 'economic overfishing' within the EEZ of each island area, and without causing or significantly contributing to 'growth overfishing' or 'recruitment overfishing' on a stock-wide basis" (WPRFMC 1998b). Given that little is known about the status of most of the PMUS, this definition of OY could equate to unrestricted fishing effort under the FMP.

There are several regulations and proposed FMP amendments which limit fishing effort under the FMP in longline fisheries and which institute various conservation measures designed to avoid or reduce protected species interactions with FMP fisheries and the consequences of any remaining interactions. The limited entry program and maximum boat-length limit for the Hawaii based longline fishery limit the amount of effort in that fishery. A proposed limited entry program for the American Samoa longline fishery would do the same there. The 25 to 75 nm longline exclusion zone around the Hawaiian Islands, 100 nm wide protected species zone around the Northwestern Hawaiian Islands, to protect Hawaiian monk seals and to eliminate gear conflicts between fisheries, and new Northwestern Hawaiian Islands Coral Reef Reserve, also serve to limit fishing effort in certain areas by prohibiting longline fishing, while still allowing other gear types. Requirements on turtle handling, including line clippers, dip nets, and use of resuscitation techniques reduce the adverse effects of a gear interaction. Finally, prohibitions on the use of shallow-set gear and other swordfish-targeting techniques, and the time and area closure south of the Hawaiian Islands in April and May reduce the likelihood of interactions between turtles and longline fishing gear.

This assessment is based on the assumption that fishing effort in all the fisheries under the Pelagics FMP, with the exception of the American Samoa-based longline fishery, will continue at the same levels as they have since implementation of the June 12, 2001 emergency regulations and that sea turtle and marine mammal interactions will continue with the same frequency and effect as they have since that date.

C. Effects of Fisheries Authorized Under the Pelagics FMP

As discussed in the Action Area (see *Description of the Action)*, the fisheries authorized under the Pelagics FMP occur throughout the central, western, eastern and northern Pacific Ocean, including waters around the Northwestern Hawaiian Islands, the main Hawaiian Islands, American Samoa, Guam, Commonwealth of the Northern Mariana Islands (Saipan, Rota, and Tinian), and the U.S. possessions of Johnston Atoll, Kingman Reef, and Palmyra, Jarvis, Howland, Baker, Midway, and Wake Islands (see Figure II-8).

The Hawaii longline fishery generally operates around the main and northwestern Hawaiian islands except for prohibited areas described above in the *Description of the Action* section. The other fisheries authorized under the Pelagics FMP generally occur closer to shore. Most of the vessels associated with the pelagic longline fishery based out of American Samoa fish within 25 nautical miles of shore, although newer, larger vessels are capable of fishing out to and beyond 50 nautical miles – a closed area around American Samoa, instituted in March, 2002, prohibits vessels longer than 50 feet from fishing within 50 nautical miles of the shore, with some exceptions. Similarly, the pole-and-line fishery based in Hawaii, the recreational fisheries that target pelagic species around Hawaii, the Hawaiian charter boat fishery, the American Samoa, Guam, Hawaii, and Commonwealth of Northern Mariana Island-based troll fisheries all generally occur within 25 miles of shore (NMFS, 2000). For each of these fisheries some fishing vessels range as far as 100 nautical miles from land.

1. Marine Mammal and Sea Turtle Interaction Analysis

This section of the Opinion evaluates the available information to determine the likelihood of a listed sea turtle or marine mammal interacting (in this instance, an "interaction" consists of an animal that is entangled in or hooked by gear associated with the fisheries) with one or more of the fisheries authorized by the Pelagics FMP. Interaction analyses also evaluate the intensity, duration, and frequency of interactions between sea turtle species and gear associated with the various Pelagic fisheries. These analyses assume that sea turtles or marine mammals are not likely to be adversely affected by a fishery if they do not interact with the fishery; these analyses also assume that the potential effects of the fisheries would be proportional to the number of interactions between the fisheries and sea turtles or marine mammals.

The only source of information available for these interaction analyses are reports of actual interactions between some of the fisheries and sea turtles and marine mammals that have been derived from observer programs and logbooks. These sources do not allow us to determine the abundance of sea turtles from different nesting aggregations that *could* interact with the Pelagics fisheries (that is, the total number and origin of turtles that are susceptible to interactions with the fisheries). As a result, we cannot estimate potential interactions or the probability of interactions that remain unreported and, as with other studies confronting these data limitations, we use our estimates with caution (Kinas 2002). Nevertheless, our analysis assumes that the spatial and temporal patterns derived from reported interactions between the fisheries and turtles represents the actual spatial and temporal distribution of the sea turtle populations in the action area. Given the information available on sea turtle biology and behavior in the pelagic environment, turtles probably occur throughout the entire fishing area but probably within certain zones based on water temperatures, currents, seasonality, and prey abundance.

a. Likelihood of Interactions By Gear Type

In general, five different fishing gear types are used under the Pelagics FMP: troll, handline, pole-and-line, and longline gear. The type of fishing gear used and the area fished will affect the likelihood of an interaction with a sea turtle or marine mammal. The following section discusses the likelihood of interactions between these gear types and sea turtles and marine mammals.

(1) Troll fishing gear

Trolling is conducted by towing lures or baited hooks from a moving vessel, using big-game-type rods and reels as well as hydraulic haulers, outriggers, and other gear. Up to six lines rigged with artificial lures or live bait may be trolled when outrigger poles are used to keep gear from tangling. When using live bait, trollers move at slower speeds to permit the bait to swim naturally (WPRFMC, 1995). Freshly caught small yellowfin tuna or skipjack tuna may be used as live bait to attract marlin. Once a fish is hooked, the gear is immediately retrieved.

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

(2) Pole-and-line

A small pole-and-line fishery operates from Hawaii that targets skipjack tuna. It is sometimes referred to as the aku (skipjack tuna) fishery or baitboat fishery. The pole-and-line fishery uses live bait thrown from a fishing vessel (ranging from 65 to 80 feet) to stimulate a surface tuna school into a feeding frenzy. The pole and line used are of equal length (3 meters). Fishing is conducted using a barbless hook with feather skirts slapped against the water until a fish strikes. The hooked fish is then yanked into the vessel in one motion. The fish unhooks when the line is slacked so that the process can be repeated. The bait most often used is anchovy.

Although the distribution of the pole-and-line fishery overlaps with the distribution of sea turtles and listed marine mammals, there is a very low likelihood of an interaction with a sea turtle or listed marine mammal because the turtle or marine mammal would need to be in the vicinity and the fisher would need to hook the animal or the animal would need to strike the hook. This type of an event is unlikely to occur because sea turtles and listed marine mammals are not likely to prey on anchovy, and the activity of the fish feeding frenzy would deter turtles from remaining in the area. For these reasons, NMFS concludes that the pole-and-line fishery is not likely to adversely affect sea turtle or listed marine mammal populations.

(3) Handline fishery

Two types of pelagic handline fishing methods are practiced in Hawaii, the *ika-shibi* method, and the *palu-ahi* method. The *ika-shibi* or night handline fishery developed from a squid (*ika*) fishery that switched to target the incidental catch of tuna (*shibi*). Lights and chum are used to attract small prey species and larger target tunas to handlines baited with squid. The vessels typically fish between 5 and 6.5 nm from shore. The night-time fishery is mostly conducted off Hilo and off Keahou, both on the island of Hawaii (Hamilton, 1996 *in* NMFS, 2000a).

The *palu-ahi* or day-handline fishery also targets tuna but fishing occurs during the day. A baited hook on the end of a handline is laid against a stone and the line wound around it. Additional pieces of chum are wound into the bundle which is then tied in a slip knot (Rizzuto, 1983 *in*

NMFS, 2000a). The bundle is lowered to the preferred depth (commonly 20-30 meters) where the line is jerked to untie the knot so the baited hook and chum are released at the target depth. Fishing usually takes place by smaller vessels within 6.5 nm from shore and by larger vessels around fish aggregating device or around sea mounts and weather buoys (100 - 200 nm from shore). As soon as a fish is caught, the gear is brought back on board.

There have been no reported interactions between gear used in the handline fishery and sea turtles or listed marine mammals. Although there is the risk that sea turtles or listed marine mammals may become hooked or entangled in the fishing gear, any caught animal can be immediately dehooked or disentangled and released. Moreover, most turtles or listed marine mammals found in the area of the handline fisheries are not likely to prey on the baited hooks. For these reasons, NMFS concludes the handline fishery, as managed under the Pelagics FMP is not likely to adversely affect listed sea turtle or marine mammal populations.

(4) Longline fisheries

Longline fishing is a passive fishing method that consists of suspending a monofilament line (main line) in the water column, by using floats, and attaching baited hooks along the line to attract fish. While the main line is deployed over the stern of the vessel, floats and hooks are attached to the main line using clips. Each float is attached to a float line and each hook is attached to a "branch line." The branch line is sometimes called a "gangion" or "dropper" line. For the most part, the branch lines are evenly spaced along the main line, except between floats where the placement of the float on the main line may lengthen the distance between the branch lines. The lengths of the branch lines and the float lines affect how deep the gear (hook) will fish and the type of species that might be caught. The depth that hooks actually fish is also determined by the vessel speed, drum speed, and shooter speed. The faster the main line is set (more line set in a shorter distance), the deeper the line will sink because of the line sag between the floats. In addition to the speed that the main line is set, the number of hooks and the size of the weight on each branch line can affect the depth and rate that the gear will sink. The type of species that are caught is also affected by the time of day the gear is set and the type of bait that is used.

American Samoa longline fishery. The longline fleet based in the island of Tutuila, American Samoa, has been, until recently, dominated by twin-hulled boats of aluminum or wood/fiberglass, called *alia*, most of which are about 30 feet long and powered by 40 horsepower outboard engines. The gear on the *alias* is stored on deck attached to a hand crank reel which can hold as much as 10 miles of monofilament mainline. These vessels, on which navigation is generally limited to visual methods, typically make only single-day trips, so most of their fishing effort occurs within 25 nautical miles of shore. Participants set between 100 and 300 hooks on a typical eight-hour trip. The gear is set by spooling the mainline off the reel and retrieved by hand cranking back onto the reel. Generally, gear setting begins in early morning; with retrieval in the mid-morning to afternoon. The longline fishery grew fairly steadily through the late 1990s, but after 2000 it expanded rapidly with the entry of a number of large vessels. The fleet is currently composed of about 40 of the relatively small (< 40 feet) *alia*, about five mid-sized (40-50 feet) monohull vessels, and about 30 large (> 50 feet) monohull vessels (WPRFMC 2002a). These large vessels, which have hydraulically powered reels and electronic navigation equipment and substantially greater gear and storage capacities than the small *alia*, tend to conduct multi-day fishing trips and can range throughout the EEZ (WPRFMC 2002a and WPRFMC 2002b). The rapid influx of the large domestic longliners during just the last two years has resulted in both a dramatic increase in longline fishing effort in the EEZ around American Samoa (from about 1.4 million hooks set in 2000 to about 5.8 million in 2001; WPRFMC 2002b) and a shift in the spatial distribution of longline effort towards waters more distant from shore.

(1) Past listed marine mammal take in the American Samoa-based longline fishery

For the American Samoa-based longline fishery, the federal logbooks from 1992 through 2001 indicate zero interactions with listed marine mammals. Although logbooks may not be the most reliable source of information on protected species interactions, the infrequent nature of interactions between listed marine mammals and the Hawaii-based longline fishery may indicate that this gear type incidentally captures very few marine mammals, particularly large whales. For this reason, NMFS concludes the American Samoa longline fishery, as managed under the Pelagics FMP is not likely to adversely affect listed marine mammal populations.

(2) Past sea turtle take in the American Samoa-based longline fishery

For the American Samoa-based longline fishery, the federal logbooks from 1992 through 1999 indicate six interactions with sea turtles (i.e. hooking/entanglement). In 1992, one vessel interacted with a green turtle. In 1998, one vessel interacted with an unidentified sea turtle; it was released alive. In 1999, one vessel reported interactions with four sea turtles. Three turtles released alive were recorded as a hawksbill, a leatherback, and an olive ridley. One turtle, identified as a green, was reported to have died from its interaction with this vessel. None of the species' identification were validated by NMFS' Southwest Fisheries Science Center; and NMFS cannot attest to the local knowledge of fishermen regarding the identity of various turtle species, particularly hard-shelled turtles. However, all four species of sea turtles reportedly caught by the fishery do occur in the fishing grounds of this longline fishery. In addition, as discussed below, logbook data may not be a reliable method to measure sea turtle interaction in the fisheries. From 2000 through October 2002, there have been no reported interactions with sea turtles in this fishery (S. Pooley, NMFS, personal communication, October 2002).

Hawaii-based longline fishery. 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 is about 1,690 hooks per set with about 27 hooks set between each float. There are approximately 66 floats used during each set. Deep set vessels use saury (sanma) as bait and the hook type used are "tuna" hooks. The average target depth is 167 meters. The gear is allowed to soak during the day and the total fishing time typically lasts about 19 hours, including setting and hauling of gear. This type of set is referred to below as "deep set."

(1) Past estimates of listed marine mammal captures and mortalities in the Hawaii-based longline fishery

Humpback whale. One humpback was reported by an observer entangled in the mainline of a Hawaii-based longline vessel in 1991. This interaction occurred inside what is now the protected species zone (50 nautical miles) of the islands and atolls of the Northwestern Hawaiian Islands. Another humpback whale was reported entangled in longline gear off Lanai by Nitta and Henderson (1993) and by whalewatch operators off Maui in 1993 (Hill and DeMaster, 1999). Confirmation was not made as to whether the gear type was pelagic longline gear, and the reports were believed to be for the same whale. In 2001, NMFS observer recorded a humpback whale entangled in the mainline of the fishing gear on a set targeting bigeye tuna. The animal was released alive. In October 2002, NMFS observed another humpback whale entangled in a mainline. This animal was released alive, but may have had some trailing line attached (<30ft).

Based on this information, NMFS concludes that there is a likelihood that humpback whales may incidentally become entangled in longline fishing gear. However, based on observer data and logbook data, such an interaction is infrequent and more likely a random event. Moreover, based on observer data (earlier non-observer reports of humpback whales entangled and trailing longline gear are not confirmed and were during a time when longline fishing was allowed within 50 miles of the islands and atolls of the Northwestern Hawaiian Islands), animals that are entangled are likely to be released alive, but they may have some trailing gear. Therefore, at this time NMFS believes that humpback whale interactions with longline gear are infrequent occurrences and that humpback whales will not be seriously injured or killed.

Monk Seal. In the early 1990s, longline operations were adversely affecting monk seals, as indicated by the sighting of a few animals with hooks and other non-natural injuries. In 1991, Amendment 3 established a permanent 50-mile protected species zone around the NWHI that closed the area to longline fishing. This protected species zone has essentially eliminated monk seal interactions with the longline fleet, except in 1994, a Hawaiian monk seal was reported released alive and injured on a Daily Longline Fishing Log by an operator of a Hawaii-based longline vessel. The species identification was not confirmed by Honolulu Laboratory personnel. The set was reported to occur 125 miles north by northwest of Kaui and targeting swordfish, with 800 hooks set and lightsticks used.

Based on logbook data, NMFS concludes that there is a possibility that monk seals may incidentally become entangled or hooked in longline fishing gear. However, there have been no monk seal interactions observed by NMFS observers, suggesting that the likelihood of an interaction is small. Moreover, the single animal was reported taken in a shallow set; shallow sets are now prohibited under the fishery management plan. This further reduces the likelihood of an interaction. Therefore, at this time, based on the data, NMFS does not anticipate monk seal interactions with longline gear.

Sperm Whale. NMFS has observed one sperm whale interaction by the Hawaii-based longline fishery. The event occurred in May, 1999 inside the Northwestern Hawaiian Islands EEZ (about 140 nautical miles north of Raita Bank), and the vessel was targeting swordfish (gear was set at night, lightsticks were used, and no line shooter was used). According to the observer report, the sperm whale's pectoral fin was entangled in the mainline. The captain stopped the boat, let out more mainline, and then backed up until he could reach the other end of the mainline. At this point, both ends of the mainline, on each side of the sperm whale, were secured on the vessel. During this time, the whale broke the mainline and swam away without trailing gear. There have been no reported sperm whale interactions by fishers in their logbook submissions.

Based on this information, NMFS concludes that there is a likelihood that sperm whales may incidentally become entangled in longline fishing gear. However, based on observer data and logbook data, such an interaction is infrequent. Animals that are entangled are likely to be released alive, but they may have some trailing gear (a single observed interaction does not allow us to determine conclusively that sperm whales in future interactions will not have trailing gear). Therefore, at this time NMFS believes that sperm whale interactions with longline gear are infrequent occurrences and that sperm whales will not be seriously injured or killed.

(2) Sea Turtle Interaction Analysis

The following discussion of sea turtle presence and behavior in the action area stems from observer reports and other scientific information available on the foraging and diving behavior and natal origin of the sea turtles known to be affected by the fisheries. The information presented below is based on past observed interactions between the Hawaii-based longline fishery and sea turtles and spans the entire collection of data from observer reports. However, due to changes in the Hawaii-based longline fishery, specifically the prohibitions on shallow-set gear and swordfishing methods, the location, frequency, and intensity of interactions may have changed after April 2001. Nevertheless, we are presenting all of the available information to provide as complete a picture as possible of the known intersection between this fishery and sea turtles and the reductions in interactions due to the changes in the fishery. Information specific to interactions occurring before April 2001, are referred to as occurring under the "prior fishery." Interaction information after April 1, 2001, occurred under the "current fishery." A similar analysis for the marine mammals adversely affected by the Western Pacific Pelagics Fisheries was not done due to the extremely rare and random nature of interactions between the fisheries and marine mammals foraging and migrating through the action areas.

As discussed in the *Approach to the Assessment* section, NMFS' Honolulu Laboratory estimated the number of interactions between the current fishery and sea turtles. These estimates are based on the number of turtles that interacted with observed longline sets; these estimates were then expanded statistically to estimate the number of interactions that would be expected for the entire fishery (observed and unobserved sets).

Green Turtles. The current fishery is expected to interact with about 8 green turtles each year (95% confidence interval = 2 - 21). Based on past experience, most of these green turtles will probably be members of the Hawaiian (French Frigate Shoals) or Mexican (Pacific coast) nesting aggregations. Of fourteen green turtles observed taken in the Hawaii-based longline fishery from 1994 to 2002, genetic tests indicated that six represented the eastern Pacific (Mexico - both Revillagigedos and Michoacan; and Galapagos) nesting aggregations, two represented the

Hawaiian nesting aggregations, five may have originated from either Hawaii or Mexico (Islas Revillagigedos), and one was of unknown origin (P. Dutton, NMFS, personal communication, October, 2002). Nevertheless, turtles from other nesting aggregations in the Pacific Ocean may also interact with these Hawaii-based longline fisheries.

Life history information collected by observers suggests that the Hawaii-based longline fisheries tend to capture juvenile, subadult and adult green turtles (straight carapace lengths ranged from 28.5 cm to 73.5 cm with an average of 51.5 cm). From those turtles for which genetic data were collected, turtles originating from Hawaiian nesting aggregations were represented by smaller animals (juvenile and sub-adult sizes); turtles from Mexican nesting aggregations were represented by larger animals (sizes that suggest they were probably adult turtles).

Green turtles have been captured in all months of the year except January and September in the prior fishery and only during March and August under the current fishery. Under the prior fishery, green turtles have been caught in the area bounded by 155°W and approximately 180°E longitude and between 5°N and 30°N latitude. Under the current fishery, green turtles have been caught in the area bounded approximately by 160°W and 170°W longitude and south of 5°N latitude (see Figure 1 and Figure 2 in Appendix C). Green turtles in these areas are likely foraging in shallow waters or at shallow depths, or transiting to foraging grounds. The non-breeding range of green turtles is generally tropical, and can extend thousands of miles from shore in some regions. Data from satellite transmitters on Hawaiian green turtles indicate that these turtles can travel more than 1,100 km from the nesting beach at French Frigate Shoals, south and southwest against prevailing currents to numerous distant foraging grounds within the Hawaiian archipelago. Green turtles outfitted with satellite tags on Rose Atoll (the easternmost island of the Samoan Archipelago) traveled on a southwesterly course to Fiji, approximately 1,500 km distant (Balazs, *et al.*, 1994). Tag returns and observations of eastern Pacific green turtles establish that these turtles also travel long distances between foraging and nesting grounds, sometimes more than 1,000 kilometers from nesting beaches. East Pacific green turtles are the second-most sighted turtle in the east Pacific during tuna fishing cruises; they appear to frequent a north-south band from 15°N to 5°S along 90°W, and between the Galapagos Islands and Central American Coast (NMFS and USFWS, 1998a), an area well outside of the ocean fished under the Pelagics FMP. Green turtles appear to prefer waters that usually remain around 20°C in the coldest month. During warm spells (e.g., El Niño), green turtles may be found considerably north of their normal distribution.

Under the prior fishery, more green turtles were captured in shallow sets compared to deep sets. Thirteen of 17 turtles caught by the prior fishery were captured in sets with less than 10 hooks per float, indicative of shallow-set gear. Because subadult green turtles reportedly perform routine dives of 20 meters, with a maximum depth of approximately 110 meters (Brill, *et al.*, 1995, *in* Lutcavage and Lutz, 1997), they are more likely to encounter shallow-set longlines than deep-set longlines which are often set below 100 meters. Based on the behavior of post-hatchlings and juvenile green turtles raised in captivity, wild green turtles in pelagic habitats probably live and feed at or near the ocean surface, and their routine dives probably do not exceed several meters in depth (NMFS and USFWS, 1998a) making these life stages also vulnerable to capture by either shallow-set longline gear, or deep-set gear that is being set or retrieved. The only mortalities (n=5, 3 under the prior fishery and 2 under the current fishery) observed were on deep sets; we assume that these turtles drowned as a result of their inability to reach the surface.

Hawksbill Turtles. Although hawksbill turtles are known to nest on the Main Hawaiian Islands (on Molokai, Maui and Hawaii), they are not known to interact with the Hawaii-based longline fishery, as there have been no reported or observed interactions between these pelagic longliners and hawksbills. As hawksbills become adults, evidence suggests that they switch foraging behaviors from shallow water habitat to a deep water habitat, feeding pelagically for the first years of life, and switching to benthic feeding as they mature. If Hawaiian hawksbills forage close to their known nesting sites, they are probably benefitting from the protected species zone instituted by the Council in 1991, where longliners are prohibited from fishing within 50 nm of the NWHI[45] and within 100 nm closed corridors connecting the non-contiguous closed circles. Further longline exclusion zones prohibit longline fishing in specific areas around the MHI (depending on the time of year and location, the exclusion zones around the MHI range from 25-75 nm). Because adult hawksbills are most likely foraging primarily in nearshore waters, the likelihood of an interaction with a longliner is very low.

Leatherback Turtles. The current fishery is expected to interact with about 8 leatherback turtles each year (95% confidence interval = 2 - 21). Based on genetic analysis, all of the leatherback turtles captured in the Hawaii-based longline fishery are from two nesting aggregations: the western Pacific region (Papua New Guinea, Indonesia, and Solomon Islands), and the eastern Pacific region (Mexico and Costa Rica). Of 17 leatherback turtles captured in the Hawaii-based longline fishery, 16 were from nesting aggregations in the southwestern Pacific, most likely Indonesia or the Solomon Islands; the remaining turtle, captured in the southern range of the Hawaii fishery, was from an eastern Pacific nesting aggregation (P. Dutton, NMFS, personal communication, October, 2002).

Straight carapace lengths taken from a subset of the leatherback turtles caught in the fishery suggest that subadults, representing both early and late pelagic stage, based on the stage structure for Malaysian turtles presented in Bolten, *et al.* (1996). However, it appears that young leatherback turtles (carapace length <100 cm) reside only in waters warmer than 26°C, which should generally place them outside of areas in which longline swordfish fleets operate (Eckert, 1999b; Eckert, 2002). If one of the measured leatherback turtles (130 cm) originated from the eastern Pacific, it could have been an adult; if it originated from the western Pacific, it would be a subadult (P. Dutton, NMFS, personal communication, January, 2001). Because the majority of the leatherback turtles caught in the fishery are probably of western Pacific origin, this individual was probably a sub-adult. Most of the leatherbacks caught in the fishery were not measured. Those leatherbacks that were not measured may have been too large to be safely brought on board; therefore they may have been adults.

The data on these interactions revealed clear spatial patterns between the prior and current fisheries and leatherback turtles. However, there is no obvious temporal pattern to those

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[45] Note: there have been no known valid records of a hawksbill anywhere in the NWHI (G. Balazs, NMFS, April, 2002).

interactions: leatherback turtles have been captured in every month of the year, except August. Under the prior fishery, leatherback turtles were captured in the area bounded by 170°E and 133°W longitude and between 5°N and 41°N latitude.

Leatherback turtles within the action area of the Hawaii-based longline fishery are probably foraging (at the surface or at depth, including the deep scattering layer) or migrating between their nesting, mating, and foraging areas. Leatherbacks are able to dive quite deep, but appear to spend most of their time (up to 90%) diving to depths shallower than 80 meters. They are highly migratory, exploiting convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Morreale, *et al.*, 1994; Eckert, 1998; Eckert, 1999a).

Leatherback turtles caught in prior fishery sets above 20°N latitude (43 out of 52 leatherback turtles observed) were caught in sets with less than 10 hooks per float, indicative of shallow-set gear and also indicative of the general area in which shallow set fishing methods were used. Leatherback turtles were primarily captured in these sets in an area bounded by 165°W and 130°W longitude and 20°N and 40°N latitude.

The remaining leatherback turtles captured in the prior fishery (9 out of 52), were associated with sets with more than 10 hooks per float, suggesting deep-set gear. These interactions occurred between 153°W and 167°W longitude and 5°N and 26°N latitude (see Figure 3 in Appendix C). Sea surface temperatures, latitude, and the distance to the approximate 17°C and 19°C isotherms were associated with these interactions, but there was a high degree of collinearity between these variables (McCracken, 2000): when McCracken examined four latitude predictor categories for leatherback turtles[46], she found that the proportion of sets associated with leatherback captures was higher in the northernmost and southernmost categories, even though these areas had lower proportions of the observed sets than the middle two categories, which had high observed sets but fewer observed takes. These observations suggest that the risk of an interaction increases toward the northern and southern boundaries of the action area. Under the current fishery, two leatherback turtles have been observed taken between 160°W and 162°W longitude and 21°N and 26°N latitude (see Figure 4 in Appendix C).

Recent information on leatherbacks tagged off the west coast of the United States has revealed an important migratory corridor from central California, to south of the Hawaiian islands, leading to western Pacific nesting beaches (P. Dutton, NMFS, personal communication, October 2002). This corridor runs through the areas typically fished by the Hawaii-based longline fleet and supports genetic findings that most of the leatherback turtles caught in the fishery originate from western Pacific beaches. Eastern Pacific leatherback turtles appear to migrate primarily to the south, into the fishing grounds of South American fishing nations, supporting the low observed interaction rate between the Hawaii-based longline fishery and eastern Pacific leatherback turtles.

Loggerhead Turtles. The current fishery is expected to interact with about 14 loggerhead turtles each year (95% confidence interval = 3 - 26), although interactions are more likely north of 22°N

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[46] These four categories were: less than 14.95°N, between 14.95°N and 24.84°N, between 24.84°N and 33.82°N, and greater than 33.82°N (McCracken 2000).

latitude (12 interactions, with a 95% confidence interval = 3 - 26) than south of 22°N (2 interactions, with a 95% confidence interval = 0 - 8). Based on genetic analyses of 133 loggerheads, all of the loggerhead turtles captured in the Hawaii-based longline fishery originated from Japanese nesting aggregations (Dutton *et al.*, 1998, P. Dutton, NMFS, personal communication, October, 2002). Available data on the length of these turtles indicate that the fishery captures pelagic-stage juvenile loggerhead turtles. These data are supported by the available information on the foraging and migrating patterns of loggerhead turtles. The transition from hatchling to young juvenile occurs in the open sea, and evidence is accumulating that this part of the loggerhead life cycle may involve a trans-Pacific developmental migration (Bowen, *et al.*, 1995). As they age, some loggerheads begin to move into shallower waters, where, as adults, they forage over a variety of benthic hard- and soft-bottom habitats.

From 1994 through March 2001, observers recorded the incidental take of 175 loggerheads (see Figure 5 of Appendix C, which shows the location of loggerhead captures by the Hawaii-based longline fleet). The existing data on these interactions revealed clear spatial patterns between the prior fishery and loggerhead turtles. There are reports of loggerhead turtle captures in all months except May and June; most captures occurred during the fall and winter months, however, especially in January and February.

Statistical analyses of captures through 1999 to determine possible associations with several different variables like sea surface temperature, latitude, and the distance to the approximate 17°C and 19°C isotherms showed a high degree of collinearity between these variables. Degree of latitude appeared to be a primary determinant of the probability of loggerhead captures in the fisheries. For example, McCracken (2000) reported that, none of 1,263 sets that were observed south of 22°N captured loggerhead turtles. Kleiber (1998) also found latitude to be the primary determinant of interactions between the fisheries and loggerhead turtles. However, after March 2001, the current fishery caught two loggerhead turtles, including one turtle far south of the area in which loggerhead turtles were typically seen (13°N latitude; see Figure 6 in Appendix C)[47].

Of 70 trips in which loggerheads were captured, 39 had captured loggerheads in more than one set, and several trips had captured multiple loggerheads in the same set. This suggests that juvenile loggerhead turtles forage or migrate in groups, or longliners target swordfish and tuna in areas of high loggerhead concentration, or both. Other data also suggest that juvenile loggerhead turtles forage or migrate in groups. Off Baja California, thousands of juvenile loggerhead turtles have been observed feeding on pelagic crabs. In the Atlantic Ocean, 68.1% of the loggerhead turtles captured in longline gear were caught in sets with other loggerheads compared with 31.9% that were caught singly (Hoey, 1998).

The existing data also lead us to conclude that loggerheads tend to congregate in areas typically fished by longliners targeting swordfish, taking advantage of high productivity associated with

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[47] Two other loggerhead turtles were reported taken in the northern portions of the action area. These turtles were captured on sets under suspicion of illegal activity (targeting swordfish) and therefore they have not been included in the interaction analysis. In addition, there are no photos or other information available to confirm that the turtle taken around 13° N was a loggerhead.

particular oceanographic features. Recent satellite tracking by Polovina *et al.* (2000) indicates that all life stages of loggerhead turtles actively migrate, swimming against weak geostrophic currents along two convergent fronts as they travel from east to west across the Pacific. Of nine juvenile loggerheads tracked in the central North Pacific, six associated with a front characterized by 17°C sea surface temperature (SST; termed "cool group") and the other three associated with a front with a SST of 20°C ("warm group"). Seasonally, these 17°C and 20°C isotherms move north and south over 10 degrees of latitude, and as the turtles moved westward, they also appeared to move north and south coincident with these isotherms. Under the prior fishery, the distribution of shallow longline sets during the first quarter was largely between the 17°C and 20°C SST fronts used by loggerheads.

Swordfish are believed to move south through these fronts, perhaps following squid. For example, during the second quarter, the prior fishery tended to locate well to the south of the 17°C SST front but overlapped the 20°C SST front. Sea turtles tracked during the first quarter of the years 1997 and 1998 occupied waters with a mean of 17°C SST, with considerable overlap with the SST associated with the fishery in the northern portion of the fishing grounds. As the fishery moved south in the second quarter, those "warm group" turtles following the 20°C front would be well within the fishing ground, while the "cool group" would likely have been well north of the fishing ground (Polovina, *et al.*, 2000). Observer data shows that the interaction rate (turtles per longline set) was substantially greater at 17°C SST than at 20°C SST (P. Kleiber, NMFS, personal communication *in* Polovina, *et al.*, 2000).

Finally, all of the 175 loggerheads observed taken by the Hawaii-based longline fishery from 1994 through March, 2001, were captured by longliners using shallow sets (i.e. target depth less than 100 meters, using less than 10 hooks per float, fishing at night, using lightsticks). 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). Loggerhead turtle maximum recorded dive depth is 128 meters. In general, loggerhead turtles tend to spend most (90%) of their time at the surface or diving to 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. However, in July 2002, a loggerhead turtle was caught in a deep set fishing at 13°N latitude, an interaction than diverged from NMFS' past observations of the overlap between this species' pelagic distribution and behavior and the deep-set portion of the longline fishery.

Olive Ridley Turtles. The current fishery is expected to interact with about 26 olive ridley turtles each year (95% confidence interval = 12 - 47). Genetic analyses suggest that the Hawaii-based longline fishery catches olive ridley turtles from nesting aggregations in the eastern and western Pacific Ocean and the Indian Ocean. Based on analyses of 39 olive ridleys captured by the Hawaii-based longline fishery, 26 % (n=10) were from the Indian Ocean or western Pacific Ocean and 74% (n=29) were from the eastern Pacific (P. Dutton, NMFS, personal communication, October, 2002). Some areas within the fishing grounds of the prior fishery had a high proportion of captured olive ridleys from both eastern and western Pacific beaches, signifying that ridleys from both sides of the Pacific converge in the north Pacific pelagic environment. Length information collected by observers indicates that the fishery interacts with sub-adult and adult olive ridley turtles. Olive ridley turtles generally have a tropical range, with a distribution from Baja California, Mexico to Chile (Silva-Batiz, *et al.*, 1996). Satellite studies of post-nesting olive ridley turtles indicated that the females traversed thousands of kilometers of deep oceanic waters, including more than 3,000 kilometers out into the central Pacific. Young olive ridley turtles tend to forage in large groups, or flotillas, in the open ocean environment. As they age, they begin to recruit to the benthic feeding grounds of the adults. Olive ridley turtles caught in the fishery may be transitioning between the open ocean and the shallower adult feeding areas, or migrating between foraging, mating, and nesting areas.

The existing data from the prior fishery on these interactions revealed clear spatial patterns but a weak temporal pattern: olive ridley turtles had been captured in every month of the year, except February, with most of the captures occurring during warmer months (May to August). In addition, the prior fishery interacted with olive ridleys throughout the fishing area, with captures reported from as far north as 33°N to as far south as 7°N latitude, and from longitudes 143°W, west to 175°W (see Figure 7 in Appendix C). Sea surface temperatures, latitude, and the distance to the approximate 17°C and 19°C isotherms were associated with the takes, but there was a high degree of collinearity between these variables. There was a clear distinction between the proportion of takes between the two categories of sea surface temperature, but over latitude, the pattern was less clear (McCracken, 2000). Observed interactions between olive ridley turtles and the current fishery follow similar patterns: olive ridleys have been captured in January, March, April, June, and July in an area between 10°N and 23°N latitude and 154°W and 168°W longitude (Figure 8 in Appendix C).

Olive ridley turtle maximum recorded dive depth is 238 meters, although the species spends a greater proportion of time at depths shallower than 40 meters (60% with 20% of total time spent at the surface), possibly making them more likely to encounter shallow set longlines than deep set longlines. Under the prior fishery, most olive ridley turtles were caught in shallow sets with less than 10 hooks per float (76% of observed interactions). All but one of the turtles killed during interactions with the prior or current fishery were caught in deep sets with more than 10 hooks per float; it is likely that these turtles died as a result of their inability to reach the surface.

(a) Past estimates of sea turtle captures and mortalities in the Hawaii-based longline fishery

Because the bycatch information provided in skipper logbooks was considered unreliable, and due to reasonable and prudent measures listed in prior biological opinions, an observer program was established in 1994 to monitor target species caught and bycatch in the Hawaii-based longline fishery. Through 1999, observer coverage ranged from 3.4% to 5.3% of annual trips (NMFS, 2000f). Since 1999, observer coverage in the fishery increased substantially due to both court-orders and changes in NMFS' regulations. In 2000, 2001, and 2002, observer coverage was approximately 10.4%, 22.5%, and 27.6% (first nine months), respectively.

In earlier biological opinions, NMFS defined "turtle take" as any interaction between a sea turtle, a fishing vessel, or its gear, particularly interactions that were likely to result in a turtle becoming entangled in fishing line or caught on a hook. Observers complete sea turtle life history forms for every turtle observed taken by a longline vessel. Turtles are either brought aboard or sampled alongside the vessel, and from such vantage points, the observer records biological characteristics as well as the fate of the turtle. Table IV-3 contains characteristics (definitions) used by observers to define the condition and fate of turtles interacting with longline gear.

Because a probability sample was not drawn on a yearly basis, a model-based predictor was used to estimate the total take of sea turtles by the fishery. In developing the prediction model, explanatory variables were considered in order to estimate takes accurately and precisely. Such variables included: latitude, longitude, distance to 17°C isotherm, distance to 19°C isotherm, year (1994-1999), month, day, hooks, hooks/float, temperature, catch of other species (e.g. tuna species, marlin, albatross, etc.), vessel length, and trip type (i.e. swordfish, tuna, mixed). Some of the variables considered and found to be associated with take were poorly represented in the logbooks during the time period of data gathering and were therefore not considered for prediction purposes. Table IV-4 shows the explanatory variables that were included in the prediction models for the various species of sea turtles.

Table IV-3 Definitions used to characterize the fate of sea turtles taken by Hawaii-based longlines

Fate	Definition	Codes
Alive [Released Unharmed]	An animal removed from the fishing gear that can swim normally. The animal is likely to have minor cuts and abrasions from being entangled. **This applies to entangled sea turtles only.**	EOK = entangled, okay
Injured	An animal released from the fishing gear with obvious physical injury or with gear attached. An injured animal may lie at the surface, breathing irregularly, or swim in an abnormal manner. **If an animal is impaled on a hook, it is considered injured.** "Internal" refers to the hook being ingested, "external" implies that the turtle was hooked in the head, beak, flipper, carapace, or plastron.	HII = hooked, internal, injured HEI = hooked, external, injured HUI = hooked, unknown, injured EI = entangled, injured
Dead	An animal removed from the fishing gear in a postmortem state (i.e. the animal died due to injuries incurred during fishing operations or was returned to the sea while comatose). Animals will show a lack of muscular activity and may float passively at or below the water's surface.	HID = hooked, internal, dead HED = hooked, external, dead HUD = hooked, unknown, dead ED = entangled, dead
Unknown	An animal lost, released, or escaped from the fishing gear whose condition was not determined.	HIU = hooked, internal, unknown; HEU = hooked, external, unknown; HUU = hooked, unknown, unknown; EU = entangled, unknown.

Table IV-4. Explanatory variables used in the prediction models

Species	Explanatory Variables	Categories
Green turtle	None	n/a

Leatherback	Latitude (4 categories)	lat ≤ 14.95°N; 14.95°N < lat ≤ 24.84°N 24.84°N lat ≤ 33.82°N. lat > 33.82°N
Loggerhead	Month (3 categories) Latitude as a polynomial Sea surface temp. (2 categories)	[1,2], [5,6], [3,4,7-12] lat + lat^2 sst ≤ 23.77°C; sst>23.77°C
Olive ridley	Sea surface temp. (2 categories)	sst ≤ 24.22°C; sst>24.22°C

Source: McCracken, 2000.

b. Factors contributing to the likelihood of an interaction with the longline fishery

As discussed in the *Approach to the Assessment* discussion, this section of the biological opinion discusses attributes of the fisheries that represent hazards for threatened and endangered turtles that interact with the longline fisheries. In addition, this section of the opinion discusses environmental conditions that represent risk factors for sea turtles.

(1) Gear

Floats. 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). Floats typically used during swordfish-style sets are bright orange, bullet-shaped, and slightly submerged. Deep sets generally use larger cylindrical inflatable or rigid spherical buoys and floats, and these also are typically orange in color (L. Enriquez, NMFS, personal communication, January, 2001; e.g. www.lindgren-pitman.com/floats.htm).

Bait. 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). In addition, a leatherback has been documented ingesting squid (the bait typically used on the now prohibited gear targeting swordfish). The authors speculate that the lightsticks used on this gear type may initially have attracted the turtle, by simulating natural prey (Skillman and Balazs, 1992).

(2) 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). Swordfish are caught by longliners in association with frontal zones where ocean currents or water masses meet to create turbulence and sharp gradients of temperature and salinity. Swordfish also make vertical migrations through the water column, rising near to the surface at night from deep waters. Thus, while searching for concentrations of swordfish under the prior fishery, longliners set their gear across these temperature gradients ("breaks") indicative of intersecting water masses, and when sea turtles were associated with these fronts, interactions were more likely.

2. General effects of longline fishing on sea turtles

The most significant hazard of longline fisheries for sea turtles results from potential entanglement in or hooking by gear used in the fishery which can injure or kill turtles. Turtles that are entangled in or hooked by longline gear can drown after being prevented from surfacing for air; alternatively, turtles that are hooked, but 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 the Hawaii-based longline fishery, 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 following discussion summarizes the information on these potential effects.

a. Effects of forcible submergence

Sea turtles can be forcibly submerged by longline gear either through a hooking or entanglement event, where the turtle is unable to reach the surface to breathe. This can occur at any time during the set, including the setting and hauling of the gear, and generally occurs when the sea turtle encounters a line that is too short to reach the surface or is too heavy to be brought up to the surface by a swimming sea turtle. For example, a sea turtle that is hooked on a 3 meter branchline attached to a mainline set at depth by a 6 meter floatline will generally not be able to swim to the surface unless it has the strength to drag the mainline approximately 3 more meters (discussed further below).

Turtles hooked by longline gear will sometimes drag the clip, attached to the branch line, along the main line. If this happens, the potential exists for a turtle to become entangled in an adjacent branch line which may have another species hooked such as a shark, swordfish, or tuna. According to observer reports, most of the sharks and some of the larger tuna such as bigeye are still alive when they are retrieved aboard the vessel, whereas most of the swordfish are dead. If a turtle were to drag the branch line up against a branch line with a live shark or bigeye tuna attached, the likelihood of the turtle becoming entangled in the branch line is greater. If the turtle becomes entangled in the gear, then the turtle may be prevented from reaching the surface. The potential also exists, that if a turtle drags the dropper line next to a float line, the turtle may wrap itself around the float line and become entangled.

Sea turtles that are forcibly submerged by longline gear undergo respiratory and metabolic stress that can lead to severe disturbance of their acid-base balance. While most voluntary dives by sea turtles appear to be aerobic, showing little if any increases in blood lactate and only minor changes in acid-base status (pH level of the blood), sea turtles that are stressed as a result of being forcibly submerged through hooking or entanglement in a line rapidly consume oxygen stores, triggering an activation of anaerobic glycolysis, and subsequently disturbing their acid-base balance, sometimes to lethal levels. It is likely that the rapidity and extent of the physiological changes that occur during forced submergence are functions of the intensity of struggling as well as the length of submergence (Lutcavage and Lutz, 1997). In a field study examining the effects of shrimp trawl tow times and sea turtle deaths, there was a strong, positive correlation between the length of time of the tow and sea turtle deaths (Henwood and Stuntz, 1987, *in* Lutcavage and Lutz, 1997).

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). 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 the Hawaii-based longline fishery or other 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).

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 on a longline. 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. During the warmer months, routine metabolic rates are higher, so the impacts of the stress due to entanglement or hooking may be magnified. 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 (*in* 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.

Although a low percentage of turtles that are captured by longliners actually are reported dead, sea turtles can drown from being forcibly submerged. Such drowning may be either "wet" or "dry." In the case of dry drowning, a reflex spasm seals the lungs from both air and water. With wet drowning, water enters the lungs, causing damage to the organs and/or causing asphyxiation, leading to death. 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 of course 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).

b. *Effects of entanglement*

Sea turtles are particularly prone to entanglement as a result of their body configuration and behavior. Records of stranded or entangled sea turtles reveal that fishing debris can wrap around the neck or flipper, or body of a sea turtle and severely restrict swimming or feeding. Over time, if the sea turtle is entangled when young, 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 both 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).

c. *Effects of hooking*

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. When lightsticks were used on a shallow set at night to attract the target species, the turtles could have mistaken the lightsticks for their preferred prey and been 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).

d. *Effects of trailing gear*

Trailing line (i.e. line that is left on a turtle after it has been captured and released), particularly line trailing from an ingested hook, poses a serious risk to sea turtles. Line trailing from an ingested hook is likely to be swallowed, which may occlude the gastrointestinal tract, preventing or hampering foraging, leading to eventual death. Trailing line may also become snagged on a floating or fixed object, resulting in further entanglement, with potential loss of appendages, which may affect mobility, feeding, predator evasion, or reproduction. 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 observer or the vessel and its crew at risk. Turtles with most or all of the trailing gear removed are expected to have a better chance of surviving the interaction in the long term.

e. *Post-hooking survival studies - (lightly hooked v. deeply hooked)*

Research has been conducted in both the Atlantic and the Pacific to estimate post-hooking survival and behavior of sea turtles captured by longline. In the Pacific, from 1997 to late 2000, a total of 54 pelagic turtles hooked by the Hawaii-based longline fishery have had satellite transmitters attached to them in order to track their location and distance traveled following the interaction. Of these 54 turtles, 15 produced no transmissions, or their transmissions lasted less than a month - 11 had deeply ingested hooks (turtles had swallowed the hook, and it was not removed) and 4 were lightly hooked.(turtles had the hook lodged externally (beak or flipper), permitting easy removal) (D. Parker and G. Balazs, NMFS, personal communication, April, 2002). No assumptions were made by the researchers regarding the fate of these turtles that failed to transmit or only transmitted for a short period of time. Assuming that the satellite transmitter was working correctly, there are a number of possible explanations for few or no transmissions, any of which could be correct. Following the hooking incident, including the forced submergence, hauling of the longline and subsequent capture by the vessel, the released turtle may not have had time to recover from its experience. As discussed above, turtles that expend energy as a result of increased activity, need time at the surface to process lactic acid loads. Sea turtles often appear to be moving fairly well and then just collapse, while they rebuild their energy stores or repay their oxygen debt (E. Jacobsen, *in* Balazs, *et al.*, 1995). If a turtle does not have enough energy to remain afloat, it could submerge and die. In addition, injuries sustained as a result of the hooking incident, especially in incidents where the hook may have perforated an organ, may also result in death to the turtle. In both instances, the turtle sinks with the transmitter, and no signal is received. Whether or not these turtles remained submerged and therefore died, or the transmitters failed to transmit is a matter of speculation.

For the 34 turtles that did produce successful tracks for periods lasting more than a month, there were no significant differences (P>0.05) found for the duration of tracking (days) and the distance traveled between lightly hooked turtles (n=15) and turtles with deeply ingested hooks (n=19). Even when the 15 turtles that did not produce successful tracks were taken into account, no significant differences were found in terms of distance traveled and duration between the two groups (19 total lightly hooked, and 30 total deeply ingested). Furthermore, when species were analyzed individually for the two categories, no significant differences were found.

Polovina (NMFS, personal communication, September, 2000) used a contingency table approach to analyze the transmission duration in intervals of 1 month for 34 loggerheads (including those w/ few or no transmissions), comparing lightly hooked versus deeply hooked turtles. While 43% of the deeply hooked turtles transmitted less than one month compared to 27% of the lightly hooked turtles, the chi-squared test found no significant difference between the transmission distributions for these two categories. When the data for all hard shell turtles are combined (n=48), 22% (n=4) lightly hooked and 37% (n=11) deeply hooked turtles transmitted less than one month. Again, the difference was not statistically significant between hooking categories based on a chi-square test.

Data were also analyzed to determine whether the length of the turtle (in straight carapace length) played any role in determining differences between deeply hooked turtles and those that were lightly hooked. Only all satellite tagged loggerheads (both with successful tracks and without (n=35)) showed a significant difference (P=0.02) in size between deeply ingested (mean size =

62.0 ± 10.9 cm) and lightly hooked (mean size = 53.0 ± 6.6 cm) (D. Parker and G. Balazs, NMFS, personal communication, November, 2000).

In the eastern Atlantic, in the waters around the Azores, three juvenile loggerheads that had been lightly hooked by swordfish longline gear were instrumented with satellite-linked time-depth recorders in 1998. The number of dives performed by these hooked turtles was compared to five juvenile loggerheads that had been captured by dipnet and also instrumented. Turtles caught on longline fishing gear had significantly lower dive counts than turtle caught with dipnets during the normal (observed) period of most intense diving activity (from 9:00 am to 3:00 pm) (Bjorndal, *et al.*, 1999). During a similar study in the summer of 2000, in the same area of the Atlantic, 10 pelagic juvenile loggerheads were instrumented - four were captured with dipnets (control), and six had been deeply hooked. In all periods of the 24-hour day (separated by 6-hour increments), the hooked turtles appeared to make longer and shallower dives than control turtles, but overall, dive behavior appeared similar between hooked and non-hooked turtles, having a diurnal component (shallowest dives occurring during 21:00 and 03:00) and a seasonal component (dive depth generally increased for most turtles from summer into fall) (Riewald, *et al.*, 2000). Caution was given in interpreting both sets of data, as the studies were ongoing at the time of writing.

B. Estimation of the Risks the Pelagic Fisheries Pose to Sea Turtles

This section of the biological opinion evaluates the available evidence to assess the probable risks posed by the various fisheries managed under the Pelagics FMP based on the interaction analysis and susceptibilities of the turtles to reach conclusions about the potential effects of the fisheries on threatened and endangered sea turtles. Specifically, we evaluated the available evidence to determine if the fisheries were likely to kill or physically injure these turtles species in ways that would be expected to have chronic or acute effects on their population ecology. Although this section of our assessment included concerns for effects on individual animals, our assessment focused on the probable effects of the fisheries on populations and, through those populations, the viability of the species themselves.

The following discussion estimates the probability of injuries or death based on data extracted from interactions between these fisheries and sea turtles over time. It is important to note that much of the data presented below includes interactions between the turtles and the now-prohibited shallow-set component of the longline fishery. Past mortality estimates for turtles taken by the Hawaii-based longline fishery before 2001 were based on limited data from Aguilar, *et al.* (1995) and from information recorded by observers on the condition of the turtles when released (Kleiber, 1998). Aguilar, *et al.* (1995) estimated a 29% mortality rate for loggerheads ingesting a longline hook; therefore all turtles (hard-shelled and leatherback) that had been hooked internally were assigned a mortality rate of 29%. Turtles recorded as dead had a 100% mortality rate, and turtles recorded as okay (released uninjured) were assigned a 0% mortality rate. All species of turtles hooked externally were also assigned a 0% mortality rate (McCracken, 2000).

Observers occasionally were unable to identify a turtle to species, or to assess their condition accurately. Therefore, identified turtles hooked in an unknown location were assigned the average mortality of the turtles of their species with a known hook location. Turtles with an unknown condition (i.e. not recorded) were assigned the average within species of turtles with condition "okay," internally hooked, or externally hooked. For those turtles reported as hardshell with unknown hook location or unknown condition, the averaging was conducted over all turtles except leatherbacks (Kleiber, 1998), also taking into account temperature or latitude (McCracken, 2000). For example, there were 10 unidentified hardshell turtles observed taken from 1994 to 1999. The identity of these turtles was apportioned to loggerhead, olive ridley, or green turtle takes in the same proportion as observed takes of these species, and, except for green turtles, using the prediction models for each species. Based on the prediction models, olive ridley takes were higher at temperatures greater than 23.77°C, whereas loggerhead takes were higher at temperatures less than 24.22°C. If the sea surface temperature was not a clear indicator, the observed latitude was used to determine the species, since loggerhead takes were higher in the northern latitudes. In the two instances where the choice between the two species was most ambiguous, the identity was split fractionally among the three hardshelled species based on the proportions determined from observer data (McCracken, 2000).

Using the mortality rates assigned above for the condition of a turtle taken by the Hawaii-based longline fishery, the total number of turtles killed per year was estimated by averaging the mortality rates assigned to each condition class for the species, based on observed takes from 1994-1999. For example, of 147 loggerheads observed taken from 1994-1999, 83 were deeply hooked (29% mortality rate), 56 were externally hooked (0% mortality rate), 3 were hooked in an unknown location (17% mortality rate[48]), 1 was dead (100% mortality rate), 3 were entangled and released alive and uninjured (0% mortality rate), and 1 was of unknown condition (17% mortality rate). Averaging these, the resultant mortality rate for the 147 loggerheads observed taken by the Hawaii-based longline fishery was 17.5% (McCracken, 2000).

Given the potential for organ and tissue damage and subsequent infection (as discussed in *Post-hooking survival studies - (lightly hooked v. deeply hooked)* above), total mortalities may have been under estimated previously if lightly hooked animals were assigned a zero mortality rate. To estimate the probability of future mortalities, NMFS reviewed the results of several post-hooking survival studies from Hawaii, the eastern Atlantic, and the Mediterranean (i.e. Aguilar *et al.* 1995; Parker and Balazs pers. comm, 2000; Bjorndal, *et al.* 1999; Riewald, *et al*, 2000), as well as analyses of input from veterinarians and scientists with expertise in sea turtle biology and/or longline gear impacts (see January 4, 2001, memoranda from Don Knowles and Bruce Morehead to the Southeast Regional Office, the Office of Protected Resources).

After reviewing the available information, NMFS reached consensus on a method of estimating sea turtle mortalities (NMFS 2001b). NMFS' adopted approach apportions mortality in a manner consistent with the best scientific information in lieu of applying one standard across the board, while still providing the precautionary approach required for evaluating effects to listed species (NMFS 2001b). Table IV-5 details the estimated mortality rates for sea turtles captured on long line gear based on their condition.

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[48] Turtles with an unknown condition were assigned the average within species of turtles with a known condition (Kleiber, 1998).

Table IV-5. Sea turtle mortality rates based on level and type of interaction with longline fishing gear. Source: NMFS, 2001b

Interaction	Response	Injury	Mortality Rate
Entangled / no hook	Disentangled	No injury	0%
Entangled / external hook	Disentangled, no gear	Minor	27%
	Disentangled, trailing gear	Moderate	27%
	Dehooked, no gear	Minor	27%
Hooked in beak or mouth	Hook left, no gear	Moderate	27%
	Hook left, trailing gear	Serious	42%
	Dehooked, no gear	Moderate	27%
Hook swallowed	Hook left, no gear	Serious	42%
	Hook left, trailing gear	Serious	42%
Turtle Retrieved Dead	---	Lethal	100%

We should also note that very little of the available data contain information on leatherback survival post-interaction. In the absence of better data on this species, NMFS is using the best available scientific data as estimates of the mortality rates leatherbacks may experience while anticipating that more information is likely to become available in the future.

Based on these latter recommendations which take into account the best available scientific and commercial data, NMFS will assume that the mortality rates in Table IV-5 estimate the probability of injury and mortality for sea turtles captured by longline gear in the future. Uncertainty in these impact estimates as a result of differences in the handling of captured turtles or the small sample sizes upon which these mortality rates are drawn should be noted when drawing conclusions about the magnitude of the impacts of delayed mortality on sea turtle populations. NMFS will use these methods to estimate the probability of future mortalities only; estimates of the outcomes of past interactions, which were calculated prior to NMFS' recent review of sea turtle mortality rates, will remain unchanged.

Because the abundance and distribution, migration and foraging patterns, and physiology vary so significantly between the four species of sea turtles that may be encountered by Hawaii-based longliners fishing in the Pacific Ocean, their vulnerability to the Hawaii-based longline fishing operations also varies. The following sections review the past impacts that the Hawaii-based longline fishery has had on each of the sea turtle species.

a. Green turtles

The Hawaii-based longline fisheries rarely capture green turtles. As shown in Table IV-6, observers have recorded the incidental take of 17 green turtles by the prior fishery from 1994-

March 2001. All but one of these turtles were hooked either externally (13), or internally (3), and three were observed dead, the rest injured. In addition, all green turtles observed prior to 2000 were taken from different trips; therefore, there was no evidence within the data that a green turtle in one set implies a higher probability of a green turtle take in another set from the same trip (McCracken, 2000). However, in 2000, two of the seven turtles observed taken that year were taken during the same trip, but different sets.

Table IV-6. Green turtles observed captured by the Hawaii-based longline fishery from 1994-3/01.

Year/Fate	Condition	1994	1995	1996	1997	1998	1999	2000	Total
Alive (Okay)	Entangled	0	0	0	0	0	0	0	0
Injured	Hooked, External	2	0	3	0	2	1	3	11
	Hooked, Internal	0	0	0	0	0	1	2	3
Dead	Entangled	0	0	0	0	0	0	1	1
	Hooked, External	0	0	0	0	0	1	1	2
	Hooked, Internal	0	0	0	0	0	0	0	0

Table IV-7 shows the observed incidental take of two green turtles by the fishery as it currently operates (April 2001 - July 2002 data). These turtles were hooked, one externally and one internally. Both of the turtles were released dead.

Table IV-7. Green turtles observed captured by the current Hawaii-based longline fishery (April 2001 - July 2002).

Year/Fate	Condition	2001	2002	Total
Alive (Okay)	Entangled	0	0	0
Injured	Hooked, External	0	0	0
	Hooked, Internal	0	0	0
Dead	Hooked, External	1	0	1
	Hooked, Internal	0	1	1
	Entangled	0	0	0

Based on observer data, green turtles appear to be more likely to be hooked externally than to be entangled or hooked internally. Therefore, it is likely that green turtles may not be attracted to the baited hooks. The principal food sources for the green turtle are benthic marine algae. These algae are restricted to shallow depths where sunlight, substrate, and nutrients are conducive to plant growth. As a consequence, the feeding pastures used by green turtles are usually less than 10 meters deep and frequently not more than 3 meters deep, often right up to the shoreline. Because of these foraging strategies and food preferences, interactions between green turtles and the Hawaii-based longline fishery are rare.

From observer data (1994 through 1999), and using a model-based predictor, McCracken (2000) estimated that between 37 and 45 green turtles (average 40) were taken each year by the Hawaii-based longline fishery, and of these, an average of 5 were killed (given a 13% mortality rate; Table IV-8).

Table IV-8. Estimated numbers of green turtles captured and killed in the longline fishery with 95% prediction intervals (PI).

Year		1994	1995	1996	1997	1998	1999	Annual Avg
Takes	Estimate	37	38	40	38	42	45	40
	95% PI	[15-65]	[15-70]	[19-70]	[14-73]	[18-76]	[18-76]	[18-71]
Kills	Estimate	5	5	5	5	5	6	5
	95% PI	[0-16]	[0-17]	[1-17]	[0-17]	[1-19]	[1-19]	

Source: McCracken, 2000 and McCracken, personal communication, March 2001

Recently, NMFS-Honolulu Laboratory (2002b) estimated the incidental take of green turtles under the current fishery (July 2001 through June 2002 data; Table IV-9). Comparisons between these estimates and the estimates in Table IV-8 indicate a reduction in the interaction rates between green turtles and the Hawaii-based longline fishery since the current regime took effect.

Table IV-9. Estimates of the incidental capture (hooking and entanglement) of green turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002.

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

Analysis by Kobayashi (2002) estimated that the change in the fishery to the current regime would reduce green turtle take by 93% (95% CI: 85-100%), but actual reductions based on July 2001 through June 2002 data were much lower than expected (69%).

b. Leatherback turtles

As shown in Table IV-10, from 1994- March 2001, observers recorded the incidental take of 52 leatherback turtles in the Hawaii-based longline fishery. Of these, 3 were entangled, released alive and uninjured (5.8%), 43 were injured (83.7% – comprised of 3 entanglements, 33 hooked externally, 3 hooked internally, and 4 hooked in an unknown location), 3 died as a result of the interaction (5.8% - comprised of 2 that were entangled, and 1 that was hooked externally), and for 3 leatherbacks taken, there was no information (i.e. the observer was unable to identify the fate or condition of the turtle). Two trips had more than one leatherback interaction during the trip. One trip had three leatherback interactions and the other trip had two leatherback interactions. There were no leatherback turtles taken in the same set.

Table IV-10. Leatherbacks observed captured by the Hawaii-based longline fishery from 1994-3/2001.

Year/Fate	Condition	1994	1995	1996	1997	1998	1999	2000	2001	Total
Alive (Okay)	Entangled	2	0	1	0	0	0	0	0	3
Injured	Entangled	0	0	2	0	1	0	0	0	3
	Hooked, External	3	3	4	10	2	1	8	2	33
	Hooked, Internal	1	0	0	0	0	0	2	0	3
	Hooked, Unknown	1	0	0	2	1	0	0	0	4
Dead	Entangled	0	0	1	0	1	0	0	0	2
	Hooked, External	0	0	0	0	0	1	0	0	1
No Record		1	1	1	0	0	0	0	0	3

Table IV-11 shows the observed incidental take of two leatherback turtles by the current fishery Between April 2001 and July 2002. One of these turtles was hooked externally and one was entangled. Both of the leatherback turtles were released injured.

Table IV-11. Leatherback turtles observed captured by the Hawaii-based longline fishery 4/2001 - 7/2002.

Year/Fate	Condition	2001	2002	Total
Alive (Okay)	Entangled	0	0	0
Injured	Entangled	0	1	1
	Hooked, External	0	1	1
	Hooked, Internal	0	0	0
Dead	Hooked, External	0	0	0
	Hooked, Internal	0	0	0

Based on observations of leatherback turtles taken by the Hawaii-based longline fishery, leatherback turtles primarily appear to be hooked externally or entangled, rather than ingesting the hook (only three leatherback turtles of 54 observed taken were hooked internally, or 5.5%). This is probably due to their foraging strategy as well as their physiology. Whereas some hard-shelled turtle species (e.g. loggerheads) are piscivores and will forage on the bait used on longlines and therefore become hooked internally, leatherbacks tend to target cnidarians (e.g. medusae and siphonophores), so they may have been attracted to the lightsticks once used on the longlines (but now prohibited) at night to attract squid and subsequently were hooked externally or entangled. Turtles could be captured while feeding or swimming at the surface when the longline is being set or hauled back, or when the longline is fishing at depth.

Leatherbacks appear to be very susceptible to entanglement in fishing gear. Of 11 sea turtles examined port-mortem after being captured by Hawaii-based longline fishers, the only two turtles with leaders around their body parts were leatherback turtles (Work 2000). This susceptibility is probably the result of long pectoral flippers and active swimming behavior that are probably risk factors for entanglement in fishing gear and ocean debris. Leatherback turtles appear to rest for a very small percentage of their daily activity (0-7%, S. Eckert, manuscript in prep. May, 2000). Leatherback hatchlings studied in captivity for almost 2 years swam persistently without ever recognizing the tank sides as a barrier (Deraniyagala, 1939, *in* Wyneken, 1997). As a result, leatherback turtles that become entangled with longlines will probably continue trying to swim (Rudloe, 1979, *in* Witzell, 1984), expending energy and oxygen while becoming more entangled in the process.

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

From observer data, and using a model-based predictor, McCracken (2000) estimated that between 88 and 132 leatherback turtles (average 112) were captured each year, during the period 1994-1999, by the Hawaii-based longline fishery, and of these, an average of 9 died (Table IV-12).

Table IV-12. Estimated numbers of leatherback turtle captured and killed in the longline fisheries (1994-1999) with 95% prediction intervals (PI).

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

	95% PI	[0-22]	[0-21]	[1-21]	[0-18]	[1-28]	[1-27]	

Source: McCracken, 2000 and McCracken, personal communication, March 2001

Recently, NMFS-Honolulu Laboratory (2002b) estimated the incidental take of leatherback turtles under the current fishery (July 2001 through June 2002 data; Table IV-13). Comparisons between these estimates and the estimates in Table IV-12 indicate a reduction in the interaction rates between leatherback turtles and the Hawaii-based longline fishery since the current regime took effect.

Table IV-13. Estimates of the incidental capture (hooking and entanglement) of leatherback turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002.

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

Analysis by Kobayashi (2002) estimated that the change in the fishery to the current regime would reduce leatherback turtle take by 90% (95% CI: 83 - 98%), but actual reductions based on July 2001 through June 2002 data were higher than expected (96%).

c. *Loggerhead turtles*

Loggerhead turtles have been the species most often captured by the Hawaii-based longline fishery. From 1994 through March 2001, observers recorded the incidental take of 175 loggerheads. Of these, 3 were released alive and uninjured (1.7%), 166 were injured by hooking (94.8%) (65 hooked externally, 101 hooked internally), and 4 died as a result of the interaction (3%) (1 hooked internally and 3 hooked in an unknown location). For one loggerhead interaction, there is no information on its condition (Table IV-14). From life history data collected by observers, it appears that the Hawaii-based longline fishery primarily interacts with juvenile loggerheads. Straight carapace lengths (SCL) ranged from 38.4 cm to 90 cm (average 56.9 cm), however, approximately 75% of the captured loggerheads were less than 65 cm SCL (G. Balazs, NMFS, personal communication, January, 2001).

Table IV-14. Loggerheads observed captured in the Hawaii-based longline fisheries from 1994-3/2001.

Year/Fate	Condition	1994	1995	1996	1997	1998	1999	2000	2001	Total
Alive (Okay)	Entangled	1	1	0	1	0	0	0	0	3
Injured	Entangled	0	0	0	0	0	0	1	0	1
	Hooked, External	4	8	10	6	22	6	8	1	65
	Hooked, Internal	6	10	14	15	25	13	13	5	101

Dead	Hooked, Internal	0	0	0	0	1	0	0	0	1
	Hooked, Unknown	0	0	2	0	0	1	0	0	3
No Record		0	0	1	0	0	0	0	0	1

Table IV-15 shows the observed incidental take of four loggerhead turtles by the current fishery between April 2001 and July 2002. These turtles were hooked either externally (1) or internally (2), or entangled and released alive and uninjured (1). Two of the loggerhead turtles were released injured and one turtle, hooked internally, was released dead.

Table IV-15. Loggerhead turtles observed captured by the current Hawaii-based longline fishery 4/2001 - 7/2002.

Year/Fate	Condition	2001	2002	Total
Alive (Okay)	Entangled	0	1	1
Injured	Hooked, External	0	1	1
	Hooked, Internal	0	1	1
Dead	Hooked, External	0	0	0
	Hooked, Internal	0	1	1

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

Using mortality and take estimates described above, McCracken (2000) estimated the take and kill of loggerheads per year, as shown in Table IV-16. Of 2,505 loggerheads estimated taken by the fishery from 1994-1999, 438 were estimated killed (given a 17.5 % mortality rate).

Table IV-16. Estimates of the number of loggerhead turtles captured and killed in the longline fisheries, with 95% prediction intervals (PI).

Year		1994	1995	1996	1997	1998	1999	Annual Avg
Takes	Estimate	501	412	445	371	407	369	418
	95% PI	[315-669]	[244-543]	[290-594]	[236-482]	[259-527]	[234-466]	[273-527]
Kills	Estimate	88	72	78	65	71	64	73
	95% PI	[36-141]	[31-115]	[34-127]	[28-102]	[32-112]	[28-102]	

Source: McCracken, 2000 and McCracken, personal communication, March 2001

Recently, NMFS-Honolulu Laboratory (2002b) estimated the incidental take of loggerhead turtles under the current fishery (July 2001 through June 2002 data; Table IV-17). Comparisons between these estimates and the estimates in Table IV-16 indicate a substantial reduction in the interaction rates between loggerhead turtles and the Hawaii-based longline fishery since the current regime took effect. During February 2002, (after the fishery was modified to eliminate the targeted swordfish fishery and the shallow sets associated with it), three loggerhead turtles were captured in the fishery. Two of those three turtles were captured on sets that are believed to have been illegally using shallow-set methods to target swordfish. As a result, the numbers presented below may overestimate the past incidental take of loggerheads under the current fishery, indicating that loggerhead interaction rates have significantly decreased.

Table IV-17. Estimates of the incidental capture (hooking and entanglement) of loggerhead turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002.

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

Analysis by Kobayashi (2002) estimated that the change in the fishery to the current regime would reduce loggerhead turtle take by 99% (95% CI: 83 -100%); actual reductions based on July 2001 through June 2002 data were 98%.

d. Olive ridley turtles

As shown in Table IV-18, from 1994 through March 2001, observers recorded the incidental take of 50 olive ridleys by the Hawaii-based longline fishery. Of these, 38 were injured (76% – all hooking incidents, 15 hooked externally and 23 hooked internally) and 12 died as a result of the interaction (24% - comprised of 9 that were hooked externally, and 3 that were hooked internally). Based on life history data collected by observers, it appears that the fishery is interacting with both subadult and adult life stages of olive ridleys. For those olive ridleys brought on board and measured (n=29), straight carapace length ranged from 44.5 cm to 66.5 cm (average 55.43 cm).

None of the olive ridleys observed taken by the fishery were entangled, all were hooked; therefore, it is likely that the olive ridleys may have been attracted to the baited hook or to the lightsticks, which may be confused for pyrosomas by the turtle. While the habitat of juvenile olive ridleys is not well-known, adults use a wide range of foraging habitats, feeding pelagically in deep water as well as in shallow benthic waters. They feed on a wide variety of items, ranging from jellyfish, to crabs, molluscs and algae (*in* NMFS and USFWS, 1998d). Stomach contents of 7 olive ridleys captured by the fishery were found to contain salps, cowfish and pyrosomas. One animal had seabird feathers and pelagic snails, while another had large amounts of plastic, fishing line and cellophane. Four of the olive ridleys examined had bait in their esophagus. One of these four turtles was found with three fish used as longline bait, indicating that it had ingested bait from more than one hook (Work and Balazs, draft manuscript, January, 2001).

Table IV-18. Olive ridleys observed captured by the Hawaii-based longline fishery from 1994-3/2001.

Year/Fate	Condition	1994	1995	1996	1997	1998	1999	2000	2001	Total
Injured	Hooked, External	2	2	2	1	1	2	3	3	16
	Hooked, Internal	1	1	6	2	1	5	4	3	23
Dead	Hooked, External	0	0	1	0	2	1	2	4	10
	Hooked, Internal	0	1	0	0	1	0	1	0	3

Table IV-19 shows the observed incidental take of nine olive ridley turtles by the current fishery between April 2001 and July 2002. These turtles were hooked either externally (8) or internally (1). Eight of these turtles were released dead and one was released injured.

Table IV-19. Olive ridley turtles captured by the current Hawaii-based longline fishery between 4/2001 and 7/2002.

Year/Fate	Condition	2001	2002	Total
Alive (Okay)	Entangled	0	0	0
Injured	Hooked, External	1	0	1
	Hooked, Internal	0	0	0
Dead	Hooked, External	1	6	7
	Hooked, Internal	0	1	1

Based on observer data, olive ridleys had the highest mortality rate of all sea turtles captured in the Hawaii-based longline fisheries, probably because more olive ridleys were captured and killed in deep sets than any other species of sea turtle. As shown in Table IV-20, of 878 olive ridleys estimated to have been captured in the fisheries from 1994-1999, an estimated 292 died (assuming a 33.25% mortality rate). Although pathological lesions were noted in 5 olive ridleys necropsied after being taken and killed by the fishery, these were considered mild and incidental (i.e. the turtles were probably not predisposed to being taken as a result of the lesions) (Work, 2000). Therefore, the turtles that died as a result of the interaction probably drowned, suffocated, or died from injuries they suffered as a result of their being hooked. Of the 6 olive ridley turtles captured in deep sets, 5 died, probably because the turtles were unable to surface, because of the deep sets, and drowned.

Table IV-20. Estimates of the number of olive ridley turtles captured and killed in the longline fisheries with 95% prediction intervals (PI)

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

Source: McCracken, 2000 and McCracken, personal communication, March 2001

Recently, NMFS-Honolulu Laboratory (2002b) estimated the incidental take of olive ridley turtles under the current fishery (July 2001 through June 2002 data; Table IV-21). Comparisons between these estimates and the estimates in Table IV-20 indicate a reduction in the interaction rates between olive ridley turtles and the Hawaii-based longline fishery since the current regime took effect.

Table IV-21. Estimates of the incidental capture (hooking and entanglement) of olive ridley turtles, prediction intervals for capture estimates, and estimates of mortality for July 2001 through June 2002.

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

Analysis by Kobayashi (2002) estimated that the change in the fishery to the current regime would reduce olive ridley turtle take by 56% (95% CI: 33-77%), but actual reductions based on July 2001 through June 2002 data were higher than expected (72%).

D. Future Effects of Pelagics FMP Fisheries on Sea Turtles

Under the proposed action, NMFS expects that fishing effort in all fisheries under the Pelagics FMP will continue as it has in previous years, including limitations placed on the number and size of vessels in the Hawaii-based and American Samoa longline fisheries. NMFS also anticipates that, due to the lack of measures to avoid or reduce the amount of bycatch and mortal bycatch of listed species, these interactions will continue with the same frequency and effect as they have in the past. In the case of the Hawaii-based longline fishery, this would be the pattern of interactions since the first implementation of the current fishery by emergency (and now, final) regulations.

1. Handline, Troll, and Pole and Line Fisheries

There have been no reported interactions with sea turtles in the fisheries of the Pelagics FMP other than the Hawaii-based longline fishery, the American Samoa-based longline fishery, and the central and western Pacific U.S. purse-seine fishery (discussed below). There is a chance, based on fishing methods including bait used and gear-type, that these other fisheries do interact with sea turtles although the information is not reported. Due to low effort and target-species selectivity of the gear, incidental take and mortality in these fisheries is likely minimal and has an insignificant effect on the survival and recovery of sea turtle populations.

2. Longline Fisheries

a. American Samoa-based longline fishery

Because NMFS does not have an observer program in place for the American-Samoa-based longline fishery, the only information available is from fisher logbooks. Based on logbooks from 1992 through 2001, it is apparent that this fishery takes sea turtles, but NMFS cannot quantitatively estimate the amount or extent of take of sea turtles by this fishery. In addition, all species of listed sea turtles considered in this Opinion occur within the fishing grounds of this fishery and therefore, all of these species may be taken. Effort has greatly increased in this fishery in the last few years, but if a limited entry program is established as proposed in FMP Amendment 11, effort is unlikely to substantially increase in the future. Increases in effort are likely to result in increased levels of incidental take of sea turtles; however since NMFS has no estimates of the amount of take in recent years, it is difficult to estimate take levels in the future. Required handling and resuscitation techniques and the use of line clippers to remove gear from captured sea turtles should reduce the severity of interactions that may occur.

b. Hawaii-based longline fishery

Based on past observer data and logbook data on the effort and distribution of the Hawaii-based longline fishery, NMFS has calculated the expected annual impact of the continued operation of this fishery (see Table IV-22 below). Uncertainty in these impact estimates as a result of differences in the handling of captured turtles or the small sample sizes upon which these mortality rates are drawn should be noted when drawing conclusions about the magnitude of the impacts of delayed mortality on sea turtle populations.

NMFS calculated expected annual mortality in Table IV-22 by applying the estimated mortality rates (described in NMFS (2001b) and presented in Table IV-5) to the observed and extrapolated information on turtles that were externally hooked, deeply hooked, or retrieved dead based on data from July 1, 2001 through June 30, 2002.

Table IV-22. Rough estimates of annual capture and mortality for sea turtles taken in the Hawaii-based longline fishery, based on past interactions between July 1, 2001 and June 30, 2002. (Source: NMFS-Honolulu Laboratory 2002b)

Species	Incidental Take	Incidental Mortality[1]
Green	8	7
Leatherback	8	3
Loggerhead	14	8
Olive Ridley	26	24

[1] The estimated incidental mortality is a subset of the estimated incidental take by hooking or entanglement.

These numbers provide a rough estimate of the numbers of turtles that may be taken by the Hawaii-based longline fishery during any given year depending on effort and natural variation in ocean conditions and turtle abundance and use of the action area. As mentioned above, these numbers do not include uncertainty associated with small sample size in the scientific studies or differences in handling of captured turtles between scientific studies and fishing operations. In addition, these numbers are based on the effort in the fishery between July 2001 and June 2002. During that year, the number of vessels participating in the fishery has decreased, trips in the shallow-set fishery have been eliminated, and the number of trips in the deep set segment has increased. NMFS' analysis of the future effects of the Hawaii-based longline component of the fisheries operating under the Pelagics FMP will use these estimates when assessing annual and aggregate effects on the species (see section V. *Species' Response to the Action* below.).

V. SPECIES' RESPONSE TO THE ACTION

The *Approach to the Assessment* section of this Opinion stated that we approach jeopardy analyses in a series of steps. First, we identify the probable direct and indirect effects of an action on the physical, chemical, and biotic environment of the action area. Next, we analyze the available information to determine if we would reasonably expect threatened or endangered species to experience reductions in reproduction, numbers, or distribution in response to these effects (since the proposed fisheries are not likely to adversely affect designated critical habitat, this Opinion did not conduct "destruction and adverse modification analyses). In the final step of our analyses, we determine if any reductions in a species' reproduction, numbers, or distribution (identified in the second step of our analysis) can be expected to appreciably reduce a listed species' likelihood of surviving and recovering in the wild.

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 fisheries associated with the Pelagics FMP 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.

For the purposes of this analysis, we will assume that anything that places sea turtle populations in the Pacific Ocean at greater risk of extinction, also places the entire species at a greater risk of extinction; or, in other words, reduces the species' likelihood of survival and recovery. This assumption 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.

A. Humpback Whale

Based on the available information on interactions between humpback whales and the longline fisheries, humpback whales have been entangled in longline fishing gear. However, based on the information available on these previous interactions, the interactions appear to be rare occurrences and, when they have occurred, the humpback whales do not appear to have been injured or killed by the interaction. Because the Western Pacific Pelagic Fisheries have a small probability of interacting with endangered humpback whales and, when they occur, they do not appear to kill or injure the whales, those interactions are not likely to reduce the reproduction, numbers, or distribution of humpback whales. As a result, they are not likely to reduce the humpback whales' likelihood of surviving and recovering in the wild.

B. Hawaiian Monk Seal

Based on unconfirmed logbook data, monk seals may become entangled or hooked in longline fishing gear. However, no interactions between monk seals and the fisheries have been observed (by personnel in NMFS' Observer Program), which we interpret to indicate that the likelihood of interactions between the fisheries and monk seals is small. Further, the single report of an interaction indicated that the seal was entangled in a shallow set which are now prohibited under the Pelagics FMP. Based on these data, NMFS does not anticipate future interactions between monk seals and longline gear.

As a result, the Western Pacific Pelagic Fisheries are not likely to reduce the reproduction, numbers, or distribution of monk seals. As a result, they are not likely to reduce the monk seals' likelihood of surviving and recovering in the wild.

C. Sperm Whale

Based on the available information on interactions between sperm whales and the longline fisheries, sperm whales have been entangled in longline fishing gear. However, based on the information available on these previous interactions, the interactions appear to be rare occurrences and, when they have occurred, the sperm whales did not appear to have been injured or killed by the interaction. Because the Western Pacific Pelagic Fisheries have a small probability of interacting with endangered sperm whales and, when they occur, they do not appear to kill or injure the whales, those interactions are not likely to reduce the reproduction, numbers, or distribution of sperm whales. As a result, they are not likely to reduce the sperm whales' likelihood of surviving and recovering in the wild.

D. Green Turtles

The current fishery is expected to interact with about 8 green turtles each year (95% confidence interval = 2 - 21[49]). Because of their tendency to make relatively shallow dives, sub-adult green turtles have been more likely to encounter shallow-set longlines than deep-set longlines (which are often set below 100 meters). Similarly the routine dives of post-hatchling and juvenile green turtles made them more vulnerable to capture by either shallow-set longline gear or deep-set gear that is being set or retrieved. The only mortalities (n=5, 3 under the prior fishery and 2 under the current fishery) observed were on deep sets; we assume that these turtles drowned. In the past, shallow set gear had a higher interaction rate with green turtles (0.0044 green turtles per set) and subsequent injuries and deaths of green turtles than deep set gear (0.0014 turtles per set); now that shallow set gear has been eliminated, we expect this interaction rate to decrease (0.00057 turtles per set).

Green turtles encountered by U.S. vessels fishing managed under the Pelagics FMP may originate from a number of known breeding colonies in the Pacific Ocean. Genetic sampling of green turtles taken by the Hawaii-based longline fishery on observed trips indicates that green turtles in the action area represent turtles from nesting beaches in Hawaii (French Frigate Shoals) and the eastern Pacific (both Revillagigedos and Michoacan in Mexico and the Galapagos Islands). If the Hawaii- based longline fishery affects green turtle populations proportional to their relative abundance in the action area, about half of the green turtles that interact with the fisheries would come from the endangered eastern Pacific subpopulation, another 35 percent of the affected turtles would represent either the endangered eastern Pacific subpopulation or the Hawaiian subpopulation of threatened green turtles, and the remaining 14 percent would represent the Hawaiian subpopulation of threatened green turtles. Using this assumption, we would expect the pelagic fisheries to interact with about 4 to 7 adult or sub-adult green turtles from the endangered eastern Pacific population and between 1 and 4 adult or sub- adult green turtles from the Hawaiian subpopulation of threatened green turtles each year.

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[49] In the past, these confidence intervals have been based on statistical analyses of data derived from observer reports and logbooks over time. Because the fishery, as currently configured, has only been operating for a single year, this confidence interval had to be generated through bootstrap methods. As we collect additional data on interactions between this fishery and sea turtles over time, these confidence intervals will reflect patterns contained in the data.

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 seemed to result from their diet: because green turtles primarily feed on benthic, marine algae, they seemed less likely to be attracted to the baited hooks used in the longline fishery. As a result they were 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 turtles were more likely to interact with shallow-set gear than deep-set gear.

Nevertheless, based on past patterns of the condition of green turtles that have been observed in the fishery and expected mortality rates for turtles given their condition when they were observed, about 7 adult or sub-adult green turtles would be expected to die each year as a result of their interactions with the current fisheries. Killing about 7 adult or sub-adult green turtles each year would reduce the numbers of individuals in the species, particularly since population estimates for this species are based on estimated numbers of adult turtles. Assuming that some of these turtles would be female, we would also conclude that these deaths would reduce the species' reproduction in addition to reducing their numbers. Assuming that turtles that interact with the fishery are proportional to their relative abundance in the action area, the endangered eastern Pacific population of green turtles would experience the larger reduction in reproduction and numbers.

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 having increased extinction risk. 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), Heppell (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. This conclusion is based on the number of green 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. We will discuss the status and trend of the two aggregations separately, then summarize our conclusions for both.

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. On Colola, an estimated 500-1,000 females nested nightly in the late 1960s. In the 1990s, that number dropped to 60-100 per night, or about 800-1,000 turtles per year (Eckert, 1993). During the 1998-99 season, based on a comparison of nest counts and egg collection data, an estimated 600 green turtles nested at Colola.

In 1990, the 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 - only residents are allowed to harvest turtles for subsistence, and egg poaching occurs only occasionally. An annual average of 1,400 nesting females was estimated for the period 1976- 1982 in the Galapagos Islands (NMFS and USFWS, 1998a). More current estimates of the status and trend of this population are not available.

The additional loss of between 4 and 7 adult or sub-adult, green turtles from this subpopulation each year would reduce the number of animals in the subpopulation. If we assume that some 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.

Hawaiian Green Turtle Population. The green turtles in Hawaii are genetically-distinct and geographically isolated from other green turtle populations; therefore, we treat them as a discrete subpopulation. 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 small size and geographic isolation of this population makes it vulnerable to changes caused by reduced birth rates, increased death rates, or both. 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 the green turtles in Hawaii were first protected in the early 1970s, ending years of exploitation, the nesting population of green turtles in Hawaii has shown a definite increase (Balazs, 1996). For example, the number of green turtles nesting at an index study site at East Island has tripled since systematic monitoring began in 1973 (NMFS and USFWS, 1998a).

Killing 1 to 4 of these green turtles each year 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, then the fishery would also reduce the reproduction of this nesting aggregation.

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 some of the adult turtles that are killed in interactions with the Hawaii-based longline fisheries are females, then 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 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 Western Pacific Pelagic Fisheries 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, as discussed in the introduction to the *Effects of the Action* section, 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.

In the past, we have concluded that the additional mortalities caused by the Hawaii-based longline fishery appreciably contributed to the green turtle's risk of extinction. In the past, the Hawaii-based longline fishery interacted with an average of 40 green turtles each year; we estimated that as many as 23 of these turtles died as a result of these interactions (McCracken, 2000). Most of those interactions and deaths were associated with the shallow-set component of the Hawaii-based fishery, so we now assume the primary threat to green turtles was eliminated with the shallow-set component of the fishery.[50]

Nevertheless, we estimate that killing about 4 to 7 adult or sub-adult female green turtles from the eastern Pacific nesting aggregations and 1 to 4 from the Hawaiian nesting aggregations could still be killed in the remaining fishery. Killing this number of green turtles would represent a small, proportional change in the survival rates of female turtles in those life history stages. However, based on our analyses (see Box 1), although we might be able to detect a small effect of these additional deaths on the annual survival rate of adult or sub-adult turtles in these nesting aggregations, which we would be offset by the number of younger turtles recruiting into the adult of sub-adult population (that is, the number of younger sea turtles maturing into the adult or sub-adult life stages would exceed the number of adult or sub-adult turtles that would be killed during interactions with the fisheries, particularly in the Hawaii subpopulation of green turtles, which has been increasing slightly). As a result, we would not expect the additional mortalities associated with these fisheries to appreciably reduce the either subpopulation's likelihood surviving and recovering in the wild (or, conversely, increase the subpopulations' likelihood of becoming extinct in the wild).

We only have one year of monitoring data from the current fishery; with time, we may discover that the number and rate of interactions and mortalities associated with the fishery as it is currently configured is higher or lower than the data that are currently available would suggest (in the former instance, we would probably reinitiate formal consultation on the fisheries). However, based on the data available for this consultation, we conclude that the change in the survival rates of adult and sub-adult caused by the current fisheries would not be expected to *appreciably* reduce the western Pacific nesting aggregations' likelihood of surviving and recovering in the wild. As a result, it would not reduce appreciably the species' likelihood of surviving as recovering in the wild.

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[50] 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 result, our analyses group the endangered populations and the threatened populations and treat them both as endangered to make certain that we afford the endangered turtles the additional protection warranted by their classification.

Box 1. We explored several population models to determine whether the 7 or so green turtles the are estimated to be killed in interactions with the proposed fisheries would be expected to "appreciably reduce" the green turtle's likelihood of surviving and recovering in the wild (it is important to note that these simulations were not formal analyses of a population's viability, they focused only on the issue of "appreciable reductions" in a species' likelihood of surviving and recovering in the wild). Our final analyses relied on a deterministic model of a population's probability of reaching a quasi-extinction threshold ($n = 200$) at any time over a 50-year period using the following equation to integrate the Gaussian distribution from $t = 0$ to $t = 50$ to produce a cumulative distribution for time to quasi-extinction (see equation 3.5 of Morris, W.F. and D.F. Doak. 2002. Quantitative conservation biology. Theory and practice of population viability analysis. Sinauer Associates, Inc.; Sunderland, Massachusetts). The equation is represented as:

$$G(T|d,\mu,\sigma^2) = \varphi\left(\frac{-d-\mu T}{\sqrt{\sigma^2 T}}\right) + \exp\left(-2\mu d/\sigma^2\right)\varphi\left(\frac{-d+\mu T}{\sqrt{\sigma^2 T}}\right)$$

Where $G(T|d, \mu, \sigma^2)$ = the cumulative probability of reaching the quasi-extinction threshold at time T.
ϕ = is the standard normal cumulative distribution function (produced by the NORMDIST function in Excel)
d = $\log N_c$ - $\text{Log } N_x$ or the difference between the log of the current population size (N_c) and the log of the quasi-extinction threshold (N_x)
μ = the mean of the log population growth rate
σ^2 = the variance of the log population growth rate

To simulate the possible response of the various turtle populations, we created a "population" of about 700 and 1,000 individuals (counting only adult females) with specific mean and variances and projected the population for 50 years. The we reduced the populations by 3 to 7 individuals each year, re-ran the simulations for 50 years and compared the changes using paired Student's t-tests.

E. Hawksbill Sea Turtle

Hawksbill turtles occur in the water around the Hawaiian Islands (on Molokai, Maui and 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 an unconfirmed logbook report of an interaction between a hawksbill turtle and longline gear in American Samoa, there is a possibility of hawksbill turtles becoming incidentally entangled or hooked in longline fishing gear. However, no hawksbill turtles have been observed to interact with the longline fisheries, which indicates that the likelihood of an interaction is small. Moreover, the single report in vessel logbooks of an interaction indicated that the animal was taken in a shallow set and shallow sets are now prohibited under the Pelagics FMP. Based on the available data and the distribution of hawksbill turtles relative to the distribution of the pelagic fisheries, NMFS does not anticipate future interactions between hawksbill turtles and longline gear. Consequently, the Western Pacific Pelagic Fisheries are not likely to reduce the reproduction, numbers, or distribution of hawksbill turtles. As a result, they are not likely to reduce the turtles' likelihood of surviving and recovering in the wild.

F. Leatherback Turtles

The current fishery is expected to interact with about 8 leatherback turtles each year (95% confidence interval = 2 - 23). Most leatherback turtles will hooked externally rather than internally, although leatherback turtles also appear to be susceptible to entanglement in fishing gear. Virtually all of the leatherback turtles that would interact with the longline component of the Western Pacific Pelagic Fisheries (the number of leatherback turtles adversely affected by other fisheries included in this FMP is expected to be small). Based on the size of the leatherback turtles caught in the fishery in the past, we expect the fishery to capture either sub-adult or adult leatherback turtles.

Based on genetic analyses, most of the leatherback turtles captured in the Hawaii-based longline fishery are from two nesting aggregations: the western Pacific region (Indonesia, Papua New Guinea, and Solomon Islands), and the eastern Pacific region (Mexico and Costa Rica). The limited genetic sampling from the area indicates that about 94% of the leatherback turtles sampled in the action area originated from western Pacific nesting beaches (P. Dutton *et al.*, 2000; P. Dutton, NMFS, personal communication, January, 2001). If the current longline fisheries affect leatherback turtle populations proportional to their relative abundance in the action area, about 94 percent of the leatherback turtles that interact with the longline fisheries would come from the western Pacific populations. The remaining 6 percent would represent the eastern Pacific population. Assuming proportionality, almost all of the leatherback turtles that interact with the fishery would originate in the western Pacific population, although leatherback turtles from the eastern Pacific have a small, but distinct risk of interacting with the fishery as well.

Based on past patterns of the condition of sea turtles that have been observed in the fishery and expected mortality rates for turtles given their condition when they were observed, about 3 of the 8 leatherback turtles can be expected to die each year as a result of their interactions with the fisheries. Killing about 3 adult or sub-adult leatherback turtles each year would reduce the numbers of individuals in the species, particularly since population estimates for this species are based on estimated numbers of adult, female turtles. Assuming that some of the leatherback turtles captured and killed in the fishery would be females, we would also conclude that these deaths would reduce the species' reproduction in addition to reducing their numbers.

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 had 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 colonies 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 III,. *Status of the Species and Environmental Baseline*).

Leatherback turtles, like green turtles discussed previously, are long-lived, have high adult survival rates, and delayed maturity; 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, 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 3 adult or sub-adult leatherback turtles) would 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, and the Solomon Islands. 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 Terengganu - 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). The size of the current nesting assemblage represents less than 2 percent of the size of the assemblage reported from the 1950s; with one or two females nesting in this area each year (P. Dutton, personal communication, 2000). 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, Australia, and Papua-New Guinea (East Papua), leatherback turtles have only been known to nest in low densities and scattered colonies.

Only an Indonesian nesting assemblage has remained relatively abundant in the Pacific basin. The largest, extant leatherback nesting assemblage in the Indo-Pacific lies on the north coast of Irian Jaya (West Papua), Indonesia. The western Pacific nesting aggregation consists of about 1,000 adult females (about 500 in Indonesia, about 150 in the Solomon Islands, and about 400 in Papua New Guinea). Killing three of these adult leatherback turtles each year would reduce the abundance of this nesting aggregation. If we assume that all of the adult turtles that are killed in interactions with the Hawaii-based longline fisheries are females (an incorrect assumption since at least some of the turtles captured in the fishery have been male), then the fishery would also 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.

In the eastern Pacific Ocean, nesting populations of leatherback turtles 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 colony 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.

Given the population ecology of sea turtles in general, and leatherback turtles in particular, these mortalities would be expected to have significant, adverse effects on the population ecology of leatherback turtles in the western Pacific Ocean. Although the additional mortalities associated with Western Pacific Pelagic Fisheries would clearly reduce the numbers and may reduce the reproduction of the western Pacific subpopulation of leatherback sea turtles, the "jeopardy" standard requires us to consider those effects on a species' survival and recovery in the wild. Specifically, as discussed in the introduction to the *Effects of the Action* section, 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 green turtle narrative, 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.

In the past, NMFS has concluded that the additional mortalities caused by the Hawaii-based longline fisheries and other domestic fisheries appreciably contributed to the leatherback turtles risk of extinction. Although the number of leatherback turtles killed in these fisheries were relatively small, the status of leatherback turtles in the Pacific Ocean and prior experience with other threatened and endangered species suggested that the population could not withstand the additional threat these fisheries posed to the survival and recovery of leatherback turtles. 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*). Fujiwara and Caswell (2001) demonstrated that preventing the death of one or two female northern right whales per year could increase that population's growth rate to replacement levels. More recently, reports from the U.S. Pacific Northwest and British Columbia suggest small, incremental losses of northern spotted owls may have caused the owl to decline by as much as half in portions of its range (Dawdy 2002).

We distinguish the threat posed by the Western Pacific Pelagic Fisheries from those other circumstances primarily because these fisheries have been modified in ways that virtually eliminate the risk they pose to leatherback turtles. In the past, the U.S. Pacific pelagic fisheries interacted with an average of 112 (95% confidence interval 75-157) leatherback turtles and caused the death of between 24 to 49 of these turtles each year. The remaining mortality of about 3 adult or sub-adult leatherback turtles from the western Pacific nesting aggregations would represent a small proportional change in the survival rates of female turtles in those life history stages (0.003 percent). However, based on our analyses (see Box 1), although this might represent a reduction in the survival rate of a particular group of turtles in this subpopulation, we would not expect that reduced survival rate to represent an appreciable reduction in the subpopulation's likelihood of persisting in the wild (or an increase in the subpopulation's likelihood of becoming extinct in the wild).

Only a few published studies either calculated or reported the variance in vital rates (or lambda), so our ability to place this amount of change into perspective. 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, we would not be able to detect the effect of the remaining mortalities associated with the current fisheries on the survival rates of adult and sub-adult leatherback turtles in the western Pacific (assuming that we had the data necessary to reliably estimate survival rates). We believe the number of leatherback turtles that would be expected to interact with the current pelagic fisheries and die as a result of those interactions is so small that it would be masked by background variance, even considering the effects of the other sources of mortality that were discussed in the *Environmental Baseline*.

We only have one year of monitoring data from the current fishery; with time, we may discover that the number and rate of interactions and mortalities associated with the fishery as it is currently configured is higher or lower than the data that are currently available would suggest (in the former circumstance, we would probably reinitiate formal consultation on the fisheries). However, based on the data available for this consultation, we conclude that the change in the survival rates of adult and sub-adult caused by the current fisheries would not be expected to *appreciably* reduce the likelihood of surviving and recovering in the wild of the Pacific Ocean populations of leatherback turtles. As a result, it would not reduce the species' likelihood of surviving as recovering in the wild.

G. Loggerhead Turtles

The current fishery is expected to interact with about 14 loggerhead turtles each year (95% confidence interval = 3 - 26), although interactions are more likely north of 22°N latitude (12 interactions, with a 95% confidence interval = 3 - 29) than south of 22°N (2 interactions, with a

95% confidence interval = 0 - 8). Degree of latitude appeared to be a primary determinant of the probability of loggerhead captures in the fisheries. For example, McCracken (2000) reported that, none of 1,263 sets that were observed south of 22%N captured loggerhead turtles. Kleiber (1998) also found latitude to be the primary determinant of interactions between the fisheries and loggerhead turtles. However, after March 2001, the current fishery caught two loggerhead turtles, including one turtle far south of the area in which loggerhead turtles were typically seen (13°N latitude).

Based on genetic analyses, all of the loggerhead turtles captured in the Hawaii-based longline fishery originate from Japanese nesting aggregations (Dutton *et al.*, 1998, P. Dutton, NMFS, personal communication, October, 2002). Available data on the length of these turtles, supported by information on their foraging and migrating patterns, indicates that the fishery captures pelagic-stage juvenile loggerhead turtles.

Historically, most of the loggerhead turtles that interact with the fishery were either hooked internally or externally. The tendency to be hooked internally probably resulted from their diet: Loggerhead turtles in north Pacific pelagic habitats are opportunistic, omnivorous predators of the surface layer, feeding both by swallowing floating prey whole, biting off prey items from larger floating objects, or both. Based on past patterns of the condition of sea turtles that have been observed in the fishery and expected mortality rates for turtles given their condition when they were observed, we have estimated that about 8 of the 14 loggerhead turtles would be expected to die each year as a result of their interactions with the fisheries.

However, it is important to place these numbers into perspective: between July 2001 and June 2002 (when the fishery was modified to eliminate the targeted swordfish fishery and the shallow sets associated with it), three loggerhead turtles were captured in the fishery, two of those three turtles were captured by vessels that are believed to have been illegally using shallow sets to target swordfish. All of the 175 loggerheads that interacted with the Hawaii-based longline fishery from 1994 through March, 2001, were captured by longliners using shallow sets (i.e. target depths less than 100 meters, using less than 10 hooks per float, fishing at night, using lightsticks). 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. Eliminating the targeted swordfish fishery is expected to virtually eliminate the likelihood of interactions between the current fishery and loggerhead turtles.

Placed in this perspective, the estimated number of interactions between the current fishery and loggerhead turtles was biased by vessels that were allegedly fishing illegally; the Council and NMFS have taken further action to reduce the likelihood of such illegal activity in the future. As a result, although we estimated that 14 loggerhead turtles would interaction with the fishery and 8 of those turtles would die as a result of their interaction, those estimates may overestimate the risk by more than 66%. In July 2002, a loggerhead turtle was caught in a deep set fishing at 13%N latitude, an interaction than diverged from NMFS' past observations of the overlap between this species' pelagic distribution and behavior and the deep-set portion of the longline fishery; this recent observation is evidence that the current fishery poses a risk to loggerhead turtles even if that risk is much smaller than our current estimates.

Killing between 3 and 8 pelagic juvenile loggerhead turtles each year would reduce the numbers of individuals in the species, particularly since population estimates for this species are based on estimated numbers of adult, female turtles. 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 (see Table 2 in Appendix C; 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 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 colonies throughout the Pacific basin has declined dramatically over the past 10 to 20 years. Loggerhead turtle colonies 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 Pelagic FMP fisheries added to the current status and trend of the Japanese loggerhead population would increase the Japanese loggerhead population's rate of decline.

Although the mortalities associated with the Western Pacific Pelagic Fisheries would clearly 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, as discussed in the introduction to the Effects of the Action section, 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.

In the past, we have concluded that the additional mortalities caused by the Hawaii-based longline fishery appreciably contributed to the green turtle's risk of extinction. In the past, the Hawaii-based longline fishery interacted with an average of 418 loggerhead turtles each year; we estimated that as many as 73 of these turtles died as a result of these interactions (McCracken 2000). Most of those interactions and deaths were associated with the shallow-set component of the Hawaii-based fishery, so we now assume the primary threat to loggerhead turtles was been eliminated with the elimination of the shallow-set component of the fishery. This change in the baseline conditions associated with this fishery should dramatically virtually eliminate the risk the fishery has historically posed to loggerhead turtles.

Nevertheless, we estimate that 3 and 8 pelagic juvenile loggerhead turtles from the Japanese nesting aggregation could still be killed in the remaining fishery. Killing this number of loggerhead turtles would represent a small proportional change in the survival rates of juvenile turtles in that life history stage. However, based on our analyses (see Box 1), although we might be able to detect a small effect of these additional deaths on the annual survival rate of adult or sub-adult turtles in these nesting aggregations, which we would be offset by the number of younger turtles recruiting into the adult of sub-adult population (that is, the number of younger sea turtles maturing into the adult or sub-adult life stages would exceed the number of adult or sub-adult turtles that would be killed during interactions with the fisheries). As a result, we would not expect the additional mortalities associated with these fisheries to appreciably reduce the either subpopulation's likelihood surviving and recovering in the wild (or, conversely, increase the subpopulations' likelihood of becoming extinct in the wild).

We only have one year of monitoring data from the current fishery; with time, we may discover that the number and rate of interactions and mortalities associated with the fishery as it is currently configured is higher or lower than the data that are currently available would suggest (in the former instance, we would probably reinitiate formal consultation on the fisheries). However, based on the data available for this consultation, we conclude that the change in the survival rates of adult and sub-adult caused by the current fisheries would not be expected to *appreciably* reduce the Japanese nesting aggregations' likelihood of surviving and recovering in the wild. As a result, it would not reduce the species' likelihood of surviving as recovering in the wild.

H. Olive Ridley Turtle

The U.S. pelagic fisheries in the western Pacific Ocean will capture, injure, or kill adult and sub-adult olive ridley sea turtles. Virtually all of the olive ridley turtles that would interact with these fisheries would be affected by the longline fisheries (the number of olive ridley turtles that would interact with other fisheries included in the Pelagics FMP are expected to be minimal – if any takes occur at all). Based on past patterns of olive ridley turtles captured in the Hawaii-based longline fishery, these turtles may interact throughout the year, with most of the interactions occurring during the warmer months (May-August); and concentrated in areas surrounding the Hawaiian Island chain.

The current fisheries are expected to annually and incidentally capture about 26 adult or sub- adult olive ridley turtles (95% confidence interval = 12 - 47). Most of these turtles will probably be hooked, rather than entangled, with slightly more of them being hooked internally; internal hooking is expected to kill more turtles than external hooking. Therefore, about 24 of the olive ridley turtles captured in this fishery would die each year as a result of the interaction. In the past, shallow set gear has had a higher interaction rate of captures (0.0144 olive ridley turtles per set) and subsequent injuries and deaths of olive ridley turtles than deep set gear (0.0042 turtles per set); with the reduction in shallow set gear under the current fisheries, we expect this interaction rate to decrease (0.002 turtles per set).

Recent genetic information analyzed from 39 olive ridleys taken in the Hawaii-based longline fishery indicate that 74 percent of the turtles originated from the eastern Pacific (Mexico and Costa Rica) and 26 percent of the turtles were from the Indian and western Pacific beaches (P. Dutton, NMFS, personal communication, October 2002), indicating the animals from both sides of the Pacific converge in the north Pacific pelagic environment and may be equally affected by the proposed action.

If the longline fisheries affect olive ridley turtle populations proportional to their relative abundance in the action area (as documented through observer data), about 74 percent of the olive ridley turtles that are captured, injured, or killed by the longline fisheries would come from eastern Pacific populations. The remaining 26 percent would represent western Pacific populations. Using this assumption, it is reasonable to expect about 18 sub-adult or adult olive ridley turtles from the eastern Pacific population and another 6 sub-adult or adult olive ridley turtles from the western Pacific population would be killed each year in the Hawaii-based longline fishery. Further, it would be reasonable to expect that more of these olive ridley turtles would be taken by the shallow set component of the fishery based on that component's higher interaction rates.

We believe it is reasonable to expect that killing about 24 adult or sub-adult olive ridley turtles each year would reduce the numbers of individuals in the species, particularly since population estimates for this species are based on estimated numbers of adult turtles. Assuming that some of these turtles would be female, we would also conclude that these deaths would reduce the species' reproduction in addition to reducing their numbers. Assuming that turtles captured and killed in the fishery are proportional to their relative abundance in the action area, the western Pacific population of olive ridley turtles would experience the larger reduction in reproduction and numbers.

We do not believe these mortalities will 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.*, in press).

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 Terengganu, Malaysia, and at one time yielded 240,000 eggs (2,400 nests, with approximately 100 eggs per nest) (Siow and Moll, 1982, *in* Eckert, 1993)), while only 187 nests were reported from the area in 1990 (Eckert, 1993).

In 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.

Given initial population sizes and increases in the Mexican and Costa Rican populations in recent year, the mortalities associated with the U.S. pelagics fisheries are not likely to halt or reverse the increasing trend of those populations. Removing adult or sub-adult turtles from the eastern Pacific population could slow the recovery of the population that is occurring, although it is not clear if that reduction would be measurable given the size of the nesting population.

Population trends in the western Pacific are more difficult to discern, although it is clear that there are still large populations of olive ridleys nesting in India. Killing adult and sub-adult turtles in the western Pacific population could have more serious consequences, since 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. By removing reproductive adults and pre-reproductive sub-adults from this declining population, the Hawaii- based longline fisheries could 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 recruiting into the adult population, we believe this population can withstand the mortalities and reduced reproductive rates associated with the current fisheries without appreciable reductions in the olive ridley turtle's likelihood of the surviving and recovering in the wild.[51]

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[51] 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. 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 result, our analyses group the endangered populations and the threatened populations and treat them both as endangered to make certain that we afford the endangered turtles the additional protection warranted by their classification.

VI. CUMULATIVE EFFECTS

Cumulative effects 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. 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.

Most of the fisheries described as occurring within the action area (Section III. *Status of the Species* and *Environmental Baseline*), are expected to continue as described into the foreseeable future. Therefore, NMFS is not aware of any proposed or anticipated changes in most of these fisheries that would substantially change the impacts each fishery has on the sea turtles covered by this Opinion.

In addition to fisheries, NMFS is not aware of any proposed or anticipated changes in other human-related actions (e.g. poaching, habitat degradation) or natural conditions (e.g. over-abundance of land or sea predators, changes in oceanic conditions, etc.) that would substantially change the impacts that each threat has on the sea turtles or marine mammals covered by this Opinion. Therefore, NMFS expects that the levels of take of sea turtles described for each of the fisheries, except the California longline fishery, and non-fisheries will continue at similar levels into the foreseeable future.

VII. CONCLUSION

After reviewing the available scientific and commercial data, current status of endangered and threatened green turtles, the environmental baseline for the action area, the effects of the current fisheries, the proposed Amendment 11, and the cumulative effects, it is NMFS' biological opinion that the continued authorization of pelagic fisheries in the Western Pacific Region under the Pelagics FMP is not likely to jeopardize the continued existence of green turtles.

After reviewing the available scientific and commercial data, current status of hawksbill turtles, the environmental baseline for the action area, the effects of the current fisheries, the proposed Amendment 11, and the cumulative effects, it is NMFS' biological opinion that the continued authorization of pelagic fisheries in the Western Pacific Region under the Pelagics FMP is not likely to jeopardize the continued existence of hawksbill 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 pelagic fisheries in the Western Pacific Region under the Pelagics FMP 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 pelagic fisheries in the Western Pacific Region under the Pelagics FMP 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 pelagic fisheries in the Western Pacific Region under the Pelagics FMP is not likely to jeopardize the continued existence of olive ridley turtles.

After reviewing the available scientific and commercial data, current status of endangered eastern Pacific 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 pelagic fisheries in the Western Pacific Region under the Pelagics FMP is not likely to jeopardize the continued existence of endangered eastern Pacific olive ridley turtles.

After reviewing the available scientific and commercial data, current status of humpback whales, 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 pelagic fisheries in the Western Pacific Region under the Pelagics FMP is not likely to jeopardize the continued existence of humpback whales.

After reviewing the available scientific and commercial data, current status of sperm whales, 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 pelagic fisheries in the Western Pacific Region under the Pelagics FMP is not likely to jeopardize the continued existence of sperm whales.

After reviewing the available scientific and commercial data, current status of Hawaiian monk seals, 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 pelagic fisheries in the Western Pacific Region under the Pelagics FMP is not likely to jeopardize the continued existence of Hawaiian monk seals.

VIII. INCIDENTAL TAKE STATEMENT

Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. NMFS further defines "harm" as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding or sheltering. 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 7(o)(2), taking that is incidental to and not intended as part of the proposed action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this 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 has a continuing duty to regulate the activity covered by this incidental take statement. If NMFS 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 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))

Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. It also states that reasonable and prudent measures, and terms and conditions to implement the measures, be provided that are necessary to minimize such impacts. Only incidental take resulting from the agency action and any specified reasonable and prudent measures and terms and conditions identified in the incidental take statement are exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA.

AMOUNT OR EXTENT OF TAKE

The following table contains the anticipated amounts of estimated takes and mortalities that will occur annually by the Hawaii-based longline fishery under the Western Pacific Pelagics Fishery Management Plan.

The annual estimated incidental take of sea turtles has been calculated by using the estimates of annual capture and mortality for sea turtles in the Hawaii-based longline fishery in Table IV-22. NMFS is not including an incidental take authorization for humpback whales, sperm whales, or Hawaiian monk seals at this time because the incidental take of marine mammals has not been authorized under section 101(a)(5) of the Marine Mammal Protection Act. Following issuance of such regulations or authorizations, the Service may amend this biological opinion to include an incidental take statement for humpback whales, sperm whales, or Hawaiian monk seals, as appropriate.

Table VIII-1. Estimated annual capture and mortality levels in the Hawaii-based longline fishery based on the existing regulations implementing the fishery management plan.

Species	Annual Estimated Incidental Take	Annual Estimated Incidental Mortality
Green	8	7
Leatherback	8	3
Loggerhead	14	8
Olive Ridley	26	24
Hawksbill	0	0
Humpback whale	0	0
Monk seal	0	0

Table VIII-1. Estimated annual capture and mortality levels in the Hawaii-based longline fishery based on the existing regulations implementing the fishery management plan.

Species	Annual Estimated Incidental Take	Annual Estimated Incidental Mortality
Sperm whale	0	0

All five species of sea turtles may be taken in the other fisheries authorized by the Pelagics FMP. The known level of effort and the selectivity of the gear used in most of these fisheries leads NMFS to conclude that few takes, if any, occur in these other fisheries, although NMFS has limited data to confirm this assumption. Therefore, NMFS has quantified the amount of incidental take of sea turtles that may occur during operations of these other fisheries based on the limited information available. The resulting numbers (Table VIII-2) are possible minimums that should re-evaluated after one year of data has been gathered on these fisheries. Subsequent years' information will be used to further refine expected levels of incidental take and evaluate their impacts on listed species. Based on the observer and logbook data, NMFS does not anticipate take of listed marine mammals by these pelagic fisheries under the Pelagics FMP.

Table VIII-2. Estimated annual capture and mortality levels of sea turtles in the pelagic fisheries under the Pelagics FMP other than the Hawaii-based longline fishery.

Fishery	Annual Estimated Incidental Take (All Turtle Species Combined)	Annual Estimated Incidental Mortality (All Turtle Species Combined)
All handline fisheries	1	0
All troll fisheries	1	0
Pole and line	1	0
American Samoa longline	3 hardshell turtles, 1 leatherback	1 hardshell turtle

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, hawksbill, humpback whale, leatherback turtle, loggerhead turtle, monk seal, olive ridley turtle, or sperm whale when the reasonable and prudent measures are implemented.

Reasonable and Prudent Measures

NMFS believes the following reasonable and prudent measures, as implemented by the terms and conditions, are necessary and appropriate to minimize impacts to 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. Thus, the following reasonable and prudent measures must be implemented to allow activities of the Pelagic Fisheries to continue.

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 develop a system that will enable NMFS to collect basic listed species bycatch data in the troll and handline fisheries under the Pelagics FMP.

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

4. Comatose and lethargic sea turtles shall be retained on board, handled, resuscitated, and released according to established procedures.

5. Sea turtle mortalities shall 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 implement reasonable and prudent measure No. 1.

   1A. 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 shall be maintained at an annual average level of 20 percent or more.

   1B. NMFS shall establish an observer program, where feasible, aboard longline vessels fishing under a Pelagics FMP general permit or a limited access permit for the American Samoa-based longline fishery, should such a permit program be established. The purpose of the observer program is to provide NMFS with information necessary to determine if these fisheries interact with listed species and what level of impact the fisheries might have on those species. The feasibility of establishing an observer program aboard these vessels may depend upon the space available on the vessel to house and maintain an observer to carry out their duties.

1C. Observer programs shall collect information regarding the incidental capture, injury, and mortality of sea turtles by species, gear and set information in which each interaction occurred, and life history information.

1D. NMFS 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.

1E. NMFS observers shall record the presence or absence of tags on all sea turtles captured by longline fisheries.

1F. Data collected by observers shall be made available on a quarterly basis. The "Quarterly Status Report" will be sent to the Sea Turtle Coordinator in Silver Spring, Maryland.

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

2A. NMFS shall coordinate with the Forum Fisheries Agency observer program to collect life history information on sea turtles, such as species identification, measurements, condition, skin biopsy samples, the presence or absence of tags, and the application of flipper tags if none are present.

2B NMFS, in collaboration with the Western Pacific Fishery Management Council, shall develop a system to collect basic listed species bycatch data associated with non-longline pelagic fishing vessels fishing with hook-and-line within EEZ waters of the western Pacific region.

3. The following term and condition implements reasonable and prudent measure No. 3.

3A. NMFS shall continue to conduct protected species workshops for skippers of vessels registered for use with longline fishing permits issued under the Pelagics FMP to facilitate proficiency on mitigation, handling, and release techniques for turtles, as outlined in 50 CFR 223.206(d)(1).

3B. NMFS 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 skippers of longline vessels registered for use with permits issued under the Pelagics FMP.

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

3D. All sea turtles shall be removed from fishing gear or brought on deck prior to continuing with gear retrieval.

3E. 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 injury or mortality. If the hook cannot be removed (e.g., the hook is deeply ingested or the animal is too large to bring aboard), each vessel must carry a line clipper to cut the line as close to the hook as practicable and remove as much line as possible prior to releasing the turtle.

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

3G. 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.

3H. 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 to participants in the troll and handline pelagic fisheries in the western Pacific region.

3I. In the event of an interaction with a sea turtle, an operator of a vessel using hooks (i.e, handline and troll fishing gear) to target Pacific pelagic management unit species in waters of U.S. western Pacific EEZ, must handle the sea turtle in a manner to minimize injury and promote post-hooking survival. If a sea turtle is too large or hooked in such a manner as to preclude safe boarding without causing further damage/injury to the turtle, the fishing line must be severed and as much line removed prior to releasing the 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 223.206 (d)(1) and 660.32(b),(c), and (d).

4B. If an observer is aboard the vessel, the observer shall perform resuscitation techniques on comatose sea turtles.

4C. In the event of an interaction with a sea turtle, an operator of a vessel using hooks (i.e, handline and troll fishing gear) to target Pacific pelagic management unit species in waters of U.S. western Pacific EEZ, must handle the sea turtle in a manner to minimize injury and promote post-hooking survival as outlined in 50 CFR 660.32 (c) and (d).

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 NMFS requests the turtle be kept for further study.

IX. 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.

1. NMFS should research modifications to existing gear that (1) reduce the likelihood of gear interactions and (2) dramatically reduce the immediate and/or delayed mortality rates of captured turtles (e.g., visual or acoustic cues, dyed bait, hook type). All research funded and/or implemented by NMFS 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, via a robust experimental assessment, which would achieve the above two goals and remain economically and technically feasible for fishermen to implement.

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

3. NMFS should explore the feasibility of developing a system for fishermen to collect life history information on sea turtles.

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

5. 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.

6. NMFS should undertake efforts to implement protection measures and management actions to protect nesting leatherbacks and increase hatchling production at key nesting beaches in the Pacific.

7. NMFS should establish an observer program for the California-based longline fishery to determine the impact of the fishery may be having on sea turtle and other protected species populations.

8. NMFS should 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 .

9. NMFS should collaborate with the Forum Fisheries Agency to collect data on capture, injury and mortality of sea turtles and life history information aboard U.S. tuna purse seine vessels fishing in the western Pacific under the Treaty on Fisheries Between the Governments of Certain Pacific Island States and the Government of the United States of America (South Pacific Tuna Treaty Act). Although there currently is an observer program for the U.S. tuna purse seine vessels fishing in the western Pacific through the Forum Fisheries Agency under the Treaty on Fisheries Between the Governments of Certain Pacific Island States and the Government of the United States of America, the data collected is considered to be highly confidential by the 16 Pacific Island member countries and the release of data must be authorized by these countries before any release can occur. Currently, NMFS receives bycatch data associated with this fishery on an annual basis through the South Pacific Commission. However, the information does not provide specifics about sea turtle interactions such as location or condition, nor are the observers collecting life history information on captured sea turtles. In addition, data collected by vessel monitoring systems (VMS) is not provided to NMFS in a form which can be used to describe how U.S. vessels may be operating in the fishing areas and interacting with sea turtles. Therefore, NMFS should request that the collection of sea turtle information becomes a high priority for Forum Fisheries Agency observers and that sea-going observers have enough time to collect essential sea turtle life history and disposition information on any captured sea turtles and that VMS data be provided to NMFS for use in estimating the effects of U.S. vessels on sea turtles. This bycatch and fleet operation information is needed in an effort to obtain more representative data on sea turtle interactions. NMFS shall request that the Forum Fisheries Agency provide sea turtle data collected by observers aboard U.S. tuna purse seine vessels fishing under the Treaty on Fisheries Between the Governments of Certain Pacific Island States and the Government of the United States of America on a quarterly and annual basis. The report should include, at a minimum, the incidental capture, injury, and mortality of sea turtles by

species, type of set in which each interaction occurred, and life history information. Photographs should be taken whenever possible.

X. REINITIATION NOTICE

This concludes formal consultation on the action outlined above. 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. In instances where the amount or extent of incidental take is exceeded, NMFS-PIAO should immediately request initiation of formal consultation.

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Appendix A

Fishing Effort in the Pacific Ocean

Despite the ban on high-seas driftnet fishing in the north Pacific Ocean in the early 1990s, fishing effort by longliners, purse seiners, trollers, and coastal driftnetters continues throughout the Pacific Ocean. The number of vessels per country varies greatly, from less than 10 for some of the small island nations (e.g. Papua New Guinea, Tonga, and Vanuatu), to over 600 for the more economically powerful countries, such as Japan. For most of these fishing fleets, little or no data exists regarding the incidental bycatch of marine mammal and sea turtle populations, particularly for those species in danger of extinction. Without such information, it is difficult to assess the impacts of these fisheries on species included in this Opinion. Nevertheless, bycatch information, including survival rates following entanglements, collected by observers and through fisher self reporting does exist for some fisheries in the eastern and western Pacific Ocean. 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 summarize past and current fishing effort in the eastern and central western Pacific Ocean.

A. Fishing effort in the Central Western Pacific Ocean

Although high-seas driftnet vessels no longer operate in the North Pacific, longliners, purse seiners, trollers, and pole-and-liners continue to fish, mainly for tuna species, in the Central Western Pacific Ocean, typically west of the 150°W longitude and north and south of the equator.

Table 1 provides a summary of the known number of active longline vessels, by country, by year, from 1990-1999 in the Central Western Pacific Ocean. Preliminary estimates are represented in parenthesis ( ) and are only based on data from the last known year. Where known, the number of total hooks deployed during a particular year was included (e.g. Korea and Taiwan-distant water). Okamoto *et al.* (1999) estimated the number of hooks deployed by Japan's offshore and distant water longline fleet in the Western Pacific Ocean: 1990 - 192,000,000 hooks; 1991 - 170,000,000 hooks; 1992 - 154,000,000 hooks; 1993 - 164,000,000 hooks, 1994 - 158,000,000 hooks; 1995 - 141,000,000 hooks; 1996 - 127,000,000 hooks; and 1997 - 131,000,000 hooks. While many of the small Pacific island countries have relatively small longline fleets, Japan and Taiwan clearly dominate this fishery, fishing coastally, in distant water, and offshore. The number of Japanese coastal and distant water tuna longliners has remained relatively constant from 1990-99 (averaging 740 and 660 vessels, respectively, per year), while the number of its active offshore tuna longliners in 1997-99 have declined by nearly one half (from approximately

360 vessels to 180 vessels) since 1990[1]. Taiwan's offshore fleet is particularly large, composed of an average of 1,500 active vessels per year (based on data from 1990-99), while the number of vessels included in its distant water fleet ranged from 52 to 88 vessels over the past ten years. The number of vessels included in Korea's longline fleet has remained relatively constant from 1990-99, averaging 168 active vessels per year. The number of active longliners in other countries over the past 10 years appears relatively steady, with American Samoa and Vanuatu entering the fishery in 1995, an increase by China in the mid-1990s, and increases since the early and mid-1990s by Australia, Fiji, French Polynesia, Micronesia, New Zealand, and Samoa.

Table 1. Number of active longline vessels fishing, by country, by year, in the Central Western Pacific Ocean

Country/Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
American Samoa	–	–	–	–	–	6	13	22	27	(27)
Australia - domestic	117	111	124	109	110	109	115	137	156	174
Australia-Japan JV	14	29	56	66	52	21	–	–	–	–
China	23	39	72	310	456	422	323	140	116	(116)
Cook Islands	–	–	–	–	2	2	3	–	–	–
Fed States Micronesia	–	2	7	7	9	11	9	15	21	(21)
Fiji	6	9	18	22	37	48	42	34	39	(39)
French Polynesia	2	8	25	50	66	65	58	59	54	57
Indonesia	151	145	141	309	293	(293)	(293)	(293)	(293)	(293)
Japan - coastal	685	768	793	790	819	738	711	698	(698)	(698)
Japan- distant water	791	790	768	767	749	744	703	695	(695)	(695)
Japan - offshore	362	332	302	272	255	222	200	180	(180)	(180)
Kiribati	–	–	–	–	–	1	1	–	–	–
Korea (# vessels and total # hooks)[1]	182	220	166	148	160	154	156	148	169	(169)
	73,216	53,452	62,125	56,190	76,380	81,831	73,420	68,241	66,193	–
Marshall Islands	–	–	2	5	2	4	–	–	–	–
New Caledonia	7	6	4	4	5	8	8	9	11	13
New Zealand	17	21	30	40	56	96	84	56	(56)	(56)
Papua New Guinea	–	–	–	2	4	11	7	8	8	(8)
Philippines	26	12	10	10	10	10	10	(10)	(10)	(10)
Samoa	–	–	–	17	25	45	90	150	150	151

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[1] In reference to the Japanese tuna longline fleet, "offshore" refers to vessels that fish outside Japan's EEZ but closer to Japan, while "distant water" refers to vessels which fish in other areas throughout the Pacific Ocean (A. Coan, NMFS, personal communication, August, 2000).

Solomon Islands	–	–	–	–	–	20	36	31	22	14
Taiwan - distant water (# vessels and # hooks)[1]	52	74	88	72	67	62	56	53	64	65
	37,681	58,783	35,089	28,440	41,083	52,615	31,394	–	–	–
Taiwan - offshore Taiwan	1,139	800	1,898	1,791	1,753	1,603	1,274	1,877	1,712	1,696
Taiwan - offshore Micronesia	–	–	–	254	132	92	123	217	208	(208)
Tonga	1	1	1	6	5	7	7	(7)	(7)	(7)
United States	138	143	131	129	141	127	115	110	118	(118)
Vanuatu	–	–	–	–	–	2	3	1	1	(1)
TOTAL	**3,713**	**3,510**	**4,686**	**5,180**	**5,208**	**4,923**	**4,440**	**4,950**	**4,815**	**4,816**

[1] Number of hooks is in thousands (000s)

Source: Southwest Fisheries Science Center (SWFSC) unpublished data from Secretariat of the Pacific Community based in Noumea, New Caledonia.

Table 2 provides a summary of the known number of active purse seine vessels, by country, by year, from 1990-1999 in the Central Western Pacific Ocean.

Table 2. Number of active purse seine vessels fishing, by country, by year, in the Central Western Pacific Ocean

Country/Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Australia - domestic	1	6	13	7	4	2	4	5	4	7
Australia - distant water	8	6	2	1	–	–	–	–	–	–
Fed. States of Micronesia	–	6	7	7	8	6	4	4	3	(3)
Japan - coastal	43	38	31	27	23	20	21	20	(20)	(20)
Japan - offshore and distant water	35	35	38	36	33	31	32	35	35	35
Kiribati	–	–	–	–	1	1	1	1	1	(1)
Korea	39	36	36	34	32	30	28	27	26	26
New Zealand	3	6	7	5	6	6	6	6	6	6
Papua New Guinea	–	–	–	–	2	3	4	10	13	(13)
Philippines - domestic (purse seine & ring)	549	546	407	399	(399)	(399)	(399)	(399)	(399)	(399)
Philippines - distant water	13	15	12	12	11	13	12	12	12	(12)
Russia	5	4	3	8	4	–	–	–	–	–

Solomon Islands	4	3	3	3	3	3	3	4	4	4
Taiwan	32	39	45	43	43	42	42	42	42	42
United States	43	43	44	42	49	44	40	35	39	36
Vanuatu	–	–	–	–	1	2	2	5	5	(5)
Total	**775**	**783**	**648**	**624**	**619**	**603**	**598**	**605**	**609**	**609**

Source: Southwest Fisheries Science Center (SWFSC) unpublished data from Secretariat of the Pacific Community based in Noumea, New Caledonia.

Table 3 provides a summary of the known number of active troll vessels, by country, by year, from 1990-1999 in the Central Western Pacific Ocean.

Table 3. Number of active troll vessels fishing, by country, by year, in the Central Western Pacific Ocean

Country/year	**89-90**	**90-91**	**91-92**	**92-93**	**93-94**	**94-95**	**95-96**	**96-97**	**97-98**	**98-99**
Canada	–	–	–	–	–	–	–	–	–	2
French Polynesia	3	4	2	4	–	4	4	1	–	–
New Zealand	125	229	247	425	500	478	429	268	268	268
United States	38	58	55	47	14	21	50	28	35	–
Total	**166**	**291**	**304**	**476**	**514**	**503**	**483**	**297**	**303**	**270**

Source: Southwest Fisheries Science Center (SWFSC) unpublished data from Secretariat of the Pacific Community based in Noumea, New Caledonia.

B. Fishing effort in the Eastern Pacific Ocean

Chile

Despite significant reverses since swordfish catch peaked in 1991, Chile continues to conduct the largest gillnet and longline swordfish fishery in Latin America. This fishery is economically significant to both commercial and artisanal fishermen. Since 1980, this fishery grew by nearly an order of magnitude as fishermen developed more efficient methods and foreign demand for swordfish expanded. From 1987 the Chilean swordfish driftnet fishery expanded rapidly with many hundreds of boats concentrated primarily in four ports - Chañaral, Valparaiso, San Antonio, and Concepcion. Most of these vessels were small (14-15 meters) and switched from a harpoon fishery to a driftnet fishery. The artisanal swordfish fleet alone expanded from 4,777 days-at-sea in 1987 to 40,692 days-at-sea in 1993 (Weidner and Serrano, 1997).

Table 4. Chile – Fishing fleet, 1993-96. ( ) indicates # of artisanal swordfish vessels.

Year	Seiners	Trawlers	Long-liners	Driftnets	Traps	Harpoon	Comm. Total	Artisanal	Grand Total
1993	410	72	115	40	2	1	640	8,904 (350)	9,544
1994	383	72	88	32	3	--	578	10,864 (275)	11,442
1995	370	70	74	28	3	--	545	12,045 (286)	12,590
1996	385	73	45*	19	2	--	524	12,619	13,143

*Primarily targeting groundfish
Source: *in* Weidner and Serrano (1997).

Colombia

Colombia's commercial fleet is dominated by the coastal shrimp fleet (nearly half), but there are also a large number of tuna vessels, primarily purse seiners. As shown in the following table, foreign vessels also operate out of Colombia, including Japanese longliners targeting tuna. In 1997, there were eight foreign longliners operating out of Colombia, with over half of Japanese nationality. Most artisanal fishermen out of Colombia operate very close to shore, targeting mainly pelagics. Little is known about the number of artisanal vessels operating off the Pacific coast of Colombia; however, they are known to deploy small longlines, driftnets and purse seines (Weidner and Serrano, 1997).

Table 5. Columbia - commercial fishing fleet 1992-95.

Year	Domestic Vessels	Foreign vessels*	Total
1992	252	215	467
1993	n/a	150	n/a
1994	156	174	330
1995	192	168	360

*Foreign vessels licensed and working in association with Columbia companies.
Source: Weidner and Serrano, 1997.

Ecuador

Ecuadoran commercial fishing operations, consisting mainly of seiners, are conducted nearly entirely within their 200 mile (Exclusive Economic Zone) EEZ; however, sever larger longliners have operated over 1,000 km off the coast, west of the Galapagos Islands. The fleet continues to expand, and it is likely that operations to the west of the Galapagos will increase, given the profitability of swordfish and expanding technical capabilities. The artisanal fisheries of Ecuador are generally limited to inshore coastal waters, although some longline fishermen have begun to fish around the Galapagos. In 1996, the bulk of the Ecuadoran fishing fleet was comprised of artisanal vessels (93%), and although estimates vary, there may have been as many as 6,000-8,000 active fishing vessels in Ecuador (3,971 estimated vessels in 1996). Foreign longliners have also been operating off Ecuador for many years, and most are from Japan. In 1996, there were an estimated 15-20 foreign longliners, all Japanese, except for one (Weidner and Serrano, 1997).

Peru

Unlike Chile and Ecuador, Peru has not developed a substantial longline or driftnet fleet, and there is little information on the number of vessels, both commercial and artisanal, that are currently operating in various fisheries off Peru. Artisanal longliners generally deploy in shallow water, no deeper than 100 meters, and generally close to shore (normally no more than 50 km from the mainland), while drift gillnetters rarely fish more than 20-30 miles offshore. As of 1997 there were only four domestically built longliners, and fishing generally occurs about 50 km from the coast. Between 1980-97, there were 17 Peruvian-owned commercial lon364gliners. There is limited information on foreign fleet operations off Peru, but vessels, mostly Japanese and Spanish, do fish primarily off the southern coast, both inside and outside the 200 mile limit. Between 1980-97, there were at least 9 foreign leased longliners (Japan) and 11 Spanish longliners (Weidner and Serrano, 1997).

Mexico

In 1983, Mexico established a 50 nautical mile (NM) sportfishing-only zone along its coast to protect billfish, swordfish, tuna, and other popular species and to manage them for the recreation and tourist industries. Commercial fisheries for swordfish outside this exclusion zone included longliners until 1990 and drift gillnetters. Limited longline permits were issued in 1987, allowing only about 15 vessels to fish within Mexico's EEZ. Operating under these permits, the Japanese/Mexico joint venture fleet increased fishing effort to 2.3 million hooks between 1986-88. Due to the reduction in longline permits, a small (2 vessels) drift gillnet fleet appeared in northern Baja California in 1986, growing to 20 by 1990 and to 31 by 1993. Fishing effort increased from 15 days/month in 1989 to 20-30+ days/month in 1993. By 1994, the number of vessels had declined to 16, primarily due to low catch. Most of these vessels are home-based out on Ensenada and are similar in appearance and operation to the California/Oregon drift gillnet fishery, although they use nets up to twice as long as those used on U.S. vessels. The swordfish fishery begins in the fall for the Mexican drift gillnetters, off Ensenada, moving south to central Baja, California (between 25°N and 27°N) during December and January (Holts and Sosa-Nishizaki, 1998).

REFERENCES

Any references used in this Appendix are listed in the Biological Opinion.

Appendix B

Trends in Eastern Pacific Nesting Populations of Leatherbacks

Table 1. Estimated abundance of nesting female leatherbacks in the Eastern Pacific. [ ] = number of nests

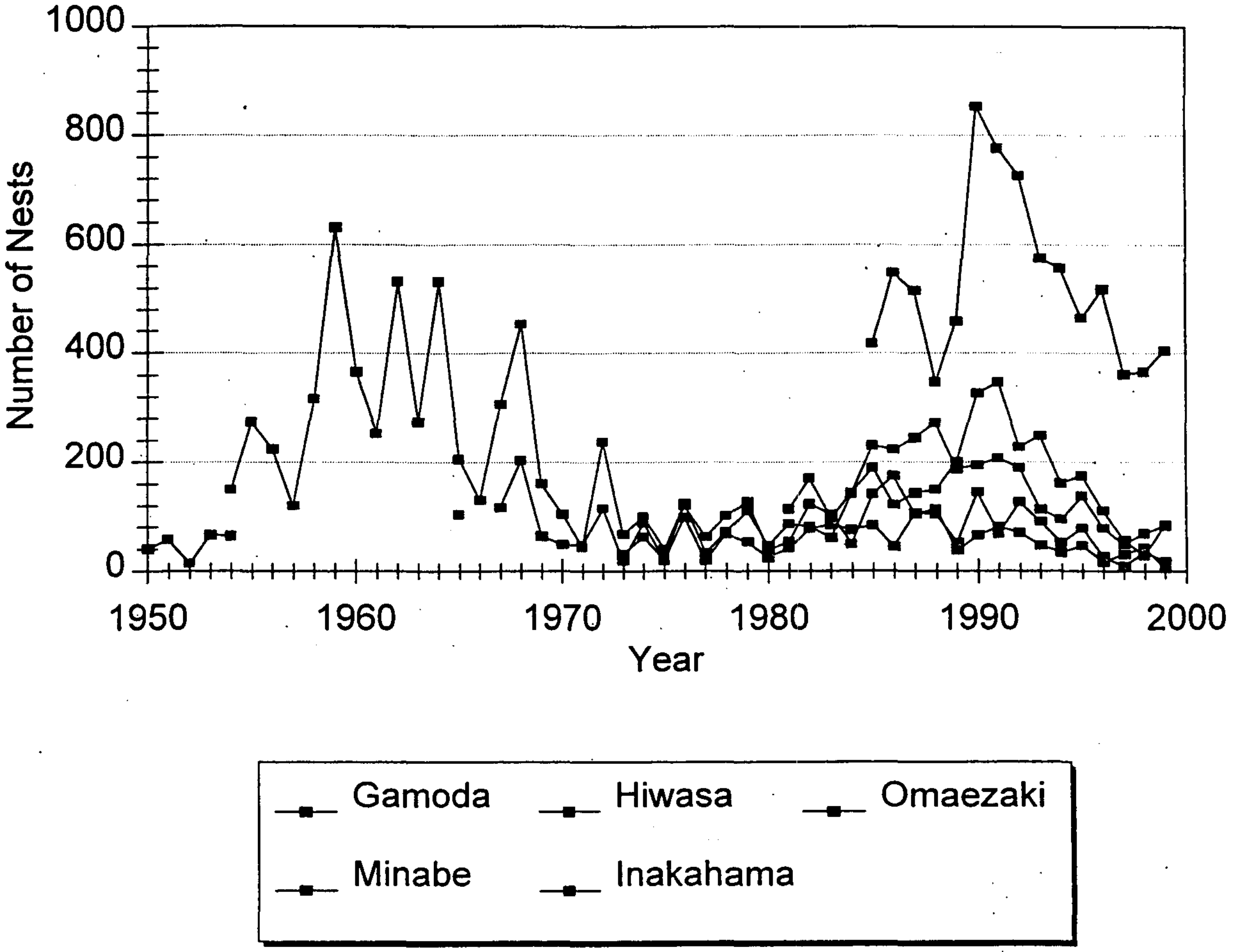
Year/Beach	**80-81**	**83-84**	**86-87**	**87-88**	**88-89**	**89-90**	**90-91**	**91-92**	**92-93**	**93-94**	**94-95**	**95-96**	**96-97**	**97-98**	**98-99**	**99-00**
Mexico																
Tierra Colorada	10,000[1]								1,000-2,000[1]		50-100[1]					[402][7]
Bahía Chacahua	2,000[1]								50-100[1]	50-100[1]						
Mexiquillo	3,000-5,000[1]		959[1]	240[1]						16[1]		[1,280][5]	[60][5]	[123][5]	[53][5]	[463[5]-469[7]]
Barra de la Cruz										299[1]						[296][7]
Other Mex. Beaches																[922][7]
Pacific Coast of Mexico												700-900[1] 1,093[3] [5,354][5]	236[3] [981[3]-1,093[5]]	250-329[3] - [1,596][5]	[1,117][5]	[4,317][5]
El Salvador																[20][7]
Guatamala																[109][7]
Nicaragua																[183][7]

Total (Mex. and Central America, w/o Costa Rica)																~1000[7]
Year/Beach	**80-81**	**83-84**	**86-87**	**87-88**	**88-89**	**89-90**	**90-91**	**91-92**	**92-93**	**93-94**	**94-95**	**95-96**	**96-97**	**97-98**	**98-99**	**99-00**
Costa Rica																
Playa Grande					1,367[4]-1,646[2]	1,340[4]-1,643[2]	665[4]-830[2]	770[4]-932[2]	909[4]-1,078[2]	180[4]-202[2]	469[2]-506[4]	421[4] 800-1000[1,6]	125[4]	195[4]	117[4]	
Playa Langosta							229[8]				239[2]	(800-1000)[1,6]				
Playa Naranjo		62[2]				93[2]	242[2]					30-240[1]				

[1] Summarized in Spotilla, *et al.* (1996), using an estimated clutch frequency of 5.
[2] Summarized in Steyermark, *et al.* (1996), using an estimated clutch frequency of 5.
[3] Summarized in Sarti *et al.* (1998), using annual average clutch frequency (observed and estimated).
[4] Summarized in Spotilla, *et al.* (2000).
[5] Sarti,L., personal communication, 2000.
[6] 800-1,000 estimated nesting females on both Playa Grande and Playa Langosta
[7] Preliminary results presented by L. Sarti, Leatherback Working Group Meeting, 23-24 May, 2000. Other beaches include Llano Grande, Playa Ventura, Agua Blanca.
[8] Chaves, *et al.*, 1996.

Trends in Loggerhead Nesting in Japan

Table 2. Annual trends of nesting beaches in Japan



Source: Naoki Kamezaki

Figure 1.
Observed Green Sea Turtle Take in the Hawaii Longline Fishery March 1994 through March 2001

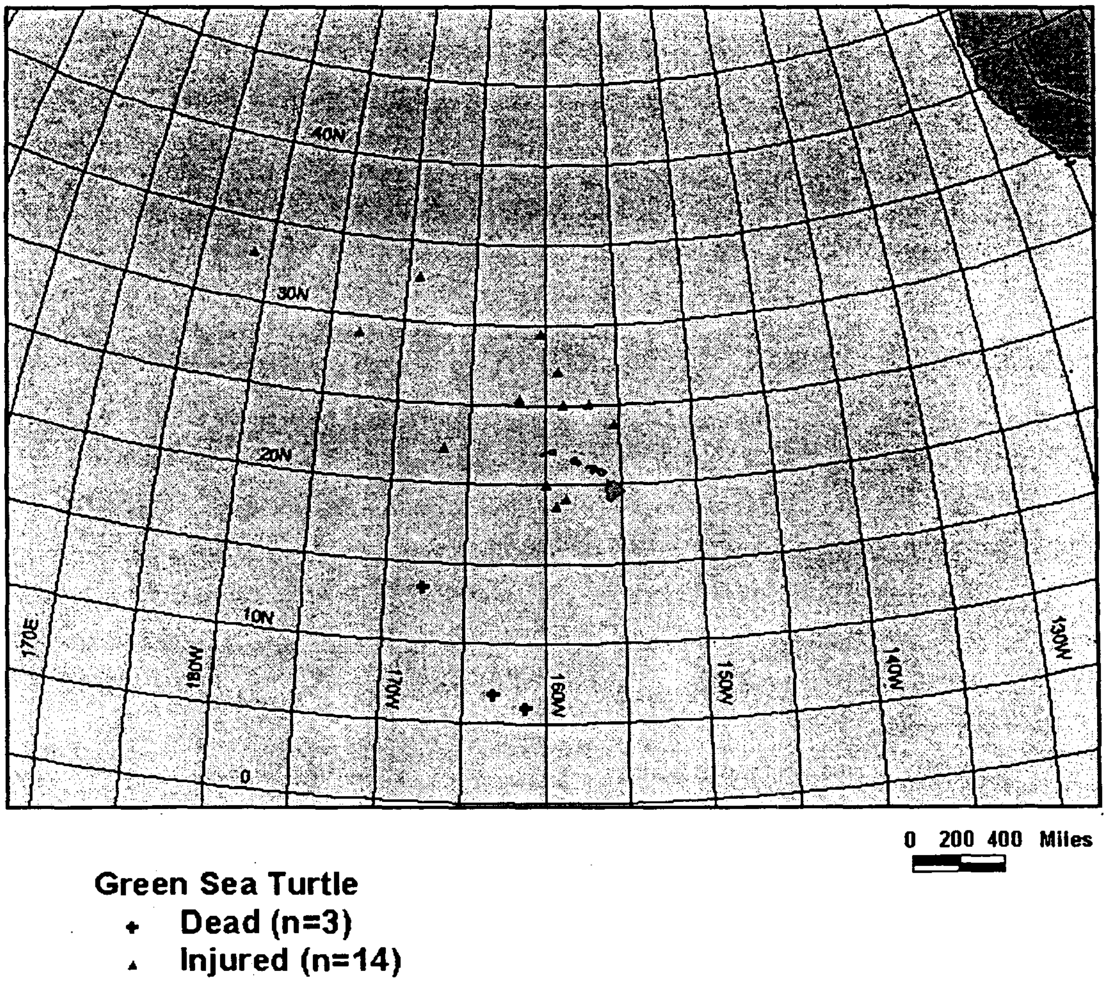


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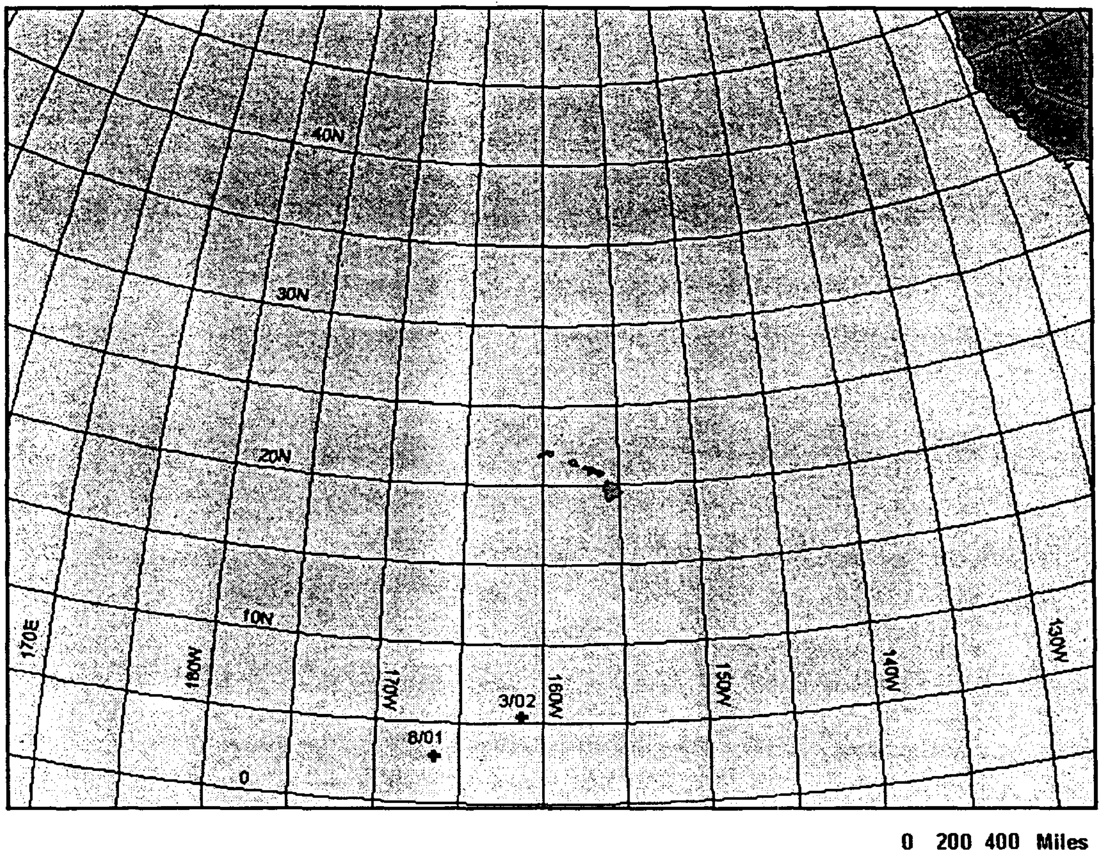
Figure 2.
Observed Green Sea Turtle Take in the Hawaii Longline Fishery April 2001 through June 2002



Green Sea Turtle
+ Dead (n=2)

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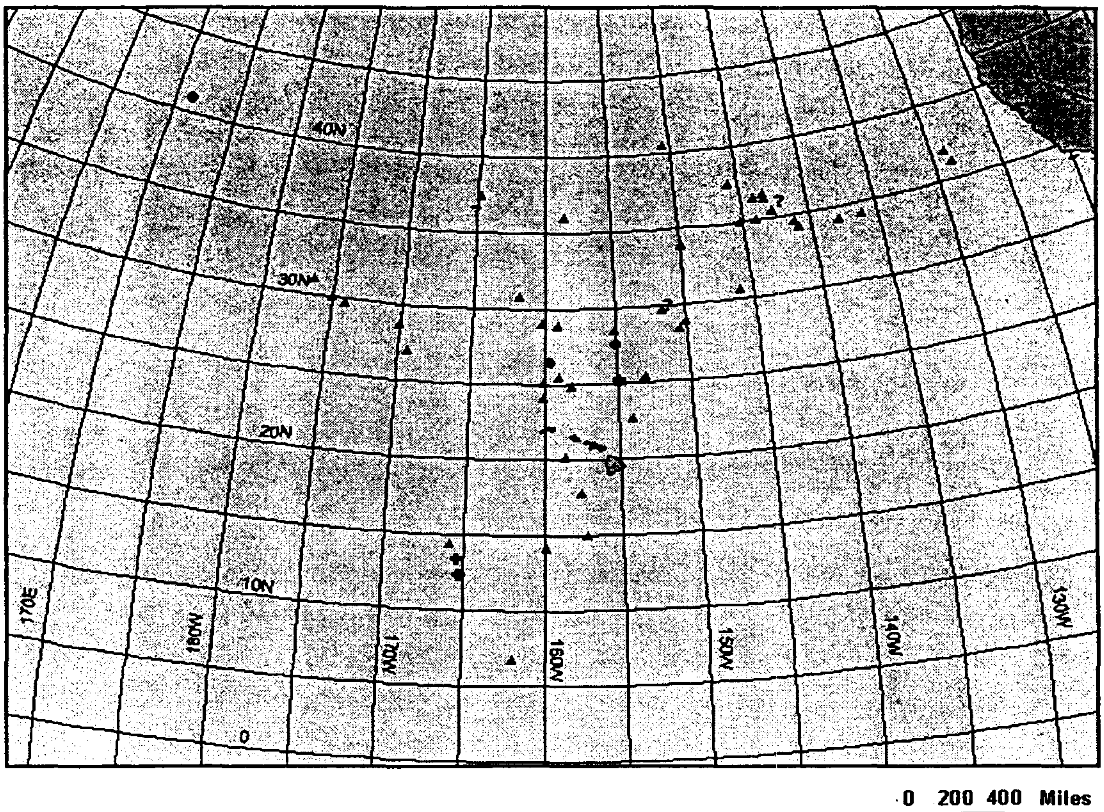
Figure 3.
Observed Leatherback Sea Turtle Take in the Hawaii Longline Fishery March 1994 through March 2001



Leatherback Sea Turlte
- ● Alive (n=3)
- + Dead (n=3)
- ▲ Injured (n=43)
- ? Unknown (n=3)

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Figure 4.
Observed Leatherback Sea Turtle Take in the Hawaii Longline Fishery April 2001 through June 2002

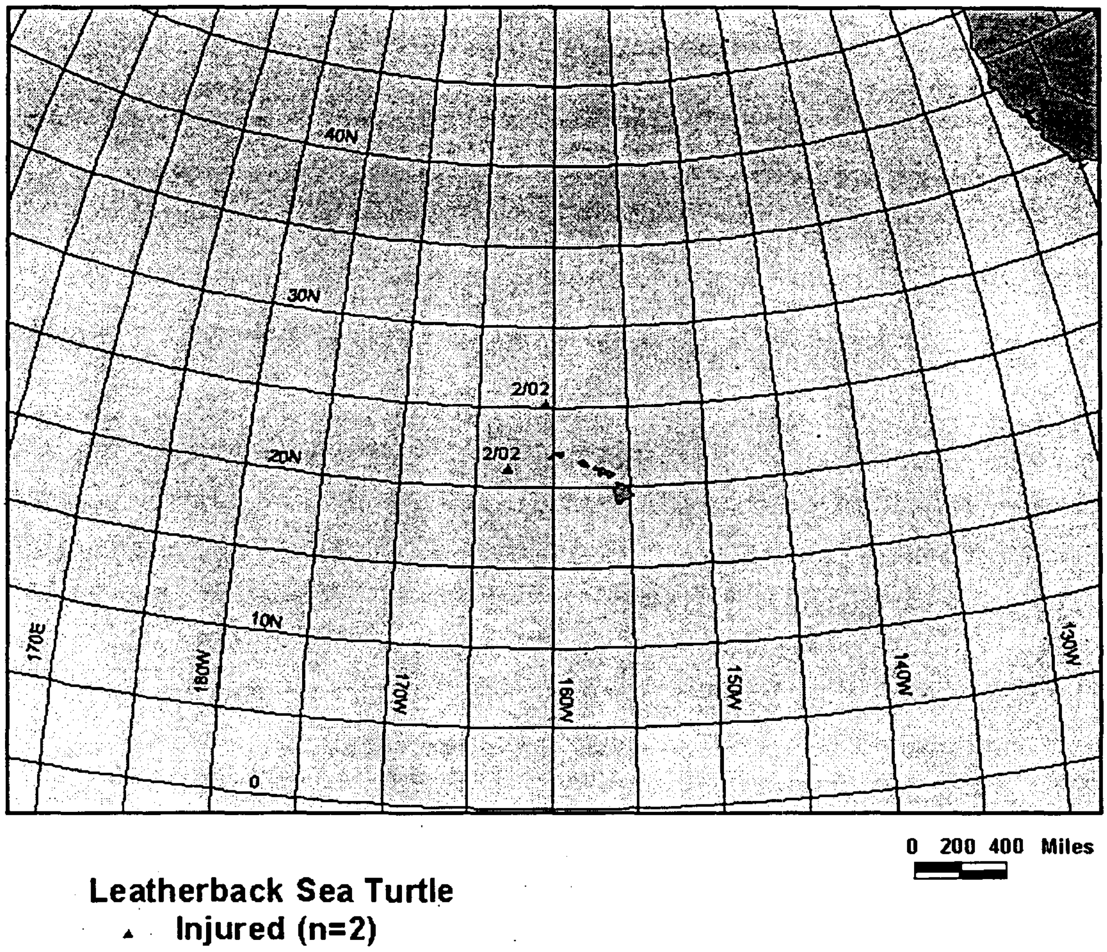

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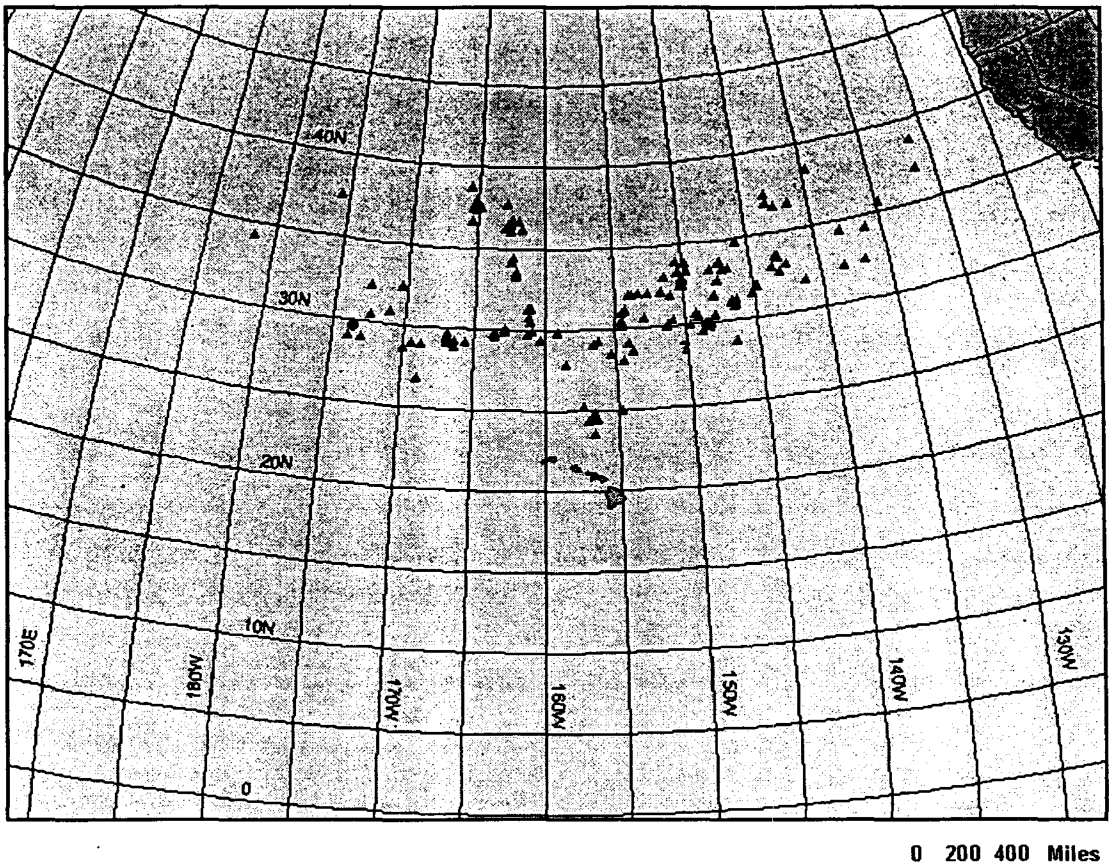
Figure 5.
Observed Loggerhead Sea Turtle Take in the Hawaii Longline Fishery March 1994 through March 2001



Loggerhead Sea Turtle

- ● Alive (n=3)
- ✚ Dead (n=1)
- ▲ Injured (n=170)
- ? Unknown (n=1)

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Figure 6.
Observed Loggerhead Sea Turtle Take in the Hawaii Longline Fishery April 2001 through June 2002

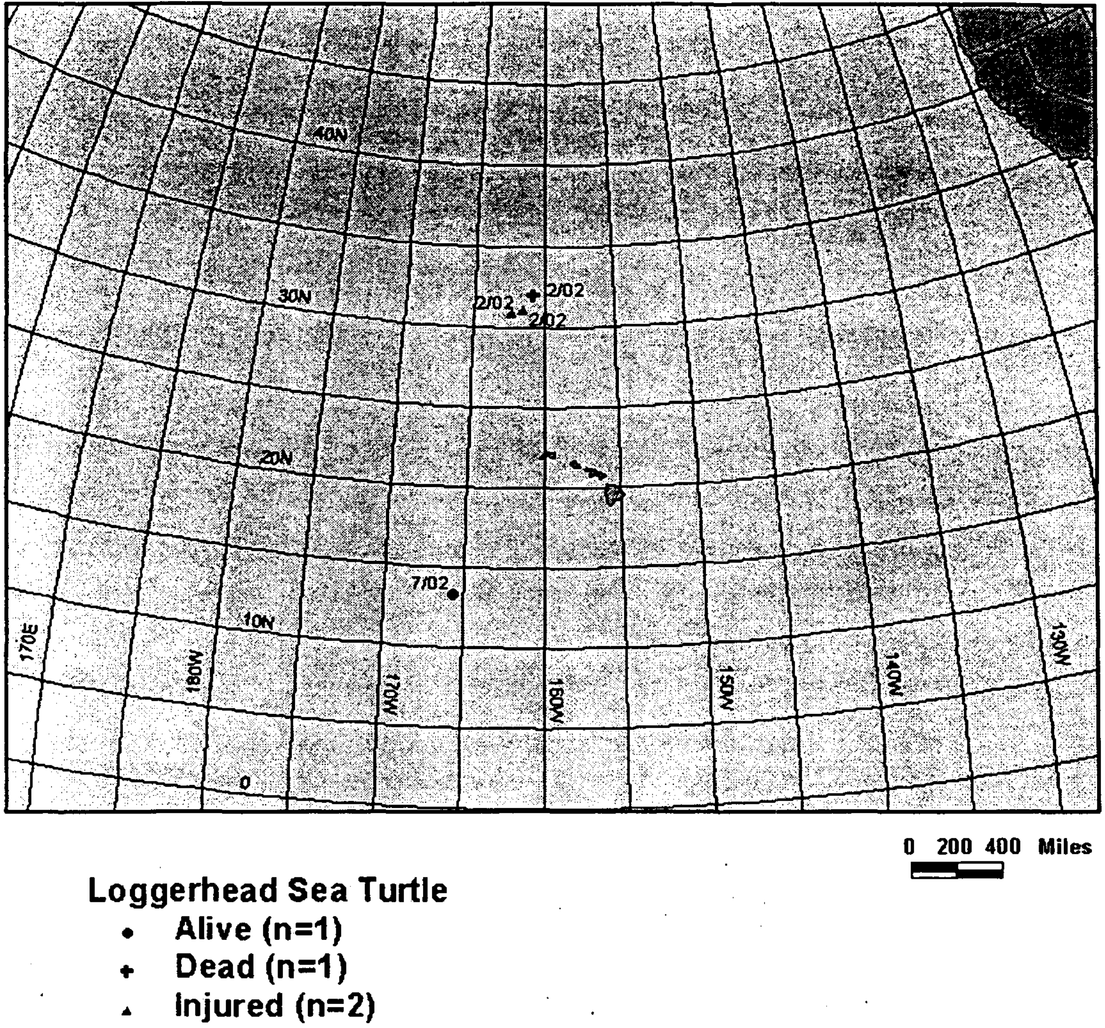

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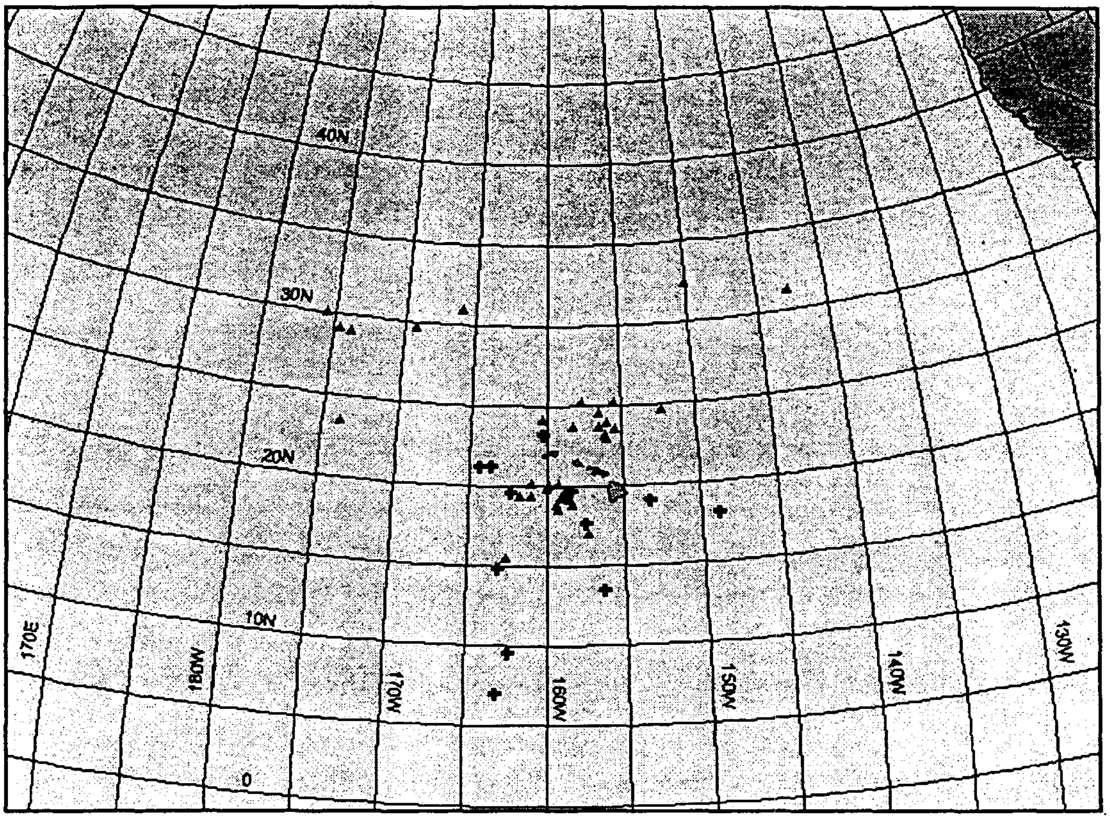
Figure 7.
Observed Olive Ridley Sea Turtle Take in the Hawaii Longline Fishery March 1994 through March 2001



Olive Ridley Sea Turtle

- ✚ Dead (n=12)
- ▲ Injured (n=38)

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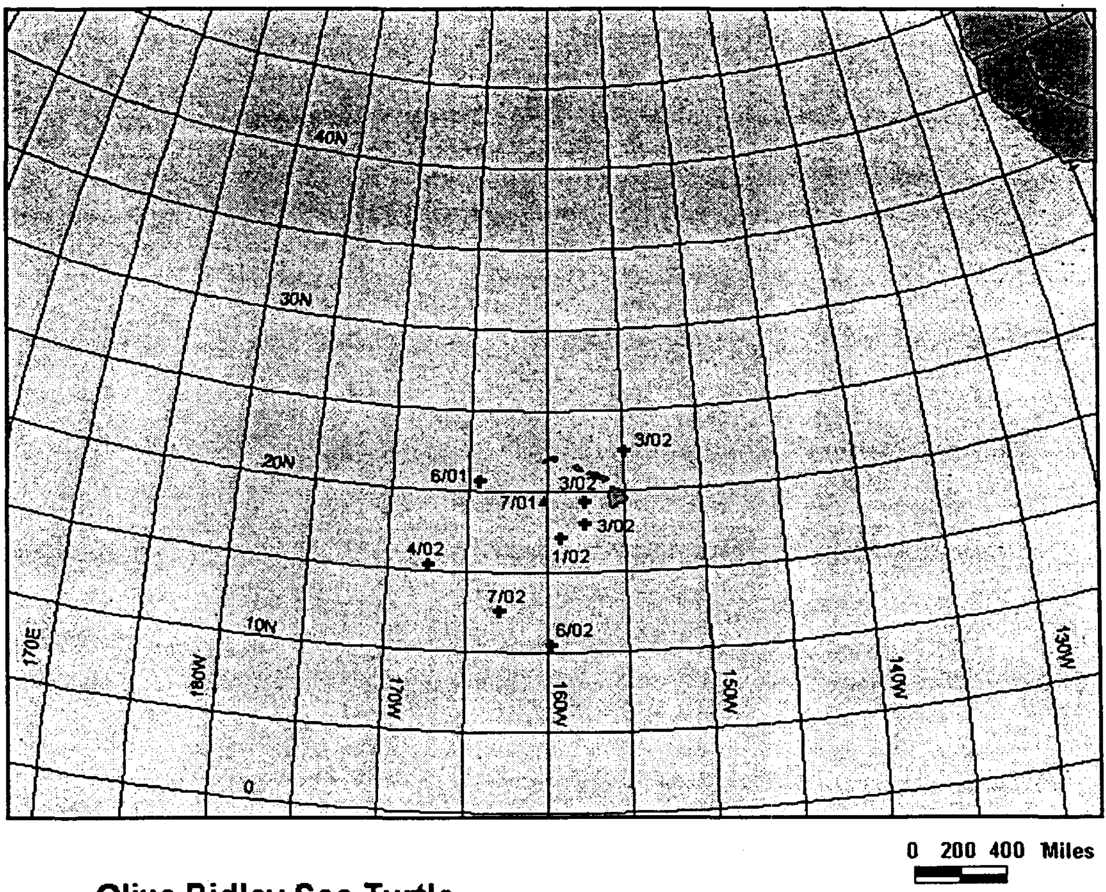
Figure 8.
Observed Olive Ridley Sea Turtle Take in the Hawaii Longline Fishery April 2001 through June 2002



Olive Ridley Sea Turtle
- ✚ Dead (n=8)
- ▲ Injured (n=1)

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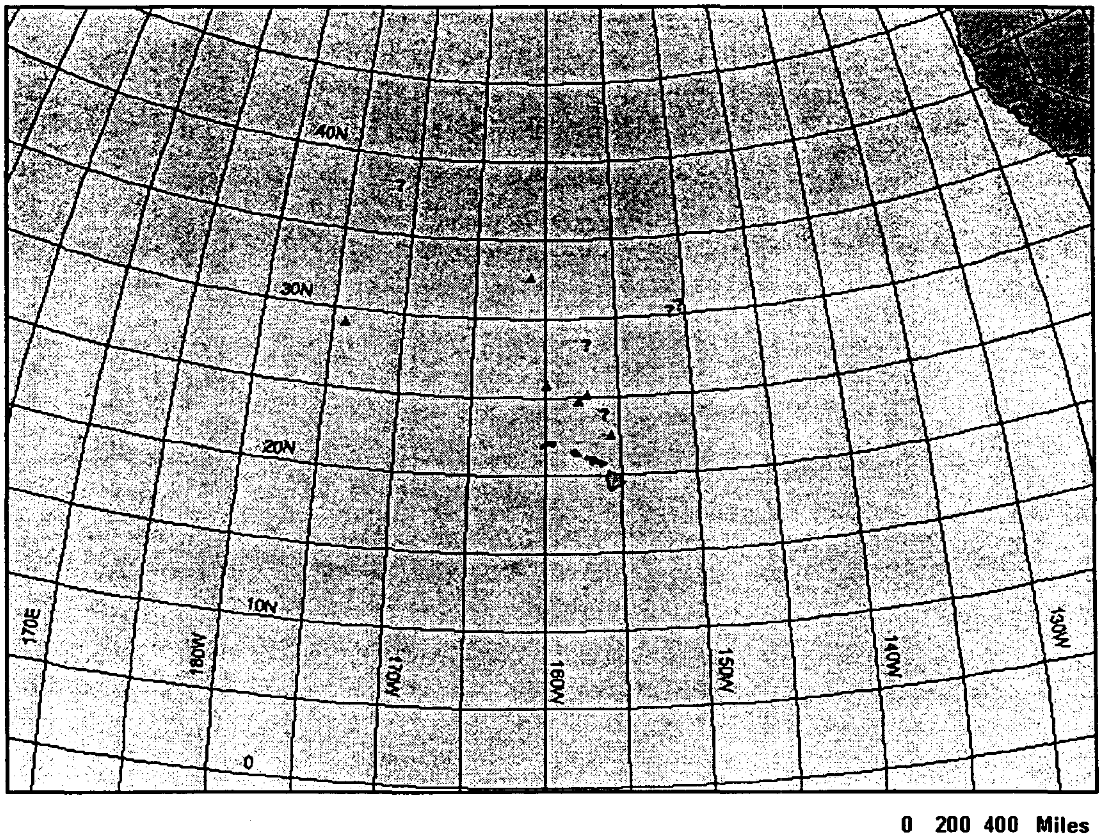
Figure 9.

Observed Unidentified Hardshell Sea Turtle Take in the Hawaii Longline Fishery March 1994 through March 2001*



Unidentified Hardshell Sea Turtle

- ▲ Injured (n=7)
- ? Unknown (n=5)

* There were no unidentified hardshell sea turtles observed caught from April 2001 through June 2002.

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