National Marine Fisheries Service
Endangered Species Act Section 7 Biological Opinion

Action Agencies: NOAA's National Marine Fisheries Service (NMFS), Permits and Conservation Division of the Office of Protected Resources

Activity Considered: Issuance of a Scientific Research Permit to the NMFS Pacific Island Region Under the Provisions of Section 10(a) of the Endangered Species Act (ESA) [Permit No. 18688]

Consultation Conducted By: Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service

Approved:

Perry Gayaldo

for Donna S. Wieting
Director, Office of Protected Resources

Date: MAY - 5 2015

Public Consultation Tracking System (PCTS) number: FPR-2015-9107

TABLE OF CONTENTS

Page

List of Tables

Page

List of Figures

Page

1 INTRODUCTION

The Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.), establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and their habitat. Section 7(a)(2) of the ESA requires Federal agencies to consult with the United States Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), or both (the Services), to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy designated critical habitat. Section 7(b)(3) of the ESA requires that the Services provide an opinion stating how the agencies' actions will affect listed species and designated critical habitat. If incidental take is anticipated, section 7(b)(4) requires the consulting agency to provide an incidental take statement (ITS) that specifies impacts of any incidental take and includes reasonable and prudent measures to minimize such impacts.

When a Federal agency's action "may affect" a listed species, that agency is required to consult formally with NMFS or the USFWS, depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR § 402.14(a)). Federal agencies are exempt from this general requirement if they have concluded that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS or the USFWS concurs with that conclusion (50 CFR § 402.14(b)).

For the action described in this document, the action agency is the NMFS Permits and Conservation Division of the Office of Protected Resources.

The biological opinion (opinion) and incidental take statement portions of this consultation were prepared by NMFS Endangered Species Act Interagency Cooperation Division in accordance with section 7(b) of the ESA and implementing regulations at 50 CFR § 402. This document represents NMFS's final opinion on the effects of these actions on endangered and threatened species and designated critical habitat.

The document will be available through NMFS' Public Consultation Tracking System using tracking number FPR-2015-9107. A complete record of this consultation is on file at NMFS Office of Protected Resources in Silver Spring, Maryland.

1.1 Consultation Background

On November 24, 2004, NMFS Office of Protected Resources (NMFS PR) received a complete application from the NMFS Pacific Islands Region (PIR) for a scientific research permit on sea turtles that are incidentally taken in longline fisheries. Formal consultation between the NMFS PR permit division and the NMFS PR Section 7 consultation division regarding the permit issuance was concluded on March 8, 2005, and Permit No. 1514 was issued on March 28, 2005 to authorize data collection during 2005-2010. On May 6, 2009, NMFS PR received a complete application from the PIR for a scientific research permit to continue research activities as allowed under permit 1514 for five more years. Formal consultation on the permit issuance was concluded on February 3, 2010, and Permit No. 14381 was issued on February 19, 2010 to authorize data collection during 2010-2015.

1.2 Consultation History

On September 8, 2014, NMFS PR received a complete application from the PIR for a scientific research permit to continue research activities as allowed under Permit No. 14381 for five more years with the added activity of satellite tagging juvenile leatherback sea turtles. This document constitutes the NMFS's opinion based on the NMFS PR Section 7 consultation division's review of the proposed issuance of scientific research Permit No. 18688 to the PIR.

As required by 50 CFR § 222.24(a), NMFS published a notice of receipt of the permit application in the Federal Register on September 22, 2014 (79 FR 56573). The first public comment period closed on October 22, 2014, and the second public comment period closed on January 15, 2015. The second comment period was provided to allow public comment on the corrected number of anticipated takes to be authorized by Permit No. 18688; there was an error published in the first notice for public comment. Formal consultation on this permit (18688) issuance was initiated December 22, 2014, and this opinion documents the formal ESA section 7 consultation.

The opinion covers research activities that would occur in the Pacific Ocean waters and their effects on green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), olive ridley (*Lepidochelys olivacea*), and hawksbill (*Eretmochelys imbricata*) sea turtles in accordance with section 7(a)(2) of the ESA of 1973, as amended (16 U.S.C. 1536). This opinion is based on information provided in the application for the proposed permit, the draft permit, published and unpublished scientific information on the biology and ecology of sea turtles, and other sources of information.

2 DESCRIPTION OF THE PROPOSED ACTION

The proposed action is the NMFS PR permit division's issuance of a scientific research permit to the PIR pursuant to ESA section 10(a)(1)(A). Within the PIR, NMFS authorizes the Hawaii Deep-Set Longline Fishery, the Hawaii Shallow-Set Longline Fishery, and the American Samoa Longline Fishery that interact with sea turtles. Incidental takes from commercial fisheries interactions are addressed as a threat in the Pacific sea turtle recovery plans (NMFS and USFWS 1998). The purpose of the proposed research is to collect scientific data on sea turtles incidentally captured in these three fisheries to help NMFS meet its recovery plan goals. The capture of sea turtles is covered under the Incidental Take Statements of the biological opinions issued for the fisheries (NMFS 2010, 2013, 2014). The proposed action includes a request for a matching number of takes to sample turtles incidentally captured by the fisheries; observers on board the fishing vessel will sample the turtles. The incidental capture of turtles falls under section 7 of the ESA, and the take is authorized by an ITS because it is a federal action, while the directed research falls under section 10(a)(1)(A) of the ESA. The proposed research is to handle, measure, weigh, photograph, flipper tag, biopsy tissue of, equip with satellite transmitters, and release or salvage green, leatherback, loggerhead, olive ridley, and hawksbill sea turtles as outlined in Table 1-3. Satellite transmitters would be attached only to loggerheads (via epoxy attachment) and juvenile/subadult leatherbacks (via pygal[1] drilling and attachment). Unlike previously issued permits for such research activities in these fisheries, Permit No. 18688 would not authorize any salvage of carcasses encountered at sea during transit to fishing areas because such salvage is authorized by regulation (50 CFR § 223.206). However, salvage of carcasses encountered during fishing activities would be authorized in Permit No. 18688. Take activities are described in more detail following the description of the action area. Research would contribute information to better understand sea turtle post-hooking survival, movements, and ecology in pelagic habitats.

For the proposed action, the permit would be valid for five years from the date of issuance and would expire on the date specified in the permit. Also, NMFS would consider issuing a single one-year extension of the permit, as part of the proposed action, if the permit holder submits a written request before the expiration of the permit and in sufficient time for processing prior to expiration. The request to extend the permit would be considered a modification, pursuant to NMFS regulations at 50 CFR § 222.306, and would have to be accompanied by full justification and supporting information and formatted in accordance with NMFS permit application instructions (OMB No. 0648-0084). As with any modification to a permit, the extension of the permit duration would be subject to the same issuance criteria as the original application, including the requirements that the taking will operate for the benefit of the species and will be consistent with the purposes and policies of the ESA.

A one-year permit extension, if granted, would only allow "takes" of sea turtles that were not used in the last year of the permit; these remaining "annual" (or "triennial" as applicable) takes would be carried forward into a sixth permit year. The extension would not grant a sixth year of takes equal to the annual takes allowed in years one through five of the permit, nor would it change any other terms or conditions of the permit. NMFS does not consider a one-year extension a substantial change to the proposed action that involves changes in environmental impacts. Hence, NMFS would not prepare a supplemental environmental assessment or reinitiate consultation for the one-year extension unless there were significant new circumstances or information relating to environmental impacts (e.g., a change in the status of the target species, listing of new threatened or endangered species in the project area).

[1] Pygal process is the tapered region near the rear of the upper "shell."

Table 1. Hawaii Shallow-Set Longline Fishery Authorized Annual Takes.

SPECIES	LIFESTAGE	EXPECTED TAKE	PROCEDURES
Green sea turtle	Subadult/ Adult	3	Handle; Mark, flipper tag; Measure; Photograph/Video; Salvage (carcass, tissue, parts); Sample, tissue; Release
Leatherback sea turtle	Subadult/ Adult	16	Handle; Mark, flipper tag; Measure; Photograph/Video; Salvage (carcass, tissue, parts); Sample, tissue; Release
Leatherback sea turtle	Juvenile/Subadult/ Adult	10*	Handle; Mark, flipper tag; Satellite tag; Measure; Photograph/Video; Salvage (carcass, tissue, parts); Sample, tissue; Release
Loggerhead sea turtle	Subadult/ Adult	28	Handle; Mark, flipper tag; Measure; Photograph/Video; Salvage (carcass, tissue, parts); Sample, tissue; Release
Loggerhead sea turtle	Subadult/ Adult	6	Handle; Mark, flipper tag; Satellite tag; Measure; Photograph/Video; Salvage (carcass, tissue, parts); Sample, tissue; Release
Olive ridley sea turtle	Subadult/ Adult	2	Handle; Mark, flipper tag; Measure; Photograph/Video; Salvage (carcass, tissue, parts); Sample, tissue; Release

* No more than 10 leatherbacks may be equipped with satellite tags for the life of the permit, not annually. Remaining activities may occur annually.

Table 2. Hawaii Deep-Set Longline Fishery Authorized Annual Takes.

SPECIES	LIFESTAGE	EXPECTED TAKE	PROCEDURES
Green sea turtle	Subadult/ Adult	3	Handle; Mark, flipper tag; Measure; Photograph/Video; Salvage (carcass, tissue, parts); Sample, tissue; Release
Leatherback sea turtle	Subadult/ Adult	24	Handle; Mark, flipper tag; Measure; Photograph/Video; Salvage (carcass, tissue, parts); Sample, tissue; Release
Loggerhead sea turtle	Subadult/ Adult	3	Handle; Mark, flipper tag; Measure; Photograph/Video; Salvage (carcass, tissue, parts); Sample, tissue; Release
Olive ridley sea turtle	Subadult/ Adult	33	Handle; Mark, flipper tag; Measure; Photograph/Video; Salvage (carcass, tissue, parts); Sample, tissue; Release

Table 3. American Samoa Longline Fishery Authorized Takes.

SPECIES	LIFESTAGE	EXPECTED TAKE	PROCEDURES
Turtle, green	Subadult/ Adult	15*	Handle; Mark, flipper tag; Measure; Photograph/Video; Salvage (carcass, tissue, parts); Sample, tissue; Release
Turtle, leatherback sea	Subadult/ Adult	1**	Handle; Mark, flipper tag; Measure; Photograph/Video; Salvage (carcass, tissue, parts); Sample, tissue; Release
Turtle, olive ridley sea	Subadult/ Adult	1**	Handle; Mark, flipper tag; Measure; Photograph/Video; Salvage (carcass, tissue, parts); Sample, tissue; Release
Turtle, hawksbill sea	Subadult/ Adult	1**	Handle; Mark, flipper tag; Measure; Photograph/Video; Salvage (carcass, tissue, parts); Sample, tissue; Release

* Allowed take is annual, not to exceed 45 over a 3-year period.
** Allowed take is over a 3-year period.

“Action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies. *Interrelated* actions are those that are part of a larger action and depend on that action for their justification. *Interdependent* actions are those that do not have independent use, apart from the action under consideration.

2.1 Proposed Activities

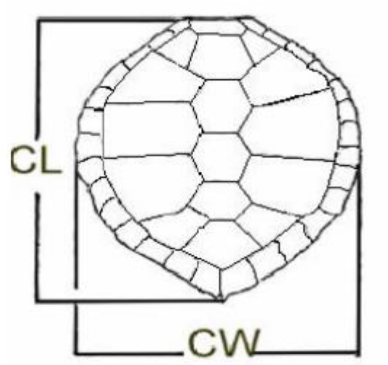
Sea turtles would be handled, measured, weighed, photographed, flipper tagged, tissue biopsied, equipped with satellite transmitters, and released or salvaged (if appropriate) as described below and noted above in Table 1-3.

2.1.1 Sea Turtle Handling and Care

Sea turtles small enough to be brought aboard the vessel would be retrieved with a dip net, and the turtles would be temporarily held on the vessel to conduct research activities. Each animal would be protected from temperature extremes and kept moist during research activities. The turtles would be placed on cleaned tires for cushioning, and the area surrounding the turtle would be free of materials that could be accidentally ingested. The maximum amount of gear would be removed from the turtle without causing further injury. Leatherbacks would be handled by two people and would not be turned on their backs. Leatherbacks would only be hand netted and boarded if they can easily and safely be brought on the vessel. All live turtles would be released upon completion of research activities, which would usually take less than approximately two hours (two hours for those animals having satellite transmitters attached) depending on weather and logistic factors and with care to avoid stress or injury.

2.1.2 Measuring and Photographing

Photographs would be taken of each turtle. Any organism, such as a barnacle, living on a turtle would only be removed from live sea turtles if such organisms interfere with data collection of the carapace measurements (Figure 1) and if removal does not pose a danger to the sea turtle. Straight carapace length, straight carapace width, and plastron length would be measured with 2-m calipers. The straight carapace length would be measured from anterior edge of the nuchal scute (the middle scute on the anterior edge of the carapace) to the posterior tip of the rear most marginal scute. Straight carapace width would be measured at the widest point on the carapace. Plastron length would be measured along the midline, from the front tip of the plastron to the rear tip of the plastron. Curved carapace length, curved carapace width, and tail length would be measured with a 153-cm flexible fiberglass tape measure. The curved carapace length would be measured from the anterior point of the nuchal scute to the posterior tip of the rear most marginal scute, following the curvature of the centerline. The curved carapace width would be measured at the widest point on the carapace following the curve of the shell. Total tail length would be measured from the posterior margin of the plastron to the end of the tail, following the curvature of the tail. Leatherback turtles' curved lengths would be measured along the midline ridge because of irregularities. Carapace width does not follow the curvature of the ridges but is measured spanning from ridge crest to ridge crest. Leatherbacks would not be turned on their carapace for plastron and tail measurements.



Points to measure for sea turtle carapace lengths.
CL = Carapace Length
CW = Carapace Width

Figure 1. Carapace measurements.
Source: NMFS PIRO 2009.

2.1.3 Flipper Tagging

All tags would be cleaned and disinfected before being used. Applicators would be cleaned and disinfected between animals. The application site would be cleaned and then scrubbed with a disinfectant (e.g., Betadine) before the tag pierces the animal's skin.

When handling and/or tagging turtles displaying fibropapilloma tumors or lesions, researchers would clean all equipment that comes in contact with the turtle with a mild bleach solution between the processing of each turtle and maintain a separate set of biopsy sampling equipment for handling animals displaying fibropapilloma tumors or lesions. Metal tags would be attached to the trailing edge of each front flipper. The preferred tagging site is adjacent to the first large scale closest to the animal's carapace. The tag would be firmly set in the skin of the flipper but with some overhang after attachment, and the tag would not inhibit free movement of the flipper. Tags would be applied so that the identifying number is on top. All tags would be checked after application to ensure that the sharp point of the tag has pierced through the flipper and locked into place.

2.1.4 Tissue Sampling

Sterile techniques would be used at all times. Biopsy punches are sterile and packaged as sealed units (Acu-punch Brand); these punches are disposable and would not be used on more than one turtle. All other equipment associated with sampling, including tweezers, would be treated with a 90-percent alcohol solution between specimens. For turtles brought on board the vessel for sampling, the biopsy site and surrounding tissue would be treated using a disposable alcohol/Betadine swab to clean the skin in the inguinal region. A sample would be taken from the base of each hind flipper to insure the recovery of genetic material for sampling. The biopsies would be packaged individually to insure that loss or destruction of one sample would not prevent this material from being analyzed.

For turtles that are too large to bring aboard, researchers would use a 10-ft pole with a stainless steel biopsy corer to collect samples from the location most safely and easily accessed by the researcher/observer before de-hooking the turtles. Only one sample would be collected with each corer, and caution would be exercised to avoid the animal's head. Suitable sampling sites include anywhere on the flippers, shoulder region, and pectoral or pelvic girdle.

2.1.5 Transmitter Attachments

Transmitter attachments would not weigh more than 5 percent of the animal’s body mass. Satellite transmitters would only be attached to loggerhead and leatherback sea turtles incidentally captured in the Hawaii shallow-set longline fishery and brought on board the vessel.

For loggerheads, a satellite transmitter (SPLASH 10-F-296A, SPLASH 10-F-295A, or Spot293A made by Wildlife Computers) would be attached only to live, conscious turtles that have a curved carapace length of 40 cm or greater. In dry conditions, the transmitter would be attached by lightly sanding and applying a two-part epoxy resin to the middle of the carapace with the antenna facing the rear. Epoxy would dry for at least one hour, during which the turtle would be kept in a safe, cool area. If epoxy produces fumes, adequate ventilation would be provided around the head of the turtle during the attachment process. Turtles would not be held in water during the application process to prevent harmful chemicals from contacting skin or eyes.

For healthy juvenile/subadult leatherback sea turtles (i.e., straight carapace length of 50-90 cm) taken in the Hawaii shallow-set longline fishery, a mini pop-up satellite archival tag (Seatags-GEO made by Desert Star) would be applied to the pygal region. The attachment site would be cleaned with separate applications of povidone-iodine antiseptic and isopropyl alcohol, and a hole about 4 mm would be drilled through the pygal process. Flexible stainless steel wire or fishing filament coated in soft tubing (surgical or vinyl) would be threaded through the hole, anchored with a 5-cm-diameter button or fishing bead on the ventral side, threaded back through the pygal process and tubing, and similarly anchored on the dorsal side. The line would be crimped on dorsal and ventral sides for the bead method; the line would be crimped only on the dorsal side for the button method. The line above the dorsal crimp would attach to the tag, and tether length would not exceed 15-20 cm.

2.1.6 Release

Live turtles and turtles that are revived and become active would be released from the area of the boat that is closest to the water to prevent potential injuries. Turtles would be released only when fishing or scientific collection gear is not in use, when the engine gears are in a neutral position, and in areas where they are unlikely to be recaptured or injured by vessels.

2.1.7 Salvage

Animals killed in the fisheries could be salvaged and sent to NMFS Pacific Islands Fishery Science Center staff in Honolulu. Researchers would salvage dead turtles that are hooked or entangled by the longline fisheries. For dead turtles, tags would not be applied, and existing tags and gear would be left in place; animals would be measured, photographed, biopsied, and retained after processing. The possibility also exists within the Hawaiian and American Samoan longline fisheries that encounters may occur with dead sea turtles that were not a result of incidental take associated with longline fishing gear, but salvaging such turtles would be authorized by 50 CFR § 223.206 rather than Permit 18688.

2.2 Permit Conditions

Researchers may perform only activities authorized as conditioned in Permit No. 18688. The permit delineates requirements related to duration of the permit; number and kinds of species, locations, and manner of taking; qualifications, responsibilities, designation of personnel; possession of permit; reports; notification and coordination; observers and inspections; modification, suspension, and revocation; penalties and permit sanctions; and acceptance of permit. The Permit and Conservation Division would include the following conditions:

2.2.1 Turtles Captured Under Another Authority Prior to Research Activities

- Research activities may be performed on sea turtles from other sources only if the Permit Holder can demonstrate that the sea turtles were taken legally (e.g., covered by the incidental take statement [ITS] of an ESA section 7 biological opinion with a “no jeopardy” conclusion.
- If the capture authority reduces the take level for a species during the life of the permit, researchers may only conduct procedures on the reduced take limit for that capture source.

2.2.2 General Handling, Resuscitation, and Release

- Researchers must:
    - Handle turtles according to procedures specified in 50 CFR § 223.206(d)(1)(i). Use care when handling live animals to minimize any possible injury;
    - Use appropriate resuscitation techniques on any comatose turtle prior to returning it to the water;
    - When possible, transfer injured animals to rehabilitation facilities and allow them an appropriate period of recovery before return to the wild; and
    - Have an experienced veterinarian, veterinary technician, or rehabilitation facility on call for emergencies.
- If an animal becomes highly stressed, injured, or comatose, researchers must contact a veterinarian immediately. For research activities occurring aboard commercial fishing

vessels, if a veterinarian cannot be contacted and the animal cannot be taken to a rehabilitation center, NMFS researchers must cease activities that will further significantly stress the animal, allow it to recuperate as conditions dictate, and return the animal to the sea.

- In addition to the Permit condition that requires immediate cessation of activities if a serious injury or mortality of the protected species occurs or if authorized take is exceeded, the Permit Holder is responsible for following the status of any sea turtle transported to rehab as a result of permitted activities and reporting the final disposition (i.e., death, permanent injury, recovery and return to wild, etc.) of the animal to the Chief, Permit and Conservation Division.
- Compromised animals include turtles that are overheated, emaciated, or have a heavy parasite load or severe bacterial infection. Regarding compromised or injured sea turtles:
    - The Permit Holder may conduct the authorized activities on compromised or injured sea turtles, but only if the activities will not further compromise the animal. Care must be taken to minimize handling time and reduce further stress to the animal.
    - Compromised or injured sea turtles must not be handled or sampled by other permit holders collaborating with you but working under separate research permits if their activities would further compromise the animal.
- While holding sea turtles, Researchers must:
    - Protect sea turtles from temperature extremes (ideal air temperature range is between 70°F and 80°F),
    - Provide adequate air flow,
    - Keep sea turtles moist when the air temperature is ≥ 75°F, and
    - Keep the area surrounding the turtle free of materials that could be accidentally ingested.
- During release, turtles must be lowered as close to the water's surface as possible to prevent injury.
- NMFS researchers must carefully observe newly released turtles and record observations on the turtle's apparent ability to swim and dive in a normal manner.
- Extra care must be exercised when handling, sampling, and releasing leatherbacks. Field and laboratory observations indicate that leatherbacks have more friable skin and softer bones than hardshell turtles which tend to be hardier and less susceptible to trauma. Researchers must:
    - Only board leatherbacks if they can be safely brought on board the vessel;
    - Handle and support leatherbacks from underneath, with one person on either side of the turtle; and
    - Not turn leatherbacks on their backs.

2.2.3 Handling, Measuring, Weighing, Passive Integrated Transponder and Flipper Tagging

- Attachment 1 of the Permit provides more information on the requirements for handling and sampling sea turtles using clean, aseptic, and sterile techniques.
- Researchers must:
    - Clean and disinfect all equipment (tagging equipment, tape measures, etc.) and surfaces that comes in contact with sea turtles between the processing of each turtle.
    - Maintain a designated set of instruments and other items should be used on turtles with fibropapillomatosis. Items that come into contact with sea turtles with fibropapillomas should not be used on turtles without tumors. All measures possible should be exercised to minimize exposure and cross-contamination between affected turtles and those without apparent disease, including use of disposable gloves and thorough disinfection of equipment and surfaces. Appropriate disinfectants include 10-percent bleach and other viricidal solutions with proven efficacy against herpes viruses.
    - Examine turtles for existing flipper tags before attaching or inserting new ones. If existing tags are found, the tag identification numbers must be recorded.
    - Clean and disinfect:
        - flipper tags (e.g., to remove oil residue) before use;
        - tag applicators, including the tag injector handle, between sea turtles; and
        - the application site before the tag pierces the animal's skin.

2.2.4 Biopsy Sampling

- A new biopsy punch must be used on each turtle.
- For turtles brought on-board the vessel for sampling, aseptic techniques must be used at all times. Samples must be collected from the trailing edge of a flipper if possible and practical (preference should be given to a rear flipper if practical). At a minimum, the tissue surface must be thoroughly swabbed with a medical disinfectant solution (e.g., Betadine, Chlorhexidine) followed by alcohol before sampling. The procedure area and researchers' hands must be clean.
- For turtles not boarded for sampling, turtles must be sampled using a pole-biopsy, or for leatherbacks via shallow carapacial scrapes, in the location most safely and easily accessed by the researcher. Samples may be collected from anywhere on the limbs or neck, avoiding the head.

- If it can be easily determined (through markings, tag number, etc.) that a sea turtle has been recaptured by the fishery and has been already sampled under this permit, no additional biopsy samples may be collected from the animal during the same permit year.

2.2.5 Transfer of Biological Samples

- Samples may be sent to the Authorized Recipients listed in Appendix 2 of the Permit provided that:
  - The analysis or curation is related to the research objectives of this permit.
  - A copy of this permit accompanies the samples during transport and remains on site during analysis or curation.
- Samples remain in the legal custody of the Permit Holder while in the possession of Authorized Recipients.
- The transfer of biological samples to anyone other than the Authorized Recipients in Appendix 2 of the Permit requires written approval from the Chief, Permits Division.
- Samples cannot be bought or sold.

2.2.6 Instrument Attachments

- No more than one transmitter may be placed on a turtle at one time.
- Total combined weight of all transmitter attachments must not exceed 5 percent of the animal's body mass.
- Each attachment must be made so that there is minimal risk of entanglement. The transmitter attachment must contain a weak link (where appropriate) or have no gap between the transmitter and the turtle that could result in entanglement. The lanyard length (if used) must be less than half of the turtle's carapace length. It must include a corrosive, breakaway link that will release the unit after its battery life.
- Transmitters must not be placed at the peak height of the carapace whenever possible.
- Researchers must make attachments as hydrodynamic as possible.
- Adequate ventilation around the head of the turtle must be provided during the attachment of transmitters if attachment materials produce fumes. Turtles must not be held in water during application to prevent skin or eye contact with harmful chemicals.
- When drilling through the pygal region (leatherbacks), procedures must follow aseptic techniques with two alternating applications of medical disinfectant (e.g., Betadine, Chlorhexidine) followed by 70 percent alcohol. A separate drill bit must be used for each turtle. Bits may be reused if sterilized by autoclave or cold sterilization (e.g., gluteraldehyde) before reuse.

2.3 Action Area

Action area means all areas affected directly, or indirectly, by the Federal action, and not just the immediate area involved in the action (50 CFR 402.02). The action area is the U.S. Exclusive Economic Zone (EEZ) around the U.S. Pacific Islands and the high seas, except prohibited areas, where Hawaii-based and American Samoa-based longline fishing vessels are managed under the Pelagics Fishery Management Plan (Figure 2, 3, 4, 5). These areas include the U.S. EEZ around the Hawaiian Islands, Johnston Atoll, Kingman Reef, Palmyra, Jarvis, Howland, Baker, Midway, and Wake Islands, and American Samoa. The Hawaii-based pelagic longline fishery operates inside and outside the EEZ primarily around the main Hawaiian Islands and Northwestern Hawaiian Islands with some trips to the EEZ around the remote U.S. Pacific Islands. Hawaii-based longline vessels vary their fishing grounds depending on their target species. American Samoa-based longline vessels operate in the U.S. EEZ around American Samoan islands and atolls.

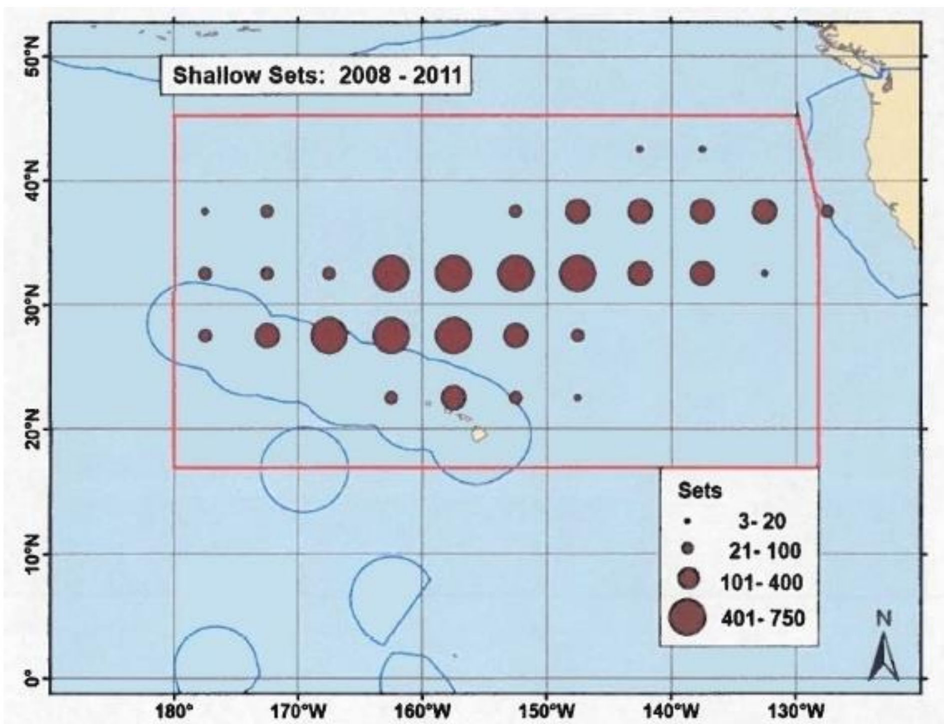


Figure 2. Action area: Hawaii shallow-set longline fishery as shown by set locations during 2008-2011.
Source: Lesley Jantz, Pacific Islands Region Observer Program, 2011.

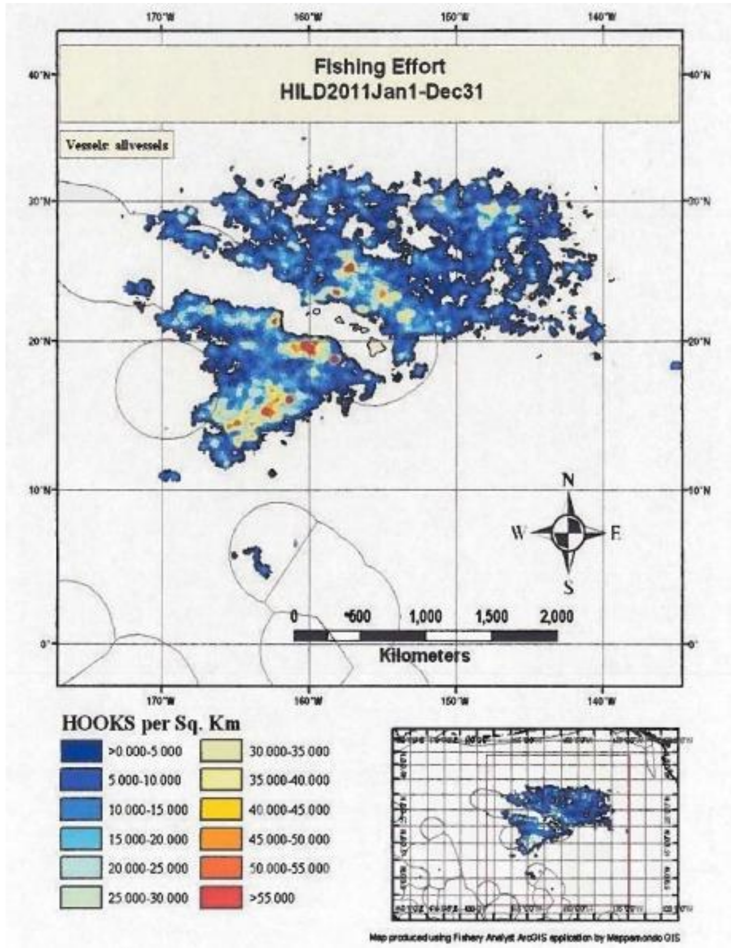


Figure 3. Action area: Hawaii deep-set longline fishery as 2011 fishing effort. Source: NMFS Pacific Islands Fishery Science Center, unpublished.

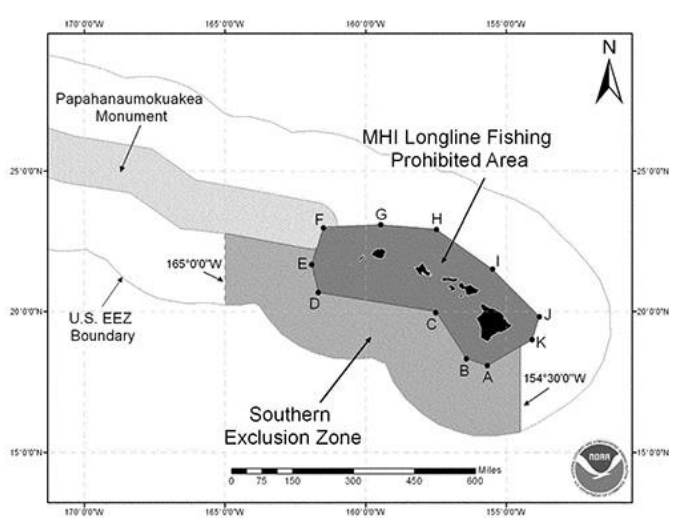


Figure 4. Exclusions to the action area in the vicinity of Hawaii. Source: NMFS Pacific Islands Regional Office, unpublished.

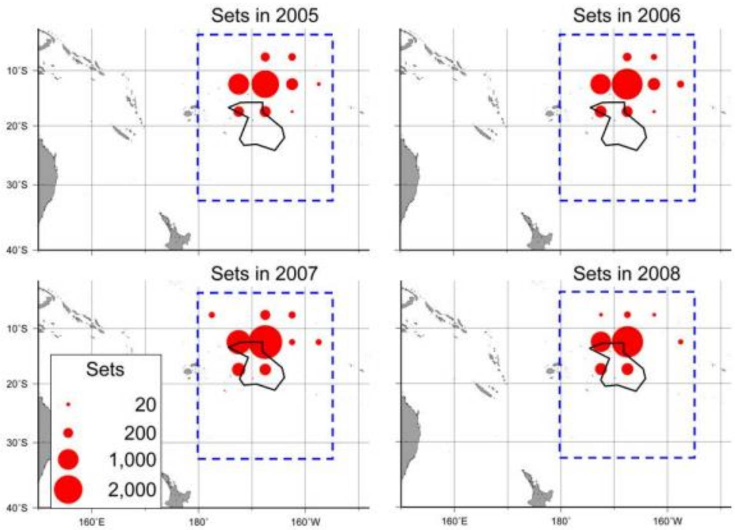


Figure 5. Action area: American Samoa longline fishery as shown by dotted blue rectangles. Source: NMFS 2010.

2.4 Interrelated and Interdependent Activities

Interrelated activities are those that are part of a larger action and depend on the larger action for their justification. Interdependent activities are those that have no independent utility apart from the action under consideration. No interrelated or interdependent activities are associated with the proposed action.

3 Approach to the Assessment

NMFS uses a step-wise approach for section 7 analyses. The first step identifies the spatiotemporal extent of the *action area* and aspects of proposed actions that are likely to have direct and indirect physical, chemical, and biotic effects on listed species, designated critical habitat, or the physical, chemical, and biotic environment of an action area. The second step identifies the listed resources that are likely to be affected by the proposed action (i.e., *exposure analyses*). Next, NMFS examines the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (i.e., *response analyses*). The final step is to evaluate the risks those responses pose to listed resources individually (i.e., *risk analyses*). When data are absent or uncertainty exists, decisions are conservative. Jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species, and destruction or adverse modification determinations must be based on an action's effect on designated critical habitat features that are essential for recovery of the listed species.

"To jeopardize the continued existence of a listed species" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR § 402.02). The jeopardy analysis considers both survival and recovery of the species.

The adverse modification analysis considers the impacts on the conservation value of designated critical habitat. Instead of relying on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.02, we relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[2]

4 STATUS OF LISTED RESOURCES

The action being considered in the opinion is not likely to affect listed species other than sea turtles. While other ESA-listed species exist near the action area, the nature of the research is such that no others would be affected. The researchers would not put any gear in the water and would only work on incidentally captured sea turtles. The action being considered in the opinion is likely to adversely affect five sea turtle species (Table 4).

Table 4. ESA-listed Species that May be Affected by Activities Authorized by Permit No. 18688.

Species	ESA Status	Critical Habitat	Recovery Plan
Green Turtle (*Chelonia mydas*)	E/T* – 43 FR 32800	63 FR 46693	63 FR 28359
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710	63 FR 28359
Loggerhead Turtle (*Caretta caretta*)	E/T** – 76 FR 58868	79 FR 39856	63 FR 28359
Olive Ridley Turtle (*Lepidochelys olivacea*)	E/T*** – 43 FR 32800	-- --	63 FR 28359
Hawksbill Turtle (*Eretmochelys imbricata)*	E – 35 FR 8491	63 FR 46693	57 FR 38818

* The green sea turtle breeding colony populations in Florida and on the Pacific coast of Mexico are endangered; all others are considered threatened.
** Loggerhead distinct population segments (DPSs) potentially affected by the action include the the endangered North Pacific and South Pacific DPSs. Other DPSs are listed separately as threatened or endangered.
*** The olive ridley sea turtle breeding colony population on the Pacific coast of Mexico is endangered; all others are threatened.

---

[2] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

Designated Critical Habitat

Critical habitat has been designated for four sea turtles: green (50 CFR § 226.208), leatherback (50 CFR § 226.207), one distinct population segment of loggerhead (50 CFR § 226.223), and hawksbill (50 CFR § 226.209). No critical habitat for any of these sea turtles or any other species occurs in the action area nor would be affected by the proposed action.

Monitoring and reduction of incidental mortality in the commercial and recreational fisheries have been identified as priority tasks in the recovery plans for sea turtles in the Pacific. Summary information on the biology and status of the potentially affected species follows.

4.1 Green Sea Turtle

Green turtles are distinguished from other sea turtles by their smooth carapace with four pairs of costal scutes, a single pair of prefrontal scales, four post-orbital scales, and a serrated upper and lower jaw (Figure 6). Adult green turtles have a light to dark brown carapace, sometimes shaded with olive, and can exceed one meter in carapace length and 200 kg in body mass. Females nesting in Hawaii average 92 cm in straight carapace length, while at the Olimarao Atoll in Yap, females average 104 cm in curved carapace length and approximately 140 kg. Eastern Pacific green turtles are conspicuously smaller and lighter than their counterparts in the central and western Pacific. At the rookeries of Michoacán, Mexico, females average 82 cm in curved carapace length, and males average 77 cm curved carapace length (NMFS and USFWS 1998a).

Figure 6. Green sea turtle (*Chelonia mydas*). Credit: Andy Bruckner, NOAA.

4.1.1 Status and Trends

Federal listing of the green sea turtle occurred on July 28, 1978, with all populations listed as threatened except for the Florida and Pacific coast of Mexico breeding populations, which are endangered (43 FR 32800). The International Union for Conservation of Nature (IUCN) classifies the green turtle as “endangered.” The recent status review concluded that there are 11 discrete population segments (DPSs) for the green sea turtle (Seminoff et al. 2015). Accordingly, NMFS and USFWS proposed to replace the current listing with eight threatened DPSs and three endangered DPSs for the green sea turtle (80 FR 15271).

A conservative estimate of mature females nesting annually indicates a 48-67 percent decline over the last three generations, but the actual decline might exceed 70 percent (Seminoff 2004). A more recent analysis of 26 threatened nesting concentrations that are likely representative of the overall trends for their respective regions showed that 12 nesting populations are increasing, 10 are stable, and 4 are decreasing (NMFS and USFWS 2007a). The review cautioned that despite the apparent global increase in numbers, the positive overall trend should be viewed cautiously since trend data are available for just over half of all sites examined. Nesting populations are doing relatively well in the Pacific, Western Atlantic, and Central Atlantic Ocean but are doing relatively poorly in Southeast Asia, Eastern Indian Ocean, and perhaps the Mediterranean (NMFS and USFWS 2007a). Data for the largest nesting concentration in Pacific Mexico, where annual nesting beach monitoring began in the 1981-1982 nesting season, show an increase in nesting. Applications of such trends should consider several caveats:

- almost half of the important nesting sites lack data,
- data are based on recent trends and do not span a full generation,
- past impacts that reduced juvenile recruitment rates may not yet be reflected in nesting abundance,
- data reflect only one segment of the population (nesting females), and
- data have not been compared to historical numbers.

Regarding the action area, green turtle populations are likely declining throughout the Pacific Ocean, with the exception of Hawaii, from a combination of overexploitation and habitat loss (Eckert 1993; Seminoff et al. 2002). In the western Pacific, the only major populations (>2,000 nesting females) of green turtles occur in Australia and Malaysia, with smaller colonies throughout the area. Indonesian nesting is widely distributed but declined substantially over the past 50 years. Hawaiian green turtles are genetically distinct and geographically isolated, and the population appears to be increasing in size despite the prevalence of fibropapillomatosis and spirochidiasis (Aguirre et al. 1998).

The East Island nesting beach in Hawaii is showing a 5.7 percent annual growth rate over more than 25 years (Chaloupka et al. 2008). The annual number of nesting females exceeds 1,000 females at each of the three key nesting populations in the eastern Pacific (NMFS and USFWS 2007a). However, historically, greater than 20,000 females are believed to have nested annually in Michoacán alone (NMFS and USFWS 2007a). Thus, the current number of nesting females is still far below historic numbers.

4.1.2 Distribution

Green turtles are found throughout the world, occurring primarily in tropical waters, and to a lesser extent, subtropical and temperate waters. Green turtles appear to prefer waters that usually remain around 20º C in the coldest month but may occur considerably north of these regions during warm-water events, such as El Niño. The species occurs in five major regions: the Pacific Ocean, Atlantic Ocean, Indian Ocean, Caribbean Sea, and Mediterranean Sea. These regions can be further divided into nesting aggregations within the eastern, central, and western Pacific Ocean; the western, northern, and eastern Indian Ocean; Mediterranean Sea; and eastern, southern, and western Atlantic Ocean, including the Caribbean Sea. Throughout the Pacific, nesting assemblages group into two distinct regional clades: 1) western Pacific and South Pacific islands, and 2) eastern Pacific and central Pacific, including the rookery at French Frigate Shoals, Hawaii. Primary nesting aggregations (i.e., sites with greater than 500 nesting females per year) of green turtles occur at Ascensión 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).

4.1.3 Reproduction and Life History

Sea turtles are long-lived species with delayed maturity and large numbers of eggs and hatchling that have low survival rates as a result of predation, environmental variation, and individual fitness (Crouse 1999). Despite low abundances of mature individuals, they have higher fitness than early life stages. Therefore, persistence of long-lived species with delayed maturity would be most vulnerable to impacts that preclude individuals from attaining age and sexual maturity. Sexual maturity for green sea turtles is longer than that of other sea turtle species and ranges from about 25-50 years (Chaloupka and Musick 1997; Hirth 1997; Limpus and Chaloupka 1997; Zug and Glor 1998; Zug et al. 2002; Chaloupka et al. 2004). Estimates of reproductive longevity range from 17 to 23 years (Carr et al. 1978; Fitzsimmons et al. 1995; Chaloupka et al. 2004).

Most female green turtles nest every two to five years (Hirth 1997). In Hawaii, females nest every three to four years and lay up to six clutches of about 100 eggs during each nesting season (Balazs and Chaloupka 2004). Eastern Pacific green turtles nest two to six times during a season with 65 to 86 eggs per clutch (Eckert 1993; NMFS and USFWS 1998a). Mean observed and estimated clutch frequencies for green turtles nesting at Colola beach (Michoacan, Mexico) are 2.5 and 3.2, respectively (Arias-Coyotl et al. 2003). Precipitation, proximity to the high tide line, and nest depth can also significantly affect nesting success (Cheng et al. 2009). During years of heavy nesting activity, density dependent factors (beach crowding and digging up of eggs by nesting females) may affect hatchling production (Tiwari et al. 2005; Tiwari et al. 2006). Precipitation can be significant in sex determination with greater nest moisture resulting in a higher proportion of males (Leblanc and Wibbels 2009). Hatchlings orient toward a light source, such as light shining off the ocean. They enter the sea in a frenzy of swimming activity, which decreases rapidly in the first few hours and gradually over the first several weeks (Ischer et al. 2009; Okuyama et al. 2009).

In general, survivorship tends to be lower for juveniles and subadults than for adults. Adult survivorship ranges from 0.82-0.97 versus 0.58-0.89 for juveniles (Chaloupka and Limpus 2005; Seminoff et al. 2003; Troëng and Chaloupka 2007); lower values coincide with areas subject to anthropogenic disturbance (Bjorndal et al. 2003). Adult females often return to the same foraging areas following nesting migrations (Broderick et al. 2006; Godley et al. 2002).

4.1.4 Diet

In coastal foraging grounds, green sea turtles rely on marine algae and seagrass as their primary dietary constituents. However, while offshore and sometimes in coastal habitats, green sea turtles are not obligate herbivores but consume invertebrates such as jellyfish, sponges, sea pens, and pelagic prey (Hatase et al. 2006; Heithaus et al. 2002; Seminoff et al. 2002). A shift to a more herbivorous diet occurs when individuals move into neritic habitats (Cardona et al. 2010). This transition may occur rapidly starting at 30 cm carapace length, but animal prey continue to constitute an important nutritional component until individuals reach about 62 cm (Cardona et al. 2010).

4.1.5 Migration

Green sea turtles are highly mobile and undertake complex movements through geographically disparate habitats during their lifetimes (Musick and Limpus 1997; Plotkin 2003). After hatchlings depart the beach for pelagic areas, green turtles reside in a variety of marine habitats for 40 or more years (Limpus and Chaloupka 1997), but they spend the majority of their lives in coastal foraging grounds. When juveniles reach about 20 to 25 cm in carapace length, they leave pelagic habitats and enter coastal foraging grounds (Bjorndal 1997). Adult females return to the same beach from which they hatched to lay eggs (Carr et al. 1978; Meylan et al. 1990). Hawaiian green turtles monitored through satellite transmitters were found to travel more than 1,100 km from their nesting beach in the French Frigate Shoals, south and southwest against prevailing currents to numerous distant foraging grounds within the 2,400-km span of the archipelago (Balazs 1994; Balazs et al. 1994; Balazs and Ellis 1996). Tag returns of eastern Pacific green turtles establish that these turtles travel more than 1,000 km between foraging and nesting grounds. In 1990, observers documented green turtles 1600 to 3200 km from shore (Eckert 1993).

4.1.6 Diving Behavior

Based on the behavior of post-hatchlings and juvenile green turtles raised in captivity, those in pelagic habitats likely live and feed at or near the ocean surface, and their dives likely do not normally exceed several meters (NMFS and USFWS 1998a). In Australia, green sea turtles rarely dive deep, staying in upper 8 m of the water column (Hazel et al. 2009). Dives during the day are shallower and shorter than those at night. Also, time spent resting and dive duration increased significantly with decreases in seasonal water temperatures. Green sea turtles along Taiwan may rest during long, shallow dives, and dives by females may be shorter in the period leading up to nesting (I-Jiunn 2009). The maximum recorded dive depth for an adult green turtle is 110 m (Berkson 1967), while sub-adults routinely dive 20 m for 9-23 minutes, with a maximum recorded dive of 66 minutes (Brill et al. 1995).

4.1.7 Threats

Threats to green sea turtles include incidental capture by fisheries, habitat modification and loss, disease, predation, and harvest of eggs, subadults, and adults. Mortality from fisheries bycatch and other human activities occurs widely. Pelagic individuals are incidentally captured in pelagic fisheries such as longlines. Benthic life stages are injured or killed by coastal fisheries (e.g., trawling or gill netting) and other hazards associated with the nearshore environment. While relatively few green turtles are taken by pelagic fisheries, sub-adult and adult green turtles are the life stages most commonly captured and injured or killed in the Hawaii-based longline fishery, and juveniles are taken in the American Samoan-based longline fishery with a 92 percent mortality rate. Also, beach erosion, coastal development, contamination, in-water structural degradation, and climate change contribute to habitat modification and loss. The presence of lights on or adjacent to nesting beaches alters the behavior of nesting adults (Witherington 1992) and is often fatal to emerging hatchlings as they are attracted to light sources and drawn away from the water (Witherington and Bjorndal 1991). When water temperatures drop rapidly, green sea turtles experience cold stunning that often leads to death. Ingestion of plastic and other marine debris is another source of morbidity and mortality (Stamper et al. 2009). Diseases also threaten a large number of subpopulations; the most commonly identified disease in green turtles is fibropapillomatosis (NMFS and USFWS 2007a). Poaching of eggs and killing of turtles, for meat and the illegal shell trade, continue to threaten subpopulations in many areas (NMFS and USFWS 2007a). Additionally, dogs, pigs, rats, crabs, sea birds, reef fishes, and sharks prey upon eggs and/or hatchlings, and sharks and killer whales prey upon juveniles and adults (Witzell 1981). Green sea turtles with many barnacles have a high probability of health concerns (Flint et al. 2009). Such threats combine to contribute noticeably to green sea turtle population declines.

4.2 Leatherback Sea Turtle

The leatherback is the largest living sea turtle. The black carapace is about 4-cm thick and made primarily of tough, oil-saturated connective tissue raised into seven prominent longitudinal ridges that taper to a blunt point posteriorly (Figure 7). The front flippers are proportionally longer than in other sea turtles and may span 270 cm in an adult. The curved carapace length for an adult female ranges from approximately 120 cm to 180 cm. The mean curved carapace length for adult females nesting in the U.S. Caribbean is 155 cm. Nesting female weight ranges between 200 kg and 700 kg, and the largest leatherback on record was a male weighing 916 kg. Hatchlings are dorsally mostly black and covered with tiny polygonal or bead-like scales; the flippers are margined in white, and rows of white scales appear as stripes along the length of the back. In the U.S. Virgin Islands, hatchlings average 61.3 mm in straight carapace length and 45.8 g in weight.

Figure 7. Leatherback sea turtle (*Dermochelys coriacea*).
Credit: Scott R. Benson, NMFS Southwest Fisheries Science Center.

4.2.1 Status and Trends

Leatherback sea turtles received protection on June 2, 1970 (35 FR 8491) under the Endangered Species Conservation Act and were listed as endangered under the ESA in 1973. Leatherback nesting worldwide has declined (NMFS and USFWS 1995). Estimates of breeding females worldwide vary and continue to be refined (Pritchard 1971; Pritchard 1982b; Spotila et al. 1996; Spotila 2004); a recent estimate is 34,000 to 95,000 total adults with 10,000-21,000 nesting females (TEWG 2007). The species as a whole is declining, and local populations are in danger of extinction (NMFS 2001). The most recent 5-year review indicates that knowledge has been gained regarding the leatherback's at-sea activities but that research should continue; the review also suggests future consideration of applying the DPS policy to leatherbacks (NMFS and USFWS 2013b). North Atlantic leatherbacks likely number 34,000-94,000 individuals, with females numbering 18,800 and the eastern Atlantic segment numbering 4,700, and the Southern Caribbean/Guianas stock has a positive population growth rate (TEWG 2007). Pacific populations are experiencing much more decline than Atlantic populations; Pacific populations have declined from an estimated 81,000 individuals to <3,000 total adults and subadults (Spotila et al. 2000). The nesting population has declined by an estimated 95 percent over the past 20 years in the Pacific (Gilman 2009). Drastic overharvesting of eggs and mortality from interactions with driftnet and longline fisheries are primary causes of the tremendous decline (Ross 1979; Eckert 1993; Spotila et al. 1996; Eckert 1997; Sarti Martinez et al. 2007).

In the western Pacific, approximately 2,700-4,500 breeding females use the major nesting beaches in Papua New Guinea, Papua, Indonesia, Solomon Islands, and Vanuatu (Limpus 2002; Dutton et al. 2007). At a main nesting beach in Indonesia (Jamursba-Medi), nests declined from over 13,000 in 1984 (Bhaskar 1985) to 1,865-3,601 nests between 2001 and 2004, which equates to four nesting seasons. In Malaysia, the major nesting rookery has collapsed from over 10,000 nests in 1956 to 20 or less (Chan and Liew 1996). The largest extant leatherback nesting assemblage in the Indo-Pacific lies on the north Vogelkop coast of Irian Jaya (West Papua), Indonesia, with over 3,000 nests recorded annually (Putrawidjaja 2000; Suárez et al. 2000).

The eastern Pacific population is in a critical state of decline with slightly more than 200 adult females and fewer than 3,000 total adult and subadult animals in the late 1990s (Spotila et al. 2000). Leatherback numbers have declined from approximately 1,504 females in 1988–1989 to an average of 188 females nesting in 2000–2001 and 2003–2004 at Parque Nacional Marino Las Baulas (one of the major nesting beaches in the eastern Pacific) (NMFS and USFWS 2013b).

4.2.2 Distribution

The leatherback is globally distributed and is found throughout waters of the Atlantic Ocean, Pacific Ocean, Indian Ocean, Caribbean Sea, Gulf of Mexico, and the Mediterranean Sea (Ernst and Barbour 1972; Casale et al. 2003; Hamann et al. 2006). Leatherbacks range farther than any other sea turtle species, having evolved physiological and anatomical adaptations that allow them to exploit cold waters (Frair et al. 1972; Greer et al. 1973; NMFS and USFWS 1995). High-latitude leatherback range in the Atlantic includes the North and Barents Seas, Newfoundland and Labrador , Argentina, and South Africa (Threlfall 1978; Goff and Lien 1988; Hughes et al. 1998; NMFS SEFSC 2001; Luschi et al. 2006). Pacific ranges extend to Alaska, Chile, and New Zealand (Brito 1998; Gill 1997; Hodge and Wing 2000). The most significant nesting beaches in the Atlantic, and perhaps in the world, are in French Guiana and Suriname (NMFS SEFSC 2001).

Leatherbacks are predominantly pelagic but can be found in continental shelf and nearshore waters with 7-27˚ C (CETAP 1982a). Aerial surveys off the western U.S. support continental slope waters as having greater leatherback occurrence than shelf waters (Bowlby et al. 1994; Carretta and Forney 1993; Green et al. 1992). Juvenile leatherbacks usually stay in warmer, tropical waters >21˚ C (Eckert 2002). Males and females show some fidelity to annual breeding sites (James et al. 2005). Four general nesting aggregations occur in the Atlantic, Pacific, and Indian Oceans and in the Caribbean Sea. Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al. 2010).

In the Pacific, the leatherback is the most common sea turtle in the eastern Pacific north of Mexico (Stinson 1984; Eckert 1993; Wing and Hodge 2002). Leatherback nesting aggregations occur widely in the Pacific, including China, Malaysia, Papua New Guinea, Indonesia, Thailand, Australia, Fiji, the Solomon Islands, and Central America (Limpus 2002; Dutton et al. 2007). In Costa Rica, leatherbacks nest at Playa Naranjo in Santa Rosa National Park, the second-most important nesting beach on the Pacific coast (Yañez et al. 2010), Rio Oro on the Osa Peninsula, and at various beaches in Las Baulas National Park, which includes Playa Langosta and Playa Grande and contains the largest colony of leatherbacks in the Pacific (Spotila 2004). Although not generally known to nest on Japanese shores, two nests were identified in the central Ryukyu Islands in 2002 (Kamezaki et al. 2002). Nesting site selection in the southwest Pacific appears to favor sites with higher wind and wave exposure, possibly as a means to aid hatchling dispersal (Santana Garcon et al. 2010).

4.2.3 Reproduction and Life History

Although leatherbacks are a long-lived species (over 30 years), they mature more quickly than most other sea turtles. Previous estimates for a female leatherback's age at sexual maturity ranged from 5 to 14 years, but more recent analysis indicates that females in the western North Atlantic may reach sexual maturity at 29 years of age (NMFS SEFSC 2001). In the United States, nesting occurs from March to July. The west coast of Central America and Mexico hosts nesting from September-March, but Costa Rican nesting peaks during April-May (Chacón-Chaverri and Eckert 2007). Females nest up to ten times per season, which is about every two to three years. They produce 100 or more eggs per clutch depending on the nesting location, and up to 30 percent of each clutch is infertile. Eggs incubate for 58–65 days (Lux et al. 2003).

Leatherback sex determination is affected by nest temperature, with higher temperatures producing a greater proportion of females (Mrosovsky 1994). A significant female bias exists in all leatherback populations thus far studied. Along the U.S. Atlantic and Gulf of Mexico coasts, 60 percent of individuals were female. Studies of Suriname nesting beach temperatures suggest a female bias in hatchlings, with estimated percentages of females hatched over the course of each season at 75.4, 65.8, and 92.2 percent in 1985, 1986, and 1987, respectively (Plotkin 1995). Likewise, hatchlings from the Pacific coast of Costa Rica were predominantly female, with estimated male to female ratios over three seasons of 0:100, 6.5:93.5, and 25.7:74.3 (Binckley et al. 1998).

4.2.4 Diet

Leatherbacks forage nocturnally in high-invertebrate prey density areas formed by favorable features (Eckert et al. 1989; Ferraroli et al. 2004; Eckert 2006). The location and abundance of prey, including medusae, siphonophores, and salpae, in temperate and boreal latitudes likely has a strong influence on leatherback distribution in these areas (Plotkin 1995). Areas above 30º N in the Atlantic appear to be popular foraging locations (Fossette et al. 2009b). Mean primary productivity in all foraging areas of western Atlantic females is 150 percent greater than in eastern Pacific waters, likely resulting in twice the reproductive output of eastern Pacific females (Saba et al. 2007). In the Pacific, leatherback prey are frequently found in the deep-scattering layer in the Gulf of Alaska (Hodge and Wing 2000). Leatherbacks have been observed feeding on jellyfish in waters off Washington State and Oregon (Eisenberg and Frazier 1983; Stinson 1984). North Pacific foraging grounds contain individuals from both eastern and western Pacific rookeries, although leatherbacks from the eastern Pacific generally forage in the Southern Hemisphere along Peru and Chile (Dutton et al. 1998; Dutton et al. 2000).

4.2.5 Migration

Leatherback sea turtles migrate throughout open ocean convergence zones and upwelling areas, along continental margins, and in archipelagic waters (Eckert 1998; Eckert 1999). In a single year, a leatherback may swim more than 9,600 km to nesting and foraging areas throughout ocean basins (Eckert 1998; Ferraroli et al. 2004; Hays et al. 2004; Sale et al. 2006; Eckert 2006;

Eckert et al. 2006; Benson et al. 2007a; Benson et al. 2007b). Movements are largely dependent upon reproductive and feeding cycles and the oceanographic features that concentrate prey, such as frontal systems, eddy features, current boundaries, and coastal retention areas (Collard 1990; Benson et al. 2011). Return to nesting beaches may be accomplished by a form of geomagnetic navigation and use of local cues (Sale and Luschi 2009). Females will either remain in nearshore waters between nesting events or range widely, presumably to feed on available prey (Byrne et al. 2009; Fossette et al. 2009). Individuals nesting in Malaysia migrate for 5-7 months to tropical feeding areas or for 10-12 months to temperate foraging grounds across the Pacific (Benson et al. 2011). Individuals nesting during the boreal summer move to feeding areas in the North China Sea, and boreal winter nesters moved across the equator to forage in the southern hemisphere (Benson et al. 2011). In the eastern Pacific, leatherback females migrate from Mexican and Central American nesting beaches to the southern hemisphere and disperse south of 10ºS (Dutton et al. 2006; Shillinger et al. 2010).

4.2.6 Diving Behavior

Leatherbacks are deep divers, with recorded depths in excess of 4000 m (López-Mendilaharsu et al. 2009), but the turtles may come into shallow waters if there is an abundance of jellyfish near shore. Dives are typically 50-84 m and 75-90 percent of dive time is shallower than 80 m (Standora et al. 1984). Two leatherbacks off South Africa were found to spend less than 1 percent of their dive time at depths greater than 200 m, which suggests that most leatherback feeding occurs in the upper 200 m (Hays et al. 2009). Dive typically last 1-14 min but can last as long as 86 min (Eckert et al. 1989; Eckert et al. 1996; Harvey et al. 2006; López-Mendilaharsu et al. 2009). Most of this time is spent traveling to and from maximum depths (Eckert et al. 1989). Dives are continual, with only short stays at the surface (Eckert et al. 1986; Eckert et al. 1989; Southwood et al. 1999). Off Playa Grande, Costa Rica, adult females spent 57–68 percent of their time underwater, diving to a mean depth of 19 m for 7.4 min (Southwood et al. 1999). Off St. Croix, adult females dove to a mean depth of 61.6 m for an average of 9.9 min, and spent an average of 4.9 min at the surface (Eckert et al. 1989). During shallow dives in the South China Sea, dives averaged 6.9–14.5 min, with a maximum of 42 min (Eckert et al. 1996). Off central California, leatherbacks dove to 20–30 m with a maximum of 92 m, corresponding with the vertical prey distribution (Harvey et al. 2006). Leatherbacks dove more shallowly (mean of 53.6 m) and moved more slowly (17.2 km/day) while in foraging areas than while travelling to or from these areas (81.8 m and 51.0 km/day) (Fossette et al. 2009).

4.2.7 Threats

As described earlier for other sea turtle species, impacts to nesting and marine habitats and direct takes via egg collection, harvest of females, predation, incidental bycatch, vessel strikes, and ingestion of marine debris threaten leatherback sea turtles (NMFS and USFWS 2013). Although global warming may expand foraging habitats into higher latitude waters, increasing temperatures may increase feminization of nests (Mrosovsky et al. 1984; James et al. 2006; McMahon and Hays 2006). Leatherbacks nest closer to the high-tide line than other sea turtle species, and sea-level rise may inundate nests, significantly reducing hatching success (Caut et al. 2010). Egg collection is widespread and attributed to catastrophic declines, such as in Malaysia. Harvest of females along nesting beaches is of concern worldwide, and 200 leatherback turtles are estimated to die in direct harvests in Indonesia.

Bycatch, particularly by longline fisheries, is a major source of mortality for leatherback sea turtles (Crognale et al. 2008; Fossette et al. 2009; Gless et al. 2008; Petersen et al. 2009). During 2001 to 2005, a Chilean longline fishery incidentally caught 284 leatherbacks (with two observed mortalities), the most frequently bycaught sea turtle species (Donoso and Dutton 2010). The California/Oregon drift gillnet fishery killed 8-17 leatherback turtles annually during 1990-2000; 500 leatherback turtles are estimated to die annually in Chilean and Peruvian fisheries; and, before 1992, the North Pacific driftnet fisheries for squid, tuna, and billfish captured an estimated 1,000 leatherback turtles each year, killing about 111 of them annually. Annual bycatch interactions total 1,400 leatherbacks annually for U.S. Atlantic fisheries (resulting in about 40 mortalities) and one 100 interactions in U.S. Pacific fisheries (resulting in about 10 mortalities) (Finkbeiner et al. 2011).

Plastic ingestion is very common in leatherbacks and can block gastrointestinal tracts leading to death (Mrosovsky et al. 2009). Along the coast of Peru, intestinal contents of 13 percent leatherback carcasses contained plastic bags and film (Fritts 1982). Although little is known regarding contaminants, some metals (arsenic, cadmium, copper, mercury, selenium, and zinc) bioaccumulate, and cadmium is found in highest concentration in leatherback tissues versus loggerhead and Kemp's ridley sea turtles (Caurant et al. 1999). A diet of primarily jellyfish, which have high cadmium concentrations, is likely the cause (Caurant et al. 1999). Organochlorine pesticides have been found in leatherbacks (McKenzie et al. 1999), and PCB concentrations in leatherbacks are equivalent to those in some marine mammals (Davenport et al. 1990; Oros et al. 2009).

4.3 Loggerhead Sea Turtle

The loggerhead is characterized by a reddish brown, bony carapace and a comparatively large head up to 25 cm wide in some adults (Figure 8). They usually have five pairs of costal scutes and three inframarginal scutes without pores. Each forelimb has two claws (Ernst and Barbour 1972). Adult males have comparatively narrow shells, gradually tapering posteriorly, and long, thick tales extending well beyond the edge of the carapace. Adults typically weigh between 80 and 150 kg and have an average curved carapace length of about 97 cm (Dodd 1988; Limpus 1985; Eckert 1993). Juveniles found off California and Mexico measure between 20 and 80 cm (average 60 cm) in length (Bartlett 1989). Hatchlings are uniformly gray, reddish, or olive brown.

Figure 8. Loggerhead sea turtle using a turtle excluder device to escape. Credit: NOAA Fisheries.

4.3.1 Status and Trends

The loggerhead sea turtle was listed under the ESA as threatened throughout its range on July 28, 1978. On September 22, 2011, NMFS designated nine DPSs of loggerhead sea turtles and listed four DPSs as threatened and five as endangered (76 FR 58868). Northwest Atlantic Ocean, South Atlantic Ocean, Southwest Indo-Pacific Ocean, and Southwest Indian Ocean DPSs are threatened, and Northeast Atlantic Ocean, Mediterranean Sea, North Indian Ocean, North Pacific Ocean, and South Pacific Ocean DPSs are endangered. The IUCN lists the loggerhead as "endangered." Although models for the North Pacific Ocean and South Pacific Ocean DPSs produce variable results (Conant et al. 2009), the populations are considered to be declining as a result of ongoing harmful activities (i.e., fishery bycatch, coastal development on nesting beaches) such that the DPSs are currently at risk of extinction. The global abundance of nesting female loggerhead turtles, which account for less than 1 percent of the total population, is estimated at 43,320–44,560 (Spotila 2004).

Although loggerheads range widely from Alaska to Chile, abundance has declined dramatically over the past few decades (NMFS and USFWS 1998c). Pacific nesting is limited to Australia and Japan. Eastern Australia supported one of the major global loggerhead nesting assemblages until recently (Limpus 1985). Now, less than 500 females nest annually, an 86 percent reduction in the size of the annual nesting population in 23 years (Limpus and Limpus 2003). The status of loggerhead nesting colonies in southern Japan and the surrounding region is uncertain, but approximately 1,000 female loggerhead turtles may nest there, which represents a 50-90 percent decline from historical estimates (Bolten et al. 1996; Dodd Jr. 1988; Kamezaki et al. 2002). Few records exist of loggerheads nesting on any of the many islands of the central Pacific, and the species is considered rare or vagrant in this region (NMFS and USFWS 1998c). Overall, the number of loggerheads nesting the Pacific has declined by 80 percent in the last couple of decades (Gilman 2009).

4.3.2 Distribution

Loggerheads are circumglobal, inhabiting continental shelves, bays, estuaries, and lagoons in temperate, subtropical, and tropical waters of Atlantic, Pacific, and Indian Oceans. Loggerheads are the most abundant sea turtle in U.S. coastal waters. Major nesting grounds are generally located in temperate and subtropical regions, with scattered nesting in the tropics (NMFS and USFWS 1998c). The two largest nesting aggregations (>10,000 females per year) are found at Masirah Island (Oman) and Peninsular Florida (United States); other large nesting aggregations (1,000 to 9,999 females) occur in Georgia through North Carolina (U.S.), Quintana Roo and Yucatán (Mexico), Brazil, Cape Verde Islands (Cape Verde), Western Australia, and Japan (Conant et al. 2009). Smaller aggregations (<1,000) occur in other parts of the U.S., Bahamas, South Africa, Mozambique, Oman, Greece, Turkey, and Australia. However, no data on population size exist for the oceanic habitat (Conant et al. 2009).

In the Pacific, loggerheads can be found throughout tropical to temperate waters, but nesting occurs only in the western Pacific along the coasts of Australia, New Caledonia, New Zealand, Indonesia, Japan, and the Solomon Islands. Population structure in the Pacific is comprised of a northwestern Pacific nesting aggregation in Japan and a smaller southwestern nesting aggregation in Australia and New Caledonia. Nesting in the North Pacific has been documented in Japan (important locations at Yakushima Island, and Miyazaki, Minabe, and Atsumi on the mainland), with low-level nesting possibly occurring in areas surrounding the South China Sea (Conant et al. 2009). Genetics of Japanese nesters suggest that this subpopulation is comprised of genetically distinct nesting colonies (Hatase et al. 2002). Almost all loggerheads in the North Pacific seem to stem from Japanese nesting beaches (Bowen et al. 1995; Resendiz et al. 1998). The East China Sea provides major post-nesting habitat (Balazs 2006), and the Kuroshio Extension Bifurcation Region appears to be an important pelagic foraging area for juveniles (Polovina et al. 2006). Other important juvenile foraging areas for the North Pacific Ocean DPS include the coast of Baja California Sur, Mexico (Pitman 1990; Peckham and Nichols 2006), Chile, and Peru (Alfaro-Shigueto et al. 2006). In the South Pacific, nesting is restricted to eastern Australia (70 percent of nests found at Mon Repos, Wreck Rock, mainland and Wreck Island, Erskine Island, and Tryon Island), New Caledonia, and, to a much lesser extent, Vanuatu and Tokelau (Conant et al. 2009). Nesting females from eastern Australia have been found foraging in waters of New Caledonia; Queensland, New South Wales, and Northern Territory, Australia; Solomon Islands; Papua New Guinea; and Indonesia (Conant et al. 2009).

4.3.3 Reproduction and Life History

Loggerheads nest on ocean beaches and occasionally on estuarine shorelines in temperate and subtropic zones but not in the tropics (NMFS and USFWS 2007c; Witherington et al. 2006). Typical nesting beaches are wide, sandy, backed by low dunes, and fronted by a flat, sandy approach (Conant et al. 2009). Approximate clutch size is 100-130 eggs (Dodd 1988) with about 110 eggs/clutch on beaches facing the Indian Ocean and about 130 eggs/clutch in Queensland. In Japan, breeding occurs from May to August, and females lay at least three clutches (60-115 eggs) per season every two to three years (Iwamoto et al. 1985; Nishimura 1994; NMFS and USFWS 1998c). Inter-nesting intervals at Pacific Australian nesting sites average 13-14 days, and females migrate at multiple-year intervals (NMFS and USFWS 1998c). Temperature, moisture, and gas diffusion are important to successful embryo development; temperatures during incubation influence hatchling sex (NMFS and USFWS 1998c). Hatchling loggerheads migrate to the ocean, where they are generally believed to lead a pelagic existence for as long as 7-12 years (NMFS 2007c).

Loggerhead life history is characterized by development to a juvenile in the oceanic zone, which can last for over a decade, followed by recruitment to neritic zone where they become adults (NMFS 2013). In the central northern Pacific Ocean, juveniles congregate at the Kuroshio Extension Bifurcation Region (NMFS 2013). The neritic zone provides foraging, inter-nesting, and migratory habitat for adults, and some may move between the neritic and oceanic zones. For example, some adult females nesting in Japan inhabit oceanic habitats rather than neritic habitats (Conant et al. 2009). Between nests, females appear to swim offshore into the Kuroshio Current, possibly to speed egg development (Sato et al. 1998). Loggerhead mating likely occurs along migration routes to nesting beaches, as well as in offshore from nesting beaches several weeks prior to the onset of nesting (Dodd 1988; NMFS and USFWS 1998c). Loggerheads are a slow growing species with sexual maturity as late as 37 years (NMFS 2013), and generation time for the North Pacific population is estimated at 33 years (Snover 2008).

4.3.4 Diet

Loggerheads in the North Pacific are opportunistic feeders that target items floating at or near the surface, and the turtles will actively forage at depth if high densities of prey are present (Parker et al. 2002). Hatchlings feed on macroplankton associated with *Sargassum* communities (NMFS and USFWS 1998c). Pelagic and benthic juveniles forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd 1988; Wallace et al. 2009). The Transition Zone Chlorophyll Front and Kuroshio Extension Current are likely important foraging areas for juvenile loggerheads (Polovina et al. 2008). Also, large aggregations of juveniles off Baja California feed on dense concentrations of the pelagic red crab *Pleuronocodes planipes* (Pitman 1990; Nichols et al. 2000). Many loggerheads sampled off Baja California Sur had exclusively pelagic red crab in their stomachs, revealing the importance of this area and this prey species for loggerheads (Peckham and Nichols 2003). Adults forage in neritic habitats over a variety of hard and soft bottoms, and loggerheads in the deep, offshore waters of the western North Pacific feed on jellyfish, salps, and other gelatinous animals (Dodd Jr. 1988; Hatase et al. 2002).

4.3.5 Migration

North Pacific loggerhead range spans the entire North Pacific Ocean, and migration between various habitats may involve movement across the entire northern ocean basin. Loggerhead hatchlings migrate offshore and become associated with *Sargassum* habitats, driftlines, and other convergence zones (Carr 1986). Loggerheads hatched on beaches in the southwest Pacific travel have been found to range widely in the southern portion of the basin, with individuals from populations nesting in Australia found as far east as Peruvian coast foraging areas still in the juvenile stage (Boyle et al. 2009). Individuals hatched along Japanese coasts have been found to migrate to waters off Baja California via the North Pacific Subtropical Gyre (and the Kuroshio Extension) to feed for several years before migrating back to western Pacific waters to breed (Bowen et al. 1995; Resendiz et al. 1998; Nichols et al. 2000; Polovina et al. 2006). After 14-32 years of age, loggerheads shift to a benthic habitat, where immature individuals forage in the open ocean and coastal areas along continental shelves, bays, lagoons, and estuaries (NMFS 2001; Bowen et al. 2004). Adults make lengthy migrations from nesting beaches to foraging grounds in oceanic waters off Japan (Hatase et al. 2002). Loggerheads returning to Japanese waters seem to migrate along nutrient-rich oceanic fronts (Nichols et al. 2000; Polovina et al. 2000; Kobayashi et al. 2008). Turtle research in Hawaii longline fisheries shows individual movement north and south within a thermal range of 15-25º C, or 28-40º N, with juveniles following the 17-20º C isotherm (Nichols et al. 2000; Kobayashi et al. 2008). The Kuroshio Current off Japan may be significant for juvenile and adult loggerheads as a wintering areas for those individuals not migrating south (Hatase et al. 2002).

4.3.6 Diving Behavior

Loggerhead diving behavior varies based upon habitat, with longer surface stays in deeper habitats than in coastal ones, and routine dives range from 4 to 172 min (Byles 1988; Renaud and Carpenter 1994; Sakamoto et al. 1990). The maximum-recorded dive depth for a post-nesting female was over 230 m, although most dives are far shallower (9-21 m) (Sakamoto et al. 1990). Off Japan, dives are shallower than 30 m (Sakamoto et al. 1993). In the Pacific, about 70 percent of dives are very shallow (<5 m), and 40 percent of the dive was within 1 m of the surface, which could have been a result of preferential association with strong surface temperature fronts during the study (Polovina et al. 2003; Spotila 2004).

4.3.7 Threats

Similar to other sea turtle species, loggerheads experience threats from destruction, modification, and degradation of beach and pelagic habitats; poaching, killing, and predation; cold stunning; incidental takes in fisheries; and unquantified effects of climate change. Adverse effects to nesting habitat results from coastal development and construction, placement of erosion control structures, beachfront lighting, vehicular and pedestrian traffic, sand extraction, beach erosion, beach nourishment, beach pollution, removal of native vegetation, and planting of non-native vegetation (Mazaris et al. 2009). Marine habitats are altered by oil and gas exploration, marine pollution, underwater explosions, dredging, offshore artificial lighting, power plant entrapment and impingement, entanglement in debris, ingestion of marine debris, marina and dock construction and operation, boat collisions, poaching, trawl, purse seine, hook and line, gill net, pound net, longline, and trap fisheries.

Fisheries regulations significantly reduced loggerhead bycatch; about 50 individuals are incidentally caught in U.S. fisheries in the Pacific resulting in about 20 mortalities annually (Finkbeiner et al. 2011). Along Baja California, it is estimated that 1,500-2,950 loggerheads are killed annually by local fishing fleets (Peckham et al. 2008). Offshore longline tuna and swordfish longline fisheries are also a serious concern for the survival and recovery of loggerhead sea turtles and appear to affect the largest individuals more than younger age classes (Aguilar et al. 1995; Howell et al. 2008; Tomás et al. 2008; Carruthers et al. 2009; Petersen et al. 2009).

Organochlorines detected in loggerhead tissue have the potential to suppress the immune system, affect metabolic regulation, and cause deficiencies in endocrine, developmental, and reproductive health (Keller et al. 2004; Storelli et al. 2007; Oros et al. 2009). Omnivory likely makes loggerheads prone to bioaccumulate toxins (Godley et al. 1999; Mckenzie et al. 1999). Heavy metals have also been found in tissues at levels that increase with turtle size (Godley et al. 1999; Saeki et al. 2000; Fujihara et al. 2003; Gardner et al. 2006; Garcia-Fernandez et al. 2009).

Climate change may result in loss of nesting habitat from sea level rise. Also, incubation temperature determines sex of loggerhead embryos. Ambient temperature increase by just 1º-2º C can potentially change hatchling sex ratios to all or nearly all female in tropical and subtropical areas (Hawkes et al. 2007). Over time, genetic diversity or even population viability may be affected if males become a small proportion of populations (Hulin et al. 2009). Sea surface temperatures on loggerhead foraging grounds correlate to the timing of nesting, with higher temperatures leading to earlier nesting (Mazaris et al. 2009; Schofield et al. 2009). Increasing ocean temperatures may also lead to reduced primary productivity and eventual food availability, and warmer temperatures may also decrease the energy needs of a developing embryo (Reid et al. 2009).

4.4 Olive Ridley Sea Turtle

The olive ridley is the smallest living sea turtle. Adults have a carapace length about 60 to 70 cm, and they rarely weigh over 50 kg. They are olive or grayish green on the dorsal side with a greenish white underpart (Figure 9), and adults are moderately sexually dimorphic. Hatchlings are dark gray or black with a pale yolk scar. Hatchlings and juveniles have serrated posterior marginal scutes that become smooth with age. Juveniles also have three longitudinal dorsal keels; the central keel gives younger animals a serrated profile and persists almost until maturity. Two keels on the plastron also disappear with age. The adult has a rounded carapace.

Figure 9. Olive ridley sea turtle (*Lepidochelys olivacea*).
Credit: Robert Pitman, NOAA.

4.4.1 Status and Trends

The olive ridley is the most abundant sea turtle in the world (Pritchard 1997). Worldwide, abundance of nesting female olive ridleys is estimated at two million (Spotila 2004). Nonetheless, the Mexican nesting population of olive ridley on the Pacific coast was listed as endangered, and all other populations were listed as threatened under the ESA on July 28, 1978 (43 FR 32800). Historically, the olive ridley was abundant in the eastern Pacific. The endangered population appears stable at some arribada locations (e.g., Mismaloya and Moro Ayuta) and increasing at La Escobilla, but populations have experienced steep declines that have not yet been overcome (Cliffton et al. 1982; NMFS and USFWS 2014). Threatened olive ridley arribada nesting beaches in the eastern Pacific occur in Nicaragua (Chacocente, La Flor, Masachapa, Pochomil, Boquita), Costa Rica (Nancite, Ostional), and Panama (Isla Canas). Threatened olive ridley nesting beaches in the western Pacific occur in Australia, Brunei, Malaysia, Indonesia, Vietnam, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, Panama, and Colombia (NMFS and USFWS 2014). Although the threatened large arribada populations in the eastern Pacific have declined since the 1970s, nesting trends in Mexico at non-arribada beaches are stable or increasing in recent years, but current threats remain a serious concern for these populations (NMFS and USFWS 2014). Nesting continues to decline at some arribada beaches (e.g., Nancite in Costa Rica) and is stable or increasing at others (e.g., Ostional in Costa Rica) (NMFS and USFWS 2014). The largest known arribadas in the eastern Pacific are on the coast of Costa Rica (~475,000-650,000 females estimated nesting annually) and in southern Mexico (~800,000 nests per year at La Escobilla, in Oaxaca, Mexico). Along Costa Rica, 25,000-50,000 olive ridleys nest at Playa Nancite, and 450,000-600,000 turtles nest at Playa Ostional annually (NMFS and USFWS 1998d). At a nesting site in Costa Rica, an estimated 0.2 percent of 11.5 million eggs laid during a single arribada produced hatchlings (NMFS and USFWS 1998d). Two of the five arribada beaches in Nicaragua have available estimates – Chacocente at over 42,000 nests and La Flor at 1,300 to 9,000 turtles per arribada (NMFS 2004). The most recent 5-year review concluded that a global status review should be conducted to assess applicability of the

DPS policy to olive ridleys and to determine whether any DPSs warrant reclassification (NMFS and USFWS 2014).

4.4.2 Distribution

Olive ridley turtles occur throughout the world primarily in tropical and subtropical waters, but olive ridleys are uncommon in the western Pacific and western Indian Oceans, and most of the North Atlantic (Spotila 2004). The species is divided into three main populations in the tropical regions of the Pacific, Indian, and Atlantic Oceans (Fretey 1999; Hodge and Wing 2000; Foley et al. 2003; Fretey et al. 2005). These turtles prefer to nest along continental margins and, rarely, on oceanic islands. 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. The largest nesting aggregation in the world occurs in the Indian Ocean along the northeast coast of India (Orissa); the second most important nesting area occurs in the eastern Pacific, along the west coast of Mexico and Central America (NMFS and USFWS 1998d).

Concentrations at sea have been noted mainly in tropical neritic waters usually adjacent to known nesting areas. Unpublished data assembled by the Inter-American Tropical Tuna Commission show that olive ridleys are present from 30°N to 15°S and are most often seen within 2200 km from shore. However, they are seen as far as 140°W, and NMFS has documented this species as far north as 43°N. They appear to occupy foraging areas geographically distributed over a very broad range within their oceanic habitat (Plotkin et al. 1994b).

4.4.3 Reproduction and Life History

Olive ridley turtles have two reproductive behaviors: some females are solitary nesters, and others are arribada nesters (Plotkin and Bernardo 2003). Olive ridleys are known for arribadas, which are synchronized mass nesting emergences that occur only on a few beaches worldwide. 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. The mean clutch size for nests on Mexican beaches is 105.3 eggs, and in Costa Rica, clutch size is about 100 to 107 eggs (NMFS and USFWS 1998d). Arribada nesters produced larger clutches than solitary nesters, perhaps to offset the large number of predators near the arribada sites (Plotkin and Bernardo 2003). Females generally lay 1.6 clutches per season in Mexico and 2 clutches per season in Costa Rica (Eckert 1993). Arribada nesters have high site fidelity, remain near the nesting beach during the internesting period, and are relatively inactive, and solitary nesters appear to have low site fidelity (Plotkin and Bernardo 2003). Data on the remigration intervals of olive ridleys in the eastern Pacific are scarce; however, in the western Pacific

(Orissa, India), females have an annual mean remigration interval of 1.1 years with a reproductive span in females up to 21 years (Pandav and Kar 2000).

Hatchlings leave the beach to begin a pelagic phase, the so-called "lost year" because no information is available on the movements or the kind of habitat these turtles use during their first year (or possibly years) of life. Similarly, information on the habitat of juvenile ridleys is very limited. Depending on food sources, the distribution of juveniles may be similar to that of adults. Young olive ridleys may 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. During four surveys carried out between Socorro Island of the Revillagigedo Archipelago and Bahia de Manzanillo between November 1999 and December 2000, 11 juvenile olive ridleys, measuring around 29 cm curved carapace length, were found close together in deep water and almost always in pairs (Juárez-Cerón and Sarti-Martínez 2003). Olive ridleys reach sexual maturity between 8 and 10 years of age, and approximately 3 percent of hatchlings recruit to the reproductive population.

Like leatherback turtles, most olive ridley turtles lead a primarily pelagic existence (Plotkin et al. 1994a). Olive ridley turtles from the east and west Pacific have different habitat associations. Western Pacific olive ridley turtles associate with major ocean currents, and olive ridley turtles from the eastern Pacific typically remain within the center of the Subtropical Gyre where waters are warm, vertically stratified with deep thermoclines, and do not have strong surface temperature or chlorophyll gradients (Polovina et al. 2004). Olive ridleys from the western Pacific were found in habitat characterized by wind-induced upwelling and shoaling of the thermocline, which may allow them to forage more shallowly in these areas, which may provide an energetic advantage to turtles migrating across the Pacific (Polovina et al. 2004). Throughout the eastern tropical Pacific Ocean, olive ridleys appear to forage 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, sea turtles occurred in 15 percent of observations suggesting that flotsam may provide the turtles with food, shelter, and/or orientation cues in an otherwise featureless landscape; 75 percent of the sighted turtles were olive ridleys (Arenas and Hall 1992). During 1989 to 2000, a large distribution of adults occurred on the continental shelf and slope near major nesting beaches next to the Pacific trench in upwelling regions (Kopitsky et al. 2003). Adults were frequently found in shallow waters, and juveniles were observed in deeper waters off the continental shelf.

4.4.4 Diet

Olive ridleys typically forage offshore and feed on a variety of benthic and pelagic species, such as jellyfish, squid, salps, red crabs, acorn and gooseneck barnacles, mollusks, small fish, other invertebrates, and algae (Márquez 1990). Similar to loggerheads, olive ridleys off western Baja California may feed exclusively on pelagic red crabs (NMFS and USFWS 1998d). The most common prey of olive ridley turtles are salps and pyrosomes, similar to leatherback turtles. These prey organisms occur sub-surface and migrate within the water column as part of the deep scattering layer.

4.4.5 Migration

While olive ridleys generally have a tropical to subtropical range, individuals do occasionally venture north, some as far as the Gulf of Alaska. Olive ridleys are highly migratory and may spend most of their non-breeding life cycle in deep-ocean waters, but occupy the continental shelf region during the breeding season (Beavers and Cassano 1996; Cornelius and Robinson 1986; Pitman 1992; Plotkin et al. 1994b). Reproductively active males and females migrate toward the coast and aggregate at nearshore breeding grounds near nesting beaches (Hughes and Richard 1974; Plotkin et al. 1996; Plotkin et al. 1997). Other males and females may not migrate to nearshore breeding aggregations at all (Pitman 1992). Some males appear to remain in oceanic waters, are non-aggregated, and mate opportunistically as they intercept females en route to nearshore breeding grounds and nesting beaches (Plotkin et al. 1994b; Plotkin et al. 1996). Their migratory pathways vary annually without spatial and temporal overlap among groups or cohorts of turtles, and no apparent migration corridors exist (Plotkin et al. 1994b). Olive ridleys may use water temperature more than any other environmental cue during migrations (Spotila 2004). Post-nesting migration routes from Costa Rica traverse more than 3,000 km out into the central Pacific (Plotkin et al. 1994a; Plotkin et al. 1994b).

4.4.6 Diving Behavior

Olive ridleys can dive and feed at considerable depths (80–300 m), but about 90 percent of their time is spent at depths <100 m (Polovina et al. 2003). Mated females and males did not make dives greater than 150 m, but a non-mated pelagic male and female both made dives greater than 150 m with a few dives over 250 m (Parker et al. 2003). The average dive lengths for an adult female and adult male are reported to be 54.3 and 28.5 minutes, respectively, and lengths can be up to 180 minutes for adult females, 75 minutes for adult males, and 60 minutes for juveniles (Plotkin et al. 1994b). As a result, olive ridley turtles tend to dive deep, spending 40 percent of their time at depths greater than 40 m and only 20 percent of their time at the surface where they typically feed. On 25 percent of the recorded dive days, olive ridley turtles dove to depths greater than 150 m at least once (Polovina et al. 2004). Female olive ridleys spent significantly more time at 40 to 80 m than did the males, and both male and female turtles spent at least 25 percent of total dive time in thermocline at 20-100 m (Parker et al. 2003). In the eastern tropical Pacific, more dives occur during daytime than at night, but nighttime dives are longer (Beavers and Cassano 1996; Parker et al. 2003).

4.4.7 Threats

Similar to other sea turtle species, olive ridleys experience threats from destruction, modification, and degradation of beach and pelagic habitats; poaching, killing, and predation; cold stunning; incidental takes in fisheries; and unquantified effects of climate change. High levels of adult mortality due to harvesting are believed to be the reason why rapid and large nesting population declines occurred in Mexico (Cornelius et al. 2007). In 1990, Mexico enacted a ban on commercial sea turtle harvest, which has greatly aided olive ridley conservation, but egg poaching still occurs at several solitary and arribada nesting beaches (Cornelius et al. 2007). Approximately 300,000-600,000 eggs were seized each year from 1995-1998 (Trinidad and Wilson 2000). Shrimp trawls off of Central America are estimated capture over 60,000 sea turtles annually, most of which are olive ridleys (NMFS and USFWS 2014). Olive ridleys in the eastern Pacific are also incidentally caught by purse seine fisheries and gillnet fisheries (Frazier et al. 2007). Olive ridley tissues have been found to contain the organochlorines chlordanes, lindane, endrin, endosulfan, dieldrin, DDT, and PCB (Gardner et al. 2003). These contaminants have the potential to cause deficiencies in endocrine, developmental, and reproductive health and are known to depress immune function in loggerhead sea turtles (Storelli et al. 2007). Heavy metals, including cadmium, iron, nickel, copper, zinc, and manganese, have been found in a variety of tissues in levels that increase with turtle size (Gardner et al. 2006).

4.5 Hawksbill Sea Turtle

The hawksbill is a small to medium-sized marine turtle with a mottled brown shell with overlapping scutes (Figure 10). The hawksbill sea turtle has two pairs of prefrontal scales; thick, posteriorly overlapping scutes on the carapace; four pairs of costal scutes (the anterior-most are not in contact with the nuchal scute); two claws on each flipper; and a beak-like mouth. In addition, when on land, the hawksbill has an alternating gait, unlike green and leatherback sea turtles. The carapace is heart-shaped in very young turtles and becomes more elongate or subovate with maturity. The lateral and posterior carapace margins are sharply serrated in all but very old individuals. The scutes are unusually thick and overlap posteriorly on the carapace in all but hatchlings and very old individuals. Scutes are often richly patterned with irregularly radiating streaks of brown and black on an amber background. The soft skin on the hawksbill’s venter is cream or yellow and may be pinkish-orange in mature individuals. The scales of the head and forelimbs are dark brown or black and have sharply defined yellow borders. There are typically four pairs of inframarginal scales. The head is elongate and tapers sharply to a point.

Nesting females average about 87 cm in curved carapace length (Eckert 1992), and weight may be up to 80 kg in the Caribbean (Pritchard et al. 1983), with a record weight of 127 kg (Carr 1952). Hatchlings in the U.S. Caribbean average about 42 mm in straight carapace length and range in weight from 13.5 to 19.5 g (Hillis and Mackay 1989; van Dam and Sarti 1989; Eckert 1992).

Figure 10. Hawksbill sea turtle (*Eretmochelys imbricata*). Credit: Johan Chevalier.

4.5.1 Status and Trends

Hawksbill sea turtles received protection on June 2, 1970 (35 FR 8491) under the Endangered Species Conservation Act and since 1973 have been listed as endangered under the ESA. The IUCN considers the species “Critically Endangered” based on global population declines of over 80 percent during the past three generations (Meylan and Donnelly 1999). Long-term trend data at foraging sites are few primarily because these data are logistically difficult and relatively expensive to obtain. As with green sea turtles, the primary information source for evaluating trends in global hawksbill populations is nesting beach data. The Pacific Ocean has more nesting hawksbills than the Atlantic or Indian Oceans, but the nesting abundance and population trend in the Pacific is declining severely (NMFS and USFWS 2013a). Although no historical records of abundance are known, hawksbill sea turtles are considered to be severely depleted due to the fragmentation and low use of current nesting beaches (NMFS and USFWS 2013a). Worldwide, an estimated 21,212-28,138 hawksbills nest each year among 83 sites. Among the 58 sites for with historic trends, all show a decline during the past 20 to 100 years. Among 42 sites for which recent trend data are available, 10 (24 percent) are increasing, three (7 percent) are stable and 29 (69 percent) are decreasing. Encouragingly, nesting range along Mexico and Central America appears not to have contracted, and estimates continue to increase as additional dedicated study is conducted in the eastern Pacific (Gaos et al. 2010).

4.5.2 Distribution

The hawksbill sea turtle occurs in tropical and subtropical seas of the Atlantic, Pacific, and Indian Oceans. Within the Central Pacific, nesting is widely distributed but in very low numbers. Foraging hawksbills occur near all the island groups of Oceania from the Galapagos Islands in the eastern Pacific to the Republic of Palau in the western Pacific (Witzell 1983; Pritchard 1982a,b). American Samoa and Western Samoa host fewer than 30 females annually (Tuato'o-Bartley et al. 1993; Grant et al. 1997). Guam and Hawaii each have only 5-10 nesting females annually, but the Hawaiian population shows signs of a potential increasing trend (NMFS and

USFWS 2013b). Along the far western and southwestern Pacific coasts, hawksbills nest on the islands and mainland of southeastern Asia from China and Japan, throughout the Philippines, Malaysia, and Indonesia, to Papua New Guinea (PNG), the Solomon Islands, and northeastern Australia (McKeown 1977; Limpus 1982). Additional populations are known from the eastern Pacific potentially extending from Mexico through Panama.

4.5.3 Reproduction and Life History

The best estimate of age at sexual maturity for hawksbill sea turtles is about 20-40 years (Chaloupka and Limpus 1997, Crouse 1999). Age to maturity has been estimated as a minimum of 30-35 years in the Indo-Pacific. In northeastern Australia, first breeding is estimated to occur at 31-36 years for females and 38 years for males (Limpus and Miller 2000). Reproductive females may exhibit a high degree of fidelity to their nest sites, and they nest an average of three to five times per season at regular intervals (Richardson et al. 1999). Average clutch size is higher (about 250 eggs) than that of green turtles (Hirth 1980). Nesting site selection in the southwest Pacific appears to favor sites with higher wind and wave exposure, possibly as a means to aid hatchling dispersal (Santana Garcon et al. 2010) .

Once hawksbill hatchlings leave the beach, they are pelagic and likely carried long distances by surface gyres (Meylan 1988; Meylan and Donnelly 1999). Hatchlings and small juveniles (5-21 cm straight carapace length) have been found in association with *Sargassum* in both the Atlantic and Pacific Oceans (Musick and Limpus 1997). When juveniles reach about 30-35 cm straight carapace length, they settle in neritic foraging and developmental habitats including coral reefs or other hard-bottom habitats, sea grass, algal beds, and mangrove bays and creeks (Musick and Limpus 1997; Bjorndal and Bolten 2010). Some larger juveniles may associate with the same feeding locality for more than a decade while others apparently migrate from one site to another (Musick and Limpus 1997). Adult foraging habitat, which may or may not overlap with developmental habitat, is typically coral reefs but occasionally includes other hard-bottom communities and mangrove-fringed bays. Larger individuals may prefer deeper habitats than smaller hawksbills (Blumenthal et al. 2009).

4.5.4 Diet

Pelagic hatchlings eat *Sargassum* and its associated flora and fauna, and juveniles and adults shift to benthic feeding, predominantly on sponges although evidence suggests a more omnivorous diet in the Indo-Pacific (NMFS and USFWS 1998b; NMFS and USFWS 2013b). Hawaiian and Caribbean hawksbills are specialist sponge carnivores and eat just a few genera of sponges (Balazs 1978; Meylan 1988; Vicente 1994). Much of the other material found in hawksbill stomachs appears to have been ingested coincidentally while the animal was feeding on sponges.

4.5.5 Migration

Hawksbill sea turtles are highly migratory and use a wide range of broadly separated localities and habitats during their lifetimes (Musick and Limpus 1997; Plotkin 2003). Hawksbills undertake developmental and reproductive migrations that may span hundreds or thousands of kilometers (Meylan 1999). Reproductive females periodically migrate to their natal beach to nest. Movements of reproductive males are less well known but are presumed to involve migrations to the nesting beach or to courtship stations along the migratory corridor.

4.5.6 Diving Behavior

Hawksbills have long dive durations, but dives are not particularly deep. Diving ability varies with age and body size. As individuals increase with age, dive duration and depth increase (Blumenthal et al. 2009). Caribbean hawksbills have diurnal diving behavior with dives lasting almost double the length of night dives (van Dam and Diez 1997; Blumenthal et al. 2009). Daytime dives averaged 5 m in depth, and nighttime dives averaged 43 m (Blumenthal et al. 2009). Adult females along St. Croix reportedly have average dive times of 56 min, with a maximum time of 73.5 min (Starbird et al. 1999). Typical day and night dive times were 34–65 and 42–74 min, respectively. Immature individuals have much shorter dives of 8.6–14 min to a mean depth of 4.7 m while foraging (van Dam and Diez 1997).

4.5.7 Threats

Threats to hawksbill sea turtles are similar to those for other sea turtles and include incidental capture by fisheries, habitat modification and loss, disease, predation, and harvest of eggs, subadults, and adults. Although hawksbills are subject to the suite of threats that affect other marine turtles, the decline of the species is primarily attributed to centuries of exploitation for tortoise shell, the beautifully patterned scales that cover the turtle’s shell (Parsons 1972). Hawkbills’ predictable nesting sites and timing make them vulnerable to capture on the nesting beach. Poaching of eggs and killing of turtles continue to threaten populations in many areas (NMFS and USFWS 2007b). Also, because hawksbills prefer to nest under vegetation (Mortimer 1982; Horrocks and Scott 1991), they are particularly impacted by beachfront development and clearing of dune vegetation. At sea, hawksbills are typically associated with coral reefs, which are among the world’s most endangered marine ecosystems (Wilkinson 2002). Finally, while the effects of climate change may be difficult to predict, its potential effects to the sea turtle environment (e.g., nesting habitat) or food sources are of concern (NMFS and USFWS 2007b). Hawksbills exhibit temperature-dependent sex determination (Wibbels 2003), which suggests that the hatchling sex ratio may have a female bias (since warmer temperatures result in more female hatchlings).

5 Environmental Baseline

The “environmental baseline” includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

The environmental baseline for this biological opinion includes natural and anthropogenic effects on survival and recovery of threatened and endangered species in the action area. The following describes the fisheries and non-fisheries-related activities that affect the sea turtles discussed in this opinion. Some activities occur beyond the action area but are included below because they could affect migrating sea turtles.

5.1 Fisheries Impacts

Few fisheries in the Pacific Ocean are well 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. Such estimates are hampered by a lack of data on pelagic distribution of sea turtles.

This section summarizes some fisheries with observations or reports of incidental or intentional sea turtle takes. Estimates of total fishing effort are complicated because not all active vessels fish equivalent number of days per trip or annually; use the same number of hooks, length of net, or mesh size; or have the same carrying capacity. However, even with minimum effort estimates, substantial fishing effort occurs in the Pacific Ocean for which NMFS has minimal sea turtle bycatch information. Bycatch data exist for the few fisheries to which this permit would apply as a result of previous and ongoing research efforts. For example, between 2005 and 2010, the Hawaii shallow-set and deep-set longline fisheries combined with the American Samoa longline fishery resulted in sea turtles takes totaling 11 greens, 33 leatherbacks, 41 loggerheads, 32 olive ridleys, and 2 of unidentified species.

5.1.1 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. However, effects of high-seas driftnet fisheries operating prior to 1992 may still be evident in sea turtle population trends. Except for observer data collected in 1990-1991, no data exist regarding 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, and 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 indicates that 4,373 turtles, mostly loggerheads and leatherbacks, were entangled by the combined fleets of Japan, Korea, and Taiwan from June 1990 to May 1991 when all fleets were monitored (Table 5). Of these incidental entanglements, an estimated 1,011 turtles were killed (77 percent survival rate).

Table 5. Estimated annual bycatch and mortality of sea turtles in the North Pacific high-seas driftnet fishery for squid, tuna, & billfish in 1990-1991.

Species	Estimated Annual Take	Estimated Annual Mortality
Green	378	93
Leatherback	1,002	111
Loggerhead	2,986	805
Hawksbill	7	2
TOTAL	4,373	1,011

Source: Wetherall 1997.

Comprehensive data are lacking, but the observer data indicate the possible magnitude of past turtle mortality. The North Pacific high-seas driftnet fisheries may have killed at least 2,500 turtles per year during the late 1980s, and the estimated total driftnet bycatch was about 9,000 turtles per year (Wetherall et al. 1993). Most mortalities observed in 1990 were loggerheads in the Japanese and Taiwanese large-mesh fisheries.

Effects from historic driftnet fisheries may still be evident in sea turtle populations today. Most green, loggerhead, and leatherback turtles taken by the fisheries and measured on board were immature (Wetherall 1997). The high mortality of juveniles, sexually immature adults, and reproductive adults in the high-seas driftnet fisheries has potentially altered the current age structure and, therefore, diminished or limited the reproductive potential of affected sea turtle populations.

5.1.2 Pacific Longline Fisheries (2000)

Available data indicate that approximately 30,000 loggerheads and 20,000 leatherbacks were caught as bycatch by pelagic longlines throughout the Pacific in 2000, and about 2600-6000 loggerheads and 1000-3200 leatherbacks of the bycatch were mortalities (Lewison et al. 2004).

5.1.3 Japanese Tuna Longliners in the Pacific Ocean and South China Sea (historical perspective)

Extrapolation of turtle sightings and capture rates in 1978 shows that an estimated 21,200 turtles, including greens, leatherback turtles, loggerheads, olive ridleys, and hawksbills, were captured annually, including approximately 12,300 mortalities, by Japanese tuna longliners in the Western Pacific and South China Sea (Nishimura and Nakahigashi 1990). For every 10,000 hooks in the Western Pacific and South China Sea, one turtle was captured with a mortality rate of 42 percent. Although species-specific information is not available, vessels reported sightings of turtles in locations that overlap with commercial fishing grounds in the following proportions: loggerhead – 36 percent; green turtle – 19 percent; leatherback - 13.7 percent; hawksbill - 10.3 percent; olive ridley - 1.7 percent; and unknown – 19 percent. Therefore, longliners fishing in the Pacific likely had significant impacts on sea turtle populations.

5.1.4 Japanese Coastal Fisheries

Off the coast of Japan, gillnets and pound nets are very common, and an intense offshore trawl fishery for anchovy operates. Pound net fisheries offshore from the nesting beaches and in the coastal foraging areas are a major threat to the mature classes of loggerheads (approximately 70-80 cm straight carapace length) (Conant et al. 2009). Middle-layer and bottom-type pound nets have high mortality rates (almost 100 percent) because sea turtles trapped in the submerged nets cannot reach the surface to breathe. An estimated 100 loggerheads died in one area between April 2006 and September 2007 (Conant et al. 2009).

5.1.5 Taiwan Coastal Setnet and Gillnet Fishery

Taiwanese have harvested sea turtles for many years for their meat, bones for use in Chinese medicine, and eggs for profit. Sea turtle bycatch in Taiwanese fisheries occurs, but few data are available (Cheng 2002).

Setnets used in the coastal waters off Taiwan are nearshore sedentary trap nets and rarely extend below 20 m. During 1991-1995, 107 setnets existed in Taiwan, and they provided the second largest total fish yields after gillnets (Cheng and Chen 1997). Of the sea turtles caught, 82 percent were caught in setnets, and all were alive. Large juveniles, subadult, and adult green turtles accounted for 70 percent of the sea turtles taken (Table 6). Most captured loggerheads were either subadult or adult females (only one male was unidentified), and most captured olive ridleys were subadults. The one captured leatherback was released alive. Of all captured turtles, 88 percent were sold to temples for Chinese religious ceremonies, 8 percent were stuffed or butchered, and 3 percent were released at the site (Cheng and Chen 1997).

Table 6. 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.

5.1.6 Philippines

Near the Turtle Islands, an increasing number of floating dead turtles were observed in this area since 1999, which is most likely attributable to an increasing number of fishing vessels including purse seiners, shrimp trawlers, and hulbot-hulbot (demersal drive-in net) (Cruz 2002). These vessels originated primarily from Sabah, Malaysia and Manila, Philippines. Also, Chinese vessels operating illegally in Phillipine waters catch sea turtles. In January 2002, more than 58 sea turtles, primarily green turtles, were discovered on four Chinese vessels in Tabbataha Marine Park, a UNESCO Natural Heritage Park, located in the Sulu Sea (Cruz 2002).

5.1.7 Malaysia

In Malaysia, sea turtles are caught in fisheries using driftnets, lift nets, ray nets (similar to sunken driftnets with a large mesh to target rays and sharks), trawl nets, and purse seines.

5.1.8 Distant-Water Fishing Nations' Longline Fishing in the Federated States of Micronesia

Micronesian Maritime Authority fisheries observers reported on 51 distant-water fishing nation (DWFN) longline trips from 1993 through 1995 (Heberer 1997). Vessels from China, Taiwan, and Japan captured 34 sea turtles—15 olive ridley turtles, 8 green turtles, and 11 unidentified sea turtles. Thirty were released alive, and four were dead when landed (11.8 percent mortality rate). Data on hooking location or entanglement were not reported nor was the condition of each turtle by species. Low observer coverage contributes to uncertainty regarding impacts; however, sea turtles are likely taken in the longline fishery when it occurs in this area.

5.1.9 Foreign Tuna Fisheries in the Western and Central Pacific Ocean

The western and central Pacific Ocean (area west of 150°W and between 10°N and 45°S) contains a large industrial tuna fishery. Much effort occurs in the EEZs of Pacific-Island countries in the western tropical Pacific. Observers have been placed on purse seiners and longliners in this area. While observers have covered most of the fleets, three fleets historically have not been properly observed: the Japanese and Korean distant-water longline fleets operating in the eastern areas and the Australian swordfish fishery operating off eastern Australia.

Patterns of observed sea turtle interactions show that sea turtles are more likely to encounter gear in tropical waters especially when shallow set. Sea turtles encountered on deep-set gear were likely to be taken on the shallowest hooks. From available observer data, the longline fishery operating in the western and central Pacific has previously been estimated to take thousands of sea turtles per year with a high mortality rate.

5.1.10 Chile

Although data on incidental take of sea turtles in the Chilean swordfish fisheries are sparse, 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). The Chilean swordfish fishery comprised primarily artisanal fishermen with an average of 500 boats (mainly driftnetters) from 1989 to 1991 and fewer boats after 1991. The commercial fishery used gillnets, pelagic longliners, and boats that switch gear. During 1996, Chilean longline fishing in offshore areas expanded, but effects on sea turtle populations are not known (Weidner and Serrano 1997).

5.1.11 Peru

Since 1995, Peruvian law has prohibited the capture, trade, and consumption of sea turtles. Peruvian artisanal fishermen target fish species (especially sharks) normally taken in commercial longline fisheries, and turtles may be caught incidentally in gillnets and by hook and line (Weidner and Serrano 1997; Kelez et al. 2003). Fishermen from the smaller villages may release a live turtle; however, if it is dying, they will kill it. In the larger towns, fishermen will nearly always kill an incidentally caught turtle because of the demand for its meat. The carapaces have been sold in the department of Tumbes and in the northern part of the department of Piura for the tourism industry (Kelez et al. 2003). During 2000-2007, observed turtle bycatch for small-scale fisheries (bottom set net, driftnet, and longline) from three ports was 807 individuals, and the total estimated annual bycatch for all small-scale fisheries (they operate out of over 100 ports) was 5910 turtles (Table 7). Foreign longline fleets are also active off Peru, and bycatch in foreign fisheries is significant (Weidner and Serrano 1997).

Table 7. Capture estimates from small-scale fisheries in Peru from 2000 to 2007.

Species	Estimated # captured
Green turtle	2400
Loggerhead	3200
Leatherback	70
Olive Ridley	240
Hawksbill	0
Total	5910

Source: Alfaro-Shigueto et al. 2011.

5.1.12 Central American Shrimp Fishery

Shrimp trawlers on the Pacific coast of Central America took more than 60,000 sea turtles since the fishery began in the mid 1950s (Arauz 1996). Mortality rates are unknown. Olive ridley foraging grounds overlap with shrimp trawling grounds, and the olive ridley was the most common species taken (Table 8).

Table 8. Estimated turtle catch in shrimp trawls off the Pacific coast of Central America, 1993.

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

Note: N/A = not available. Figures in parentheses are estimates.
Source: Arauz 1996.

5.1.13 Costa Rica

Longlining has a high incidental take of sea turtles in Costa Rica. In the late 1990s, 34 turtles (55 percent olive ridleys and 45 percent east Pacific green turtles) were taken in two sets containing 1,750 hooks (1.42 turtles per 100 hooks), and another cruise had 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 nine cruises. Turtles represented 7.6 percent of the total catch with gear deploying nearly 40,000 hooks and a catch per unit effort of 6.364 turtles/1,000 hooks.

5.1.14 Mexican (Baja California) Fisheries

Sea turtles have been protected in Mexico since 1990, when a federal law decreed the prohibition of capturing or killing sea turtles or trading any sea turtle product. Although there are no solid estimates of fisheries-related sea turtle mortality rates for the region, several fisheries in the area interact with and kill sea turtles. Mexico's requirement for turtle excluder devices in shrimp fisheries began in 1996.

In 2005, two small-scale fishing fleets operated near a high-use area for loggerheads. The Puerto López Mateos-based fleet (9-40 vessels) soaked bottom-set gillnets for 20-48 hours in the deep area (32-45 m) (Conant et al. 2009). During a two-month period, 11 loggerheads were observed taken in 73 gillnet day-trips, and 8 were landed dead (observed mortality rate of 73 percent). The Santa Rosa fleet (5-6 vessels in 2005) fished using bottom-set longlines baited with tuna or mackerel left to soak for 20-48 hours. During the seven day-long, bottom-set longline trips observed, 24 of the 26 loggerheads taken were landed dead (observed mortality rate of 92 percent). In 2005, the bottom-set gillnet fishery killed an estimated 299 loggerheads, and the bottom-set longline fishery killed an estimated 680 loggerheads. This annual bycatch estimate of approximately 1,000 loggerheads is considered a minimum and is also supported by shoreline mortality surveys and informal interviews (Peckham et al. 2007). Incidental capture in fisheries of Baja California Sur appears to be one of the most significant sources of mortality for the loggerhead population in the North Pacific.

5.1.15 Tuna Purse Seine Fishery in the Eastern Tropical Pacific

The international fleet represents most fishing effort and carrying capacity in the Eastern Tropical Pacific (ETP) tuna fishery. Purse seiners with carrying capacities greater than 400 short tons (st) represented nearly 70 percent of the total fishing capacity operating in the ETP in 1996 (IATTC 2002). An average of 122 foreign vessels with carrying capacities greater than 400 st fished in the ETP during 1996 to 2001. Also during 1996-2001, an average of 59 foreign vessels ranging from 45-400 st in carrying capacity fished in the ETP (IATTC 1999, 2001).

During 1993-2004, vessels over 400 st killed 17-172 sea turtles per year in the ETP purse seine fishery. Most takes were olive ridleys (Table 9; IATTC 2006), which is likely because they are more abundant than any other sea turtle species in the ETP and they appear to have an affinity for floating objects (Arenas and Hall 1992). Assuming that unidentified turtle mortalities in Table 14 occurred in the same proportions as the identified turtle mortalities, 86 percent would be olive ridleys, 10.8 percent would be green turtles, 2.1 percent would be loggerheads, 1 percent would be hawksbill, and 0.1 percent would be leatherbacks. Fishery-based sea turtle mortalities dropped significantly from about 170 to 20 annual mortalities as a result of increased awareness by fishermen through educational seminars and conservation measures implemented by the Inter-American Tropical Tuna Commission (IATTC) as well as IATTC Resolutions (IAC 2012).

Table 9. Estimated sea turtle mortality for the ETP tuna purse seine fishery from 1994 to 2005. Includes only large (364 metric ton capacity and greater) vessels.

Name	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Green	16.1	13.0	12.0	13.0	9.0	10.9	6.1	7.8	2.1	0.0	0.0	1.4
Hawksbill	1.8	0.0	1.0	0.0	3.0	2.0	1.0	1.3	0.0	0.0	0.0	0.0
Leatherback	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Loggerhead	1.8	2.0	0.0	4.6	1.0	4.0	1.8	1.3	0.0	0.0	0.0	0.0
Olive Ridley	80.1	91.3	65.8	93.8	107.6	109.1	92.1	74.2	30.7	17.1	11.0	14.9.0
Unidentified	45.3	34.0	37.6	42.0	41.0	46.2	29.4	55.3	13.8	9.1	5.9	11.1
Total	**146.3**	**140.3**	**116.4**	**153.4**	**161.6**	**172.2**	**130.4**	**139.9**	**46.6**	**26.2**	**16.9**	**27.5**

Source: IATTC 2006.

As mentioned, the U.S. fleet (large vessels only) has 100 percent observer coverage; therefore, the fate of every sea turtle taken is documented. Because the U.S. fleet does not set on dolphins, sea turtles are taken in school sets and sets using fish-aggregating devices. The fate of sea turtles that interact with the U.S. purse seine fleet during such sets may only be comparable to the non-

U.S. fleet that sets on fish-aggregating devices and tuna schools. Similar to the entire purse seine fleet, most sea turtles taken by the U.S. fleet are olive ridleys (Table 10), and most are released unharmed.

5.1.16 Federally-managed U.S. Fisheries in the Western Pacific

Federally-managed fisheries in the Western Pacific are covered by ecosystem management plans (for fisheries in the EEZs of U.S. Pacific areas), a pelagics management plan, and various international agreements. NMFS consults on individual fisheries and authorizes sea turtle takes (Table 11).

Table 10. Sea turtle interactions with the U.S. tuna purse seine fleet (>363 mt vessels only) in the ETP, 1998-2005.

Name	Fate	1998	1999	2000	2001	2002	2003	2004	2005
Green	Released unharmed	3	5	2	2	1	5	0	1
Hawksbill	Released unharmed	0	0	0	1	1	0	0	0
Loggerhead	Released unharmed	0	1	5	0	0	0	0	0
Olive Ridley	Released unharmed	38	27	3	16	10	34	23	7
	Escaped/evaded net	0	0	1	0	0	0	0	0
	Light injuries*	4	6	2	0	0	7	1	1
	Grave injuries**	1	0	0	3	0	0	0	0
	Killed	0	0	0	0	0	1	0	0
Unidentified	Released unharmed	2	0	3	6	1	10	5	0
	Escaped/evaded net	2	1	1	0	0	0	0	0
	Light injuries*	0	0	0	1	0	0	0	0
	Other/Unknown	1	0	0	0	0	1	0	0
	Killed	0	0	0	0	0	0	0	1
Total		**51**	**40**	**17**	**29**	**13**	**58**	**29**	**10**

*Light injuries are considered to be non-lethal injuries.
**Grave injuries are considered to be eventually lethal to the turtle.
Source: IATTC 2006.

Table 11. Incidental take for sea turtles in Federally-managed fisheries in the Western Pacific.

Date Opinion Issued	Fishery	Authorized Take (annual)	
		Harm, Harass, Injury	Mortality
11/1/06	Western & Central Pacific purse seine	Loggerhead: 11 Leatherback: 11 Olive ridley: 11 Green: 14 Hawksbill: 14	Loggerhead: 0 Leatherback: 0 Olive ridley: 0 Green: 0 Hawksbill: 0
3/18/08	Hawaii bottomfishing	Loggerhead: 0 Leatherback: 0 Olive ridley: 0 Green: 2 Hawksbill: 0	Loggerhead: 0 Leatherback: 0 Olive ridley: 0 Green: 2 Hawksbill: 0
09/01/09	Western Pacific pelagic troll and handline	Loggerhead: 0 Leatherback: 0 Olive ridley: 0 Green: 0 Hawksbill: 0	Loggerhead: 0 Leatherback: 0 Olive ridley: 0 Green: 4 Hawksbill: 0
09/16/10	American Samoa longline*	Loggerhead: 0 Leatherback: 1 Olive ridley: 1 Green: 45 Hawksbill: 1	Loggerhead: 0 Leatherback: 1 Olive ridley: 1 Green: 41 Hawksbill: 1
01/30/12	Hawaii shallow-set longline	Loggerhead: 34 Leatherback: 26 Olive ridley: 2 Green: 3 Hawksbill: 0	Loggerhead: 7 Leatherback: 6 Olive ridley: 1 Green: 1 Hawksbill: 0
09/19/14	Hawaii deep-set longline*	Loggerhead: 9 Leatherback: 72 Olive ridley: 99 Green: 9 Hawksbill: 0	Loggerhead: 9 Leatherback: 27 Olive ridley: 96 Green: 9 Hawksbill: 0

* Authorized take is every three years instead of annually for these fisheries.
Sources: NMFS 2006, 2008, 2009, 2010, 2012, 2014.

5.2 Direct Harvest

The following direct harvest activities affect the same populations that are affected in the action area. Therefore, these impacts are direct contributors to the environmental baseline.

5.2.1 Mexico

Sea turtles have been protected in Mexico since 1990; however, sea turtles continue to be caught or “harvested,” both indirectly in fisheries and by a directed harvest of eggs, immatures, and adults.

5.2.2 Peru

The Ministério de Pesquería, 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 (Weidner and Serrano 1997). In 1995, the Peruvian government prohibited the capture, trade, and consumption of green, leatherback, olive ridley, and hawksbill turtles. However, in many ports of Peru, this decree was and is poorly enforced, and sea turtles were widely caught for human consumption. Noted Peruvian ports included Pisco, Chincha, Pucusana, Callao, and Chimbote (Alfaro-Shigueto et al. 2002). Peru conducted directed commercial turtle harvests throughout the 1980s, and as recently as 1990, over 100 metric tons of turtles were taken (Weidner and Serrano 1997).

5.2.3 Vietnam

In Vietnam, the market has a high demand for sea turtle products, and as a result, green and hawksbill turtles have been harvested heavily. Direct harvest of sea turtles is common among the coastal communities, where turtles forage and breed. In addition, sea turtle eggs are collected for food. Poverty in the country and a lack of awareness of the conservation of resources are partially to blame for this exploitation; in addition, protective regulations are absent, and government support for sea turtle research and conservation efforts is small (Hien 2002). Unfortunately, no quantitative estimates are available on the level of sea turtle mortality or the number of eggs taken.

5.2.4 Australasia (Bali, Torres Strait)

Bali historically had a large trade in live green turtles. Turtles have been used as a standard source of food and in religious festivities in southern Bali (within the Balinese-Hindu culture) for many years, and as of 2002, the demand was increasing (Dermawan 2002). While traditional religious ceremonies require the use of sea turtle meat, Hindu high priests have estimated that only 300 to 500 turtles annually serve that purpose (Dethmers and Broderick 2003). The average demand for sea turtles in Bali alone has been previously estimated at approximately 17,000 per year, although the government only permitted the harvest and slaughter of up to 3,000 turtles per year. With green turtles foraging near and nesting on Bali decreasing, the sea turtle fishery out of Bali has had to expand to more distant foraging and nesting populations throughout the Indonesian archipelago. This has required larger vessels and a network of hunters, traders, and shippers, and the fishery affects most green turtle stocks throughout the region (Dethmers and Broderick 2003).

In the Torres Strait, both a commercial fishery and a subsistence fishery have operated, taking substantially fewer turtles than the Balinese fishery. In the subsistence fishery, Islanders use small aluminum dinghies and deploy small nets or use traditional gear typically within a day’s journey from their village. Sea turtles are consumed for subsistence or used in traditional feasts. In the late 1980s, the commercial fishery was estimated to take 5,000-10,000 sea turtles annually and was marketed through Daru in Papua New Guinea. The Torres Strait fishery affects the northern Great Barrier Reef breeding unit almost exclusively (Dethmers and Broderick 2003).

5.2.5 Fiji

In Fiji, mortalities due to the traditional harvesting of adults for ceremonial purposes and subsistence and commercial harvesting of adults, eggs, and shells have been significant. For example, approximately 30,000 hawksbill shells were exported during the 1980s, with approximately 2,000 kg of shells exported in 1989 alone. Hunting for sea turtles in Fiji has historically been relatively easy because of a lack of regulation. The Fijian government placed a one-year ban on the harvest of marine turtles in 1995, implemented a three-year ban from May 1997 to December 2000, and imposed a moratorium from February 2004 until 31 December 2008 on killing turtles, digging and poaching of eggs, and all sales of turtle flesh and shell with an exemption for traditional purposes (Laveti and MacKay 2009). The Fijian government extended the moratorium until 2018 (Jupiter et al. 2010). Open sale of turtles in the markets no longer occurs, but anecdotal information suggests substantial catch for subsistence and traditional use and a possible black market for commercial sales exist (Laveti and MacKay 2009).

5.2.6 Philippines

Despite a significant increase in conservation awareness, turtles are still killed and sold for their meat and eggs in the Philippines.

5.3 Scientific Research Permits

The following research permits were issued in the past decade for the target sea turtle species in the Pacific Ocean. However, it should be noted that while research permits may result in minor, negative impacts to targeted individuals, these permits aid conservation, recovery, and management of sea turtles by providing data from research results.

5.3.1 Permit Nos. 1514 & 14381, NMFS Pacific Islands Regional Office

Researchers have been issued two consecutive five-year permits to annually measure, photograph, tissue sample, flipper tag and release or salvage (if dead) sea turtles that have been captured in the Hawaiian and American Samoan longline fisheries. Six of the loggerheads taken by each fishery may also have a pop-up satellite tag attached to their shell. The current authorized takes are for 1 green, 16 leatherback, 46 loggerhead, and 4 olive ridley sea turtles in the Hawaii shallow-set longline fishery and for 7 green, 13 leatherback, 6 loggerhead, and 41 olive ridley sea turtles in the Hawaii deep-set longline fishery. An additional 10 hawksbill, 20 olive ridley, 10 loggerhead, 10 leatherback, and 20 green sea turtles captured in the American Samoa longline fishery may be measured, photographed, tissue sampled, flipper tagged, and released, or salvaged (if dead). Between 2005 and 2010, the Hawaii shallow-set and deep-set longline fisheries combined with the American Samoa longline fishery resulted in sea turtles takes totaling 11 greens, 33 leatherbacks, 41 loggerheads, 32 olive ridleys, and 2 of unidentified species. Coverage for the incidental capture of these turtles in the fisheries is provided under the incidental take statements of the biological opinions for the fisheries (NMFS 2010, 2013, 2014).

Research conducted on incidentally captured turtles provided data on the at-sea distribution and movement patterns of sea turtles and on the post-release behavior and mortality of hard-shelled turtles that have been hooked or entangled by longline gear. Data enabled studies on post-release mortality, migratory pathways, and satellite transmitter survival (Sakamoto et al. 1997; Parker et al. 2001; Chaloupka et al. 2004b). The first permit expired March 31, 2010, and the second permit expires February 28, 2015. The scope of this Biological Opinion is the issuance of the third consecutive five-year permit (18688).

5.3.2 Permit No. 1556, Commonwealth of the Northern Mariana Islands, Division of Fish and Wildlife

Permit 1556 authorized the Commonwealth of the Northern Mariana Islands to study green and hawksbill sea turtles in the nearshore waters surrounding the Northern Mariana Islands to begin documentation of the sea turtle population in that area. Researchers collected basic biological information on the population, life-stages, and health of the sea turtles. The permit authorized take of up to 100 green and 40 hawksbill turtles annually. All turtles were captured by hand and released. The activities under this permit were authorized for five years through June 1, 2011.

5.3.3 Permit No. 1581, NMFS, Pacific Islands Fisheries Science Center

Permit 1581 authorized capture of up to 600 green and 10 hawksbill sea turtles annually by hand, scoop net, entanglement net, and bullpen net. All green sea turtles were measured, weighed, passive integrated transponder tagged, and flipper tagged. A subset of green sea turtles had their shell etched with an identification mark, were blood sampled, tissue sampled, lavaged, and had an electronic tag attached to them. Hawksbill sea turtles were measured, weighed, passive integrated transponder tagged, flipper tagged, blood sampled, and tissue sampled. All animals were released alive. The permit expired December 31, 2011.

5.3.4 Permit No. 10027, American Museum of Natural History

Researchers were authorized to capture up to 100 green and 20 hawksbill sea turtles annually by hand capture, tangle nets, dip nets, throw nets, and scoop nets. Sea turtles were measured, sampled, and marked. A subsample was lavaged and had a satellite transmitter attached. All animals were released alive. The permit expired July 31, 2013.

5.3.5 Permit No. 14097, NMFS Southwest Fisheries Science Center

The permit authorizes researchers to capture up to 300 olive ridley, 100 green, 80 leatherback, 20 loggerhead, and 20 hawksbill sea turtles annually by hand capture or dip nets in the North Pacific. Authorized activities include measuring, sampling for blood and tissue (biopsy), weighing, and flipper tagging. A subsample, excluding leatherbacks, would be lavaged and would receive a satellite transmitter attachment using epoxy. All animals would be released alive. The permit expires on June 30, 2016.

5.3.6 Permit No. 14510, NMFS Southwest Fisheries Science Center

The permit authorizes researchers to capture up to 35 green, 6 olive ridley, and 6 loggerhead sea turtles annually by tangle nets near San Gabriel River and Los Alamitos Bay in California. Authorized activities, as quantified in the permit, include measuring, sampling for blood and tissue (cloacal and oral swabs, scute scrapes, and biopsies), conducting ultrasound, photographing/videoing, weighing, lavaging, flipper tagging, PIT tagging, satellite tagging (epoxy attachment), suction-cup tagging. Also, the permit authorizes most of the above activities and necropsy or transportation for up to 10 green, 1 olive ridley, and 3 loggerhead sea turtles that have been taken under a different authority via entrainment into a power plant's cooling system along the coast of California. Finally, the permit authorizes above activities for up to 4 green, 1 olive ridley, 1 loggerhead, and 2 leatherback sea turtles stranded along the Californian coast. The permit expires on April 30, 2015.

5.3.7 Permit Nos. 1591 & 16803, NMFS Southwest Fisheries Science Center

Two consecutive five-year permits authorized researchers to capture sea turtles by tangle nets in San Diego Bay, California. The current permit (16803) authorizes researchers to capture up to 50 green, 5 olive ridley, and 5 loggerhead sea turtles annually. Authorized activities include measuring; sampling for blood, feces, and tissue (cloacal swabs and biopsies); photographing/videoing; weighing; lavaging; conducting ultrasound; and flipper, PIT, and satellite tagging. The permit expires on October 5, 2017.

5.3.8 Permit Nos. 1596 & 15634, NMFS Southwest Fisheries Science Center

Two consecutive five-year permits authorize researchers to capture up to 55 leatherback sea turtles annually (Permit 1596 authorized 58) by hoop nets off the coasts of California, Oregon, and Washington. Authorized activities, as quantified in the permit, include measuring; sampling for blood, feces, and tissue (cloacal swabs and biopsies); photographing/videoing; weighing; inserting a stomach telemeter pill; conducting ultrasound; attaching a camera via suction cup; tracking; and flipper, PIT, and satellite tagging (the latter by drilling through the pygal region). The current permit (15634) expires on April 30, 2017.

5.4 Other Potential Sources of Baseline Impacts

A number of anthropogenic activities may indirectly affect listed turtle species in the action area of this consultation. These activities result in habitat loss, debris, contaminants, vessel strikes, and disease.

5.4.1 Debris

Ingestion of marine debris is a serious threat to sea turtles. Sea turtles can mistake debris (e.g., tar and plastic) for natural food items, which can cause death. Leatherback, loggerhead, and green sea turtles feed in areas that coincide with areal accumulation of plastics (EPA 2011). Some types of marine debris, such as oil, may be directly or indirectly toxic. Other types of marine debris, such as discarded or derelict fishing gear, may entangle and drown sea turtles. Researchers have not quantified these impacts comprehensively.

5.4.2 Contaminants

Coastal runoff and river discharges carry large volumes of petrochemical and other contaminants from agricultural activities, cities, and industries into the oceans. Petrochemical and other contaminants also run off vessels at sea. Sea turtles travel between nearshore and offshore habitats and may be exposed to and accumulate these contaminants during their life cycle. Researchers have not quantified these impacts comprehensively.

5.4.3 Vessel Strikes

Vessel collisions can result in serious injury and death. Vessel collisions may pose a threat to sea turtles in or near the action area although NMFS is unclear to what extent.

5.4.4 Other Federal Activities

Other Federal activities, such as U.S. Navy operations and issuance of various licenses and permits by Federal agencies, may occur in the action area. Those activities may affect sea turtles, and the ESA requires section 7 consultation with NMFS for such actions. For example, low-frequency sonar may cause behavioral harassment of an unspecified number of sea turtles, and training and testing activities could result in harassment, harm, and mortality sea turtles.

5.5 Sea Turtle Conservation Efforts in the Pacific that Shape the Baseline

The Western Pacific Regional Fisheries Management Council, NMFS Pacific Islands Regional Office, and Southwest Fisheries Science Center are continuing to collaborate with regional and local governments around the Pacific rim, conservation and wildlife groups internationally, and the fishing industry both nationally and internationally. These parties have started to implement projects to conserve sea turtles in the Pacific in cooperation with experienced non-governmental organizations such as World Wildlife Fund - Indonesia, Kamiali Integrated Conservation Development Group of Papua New Guinea, the Sea Turtle Association of Japan, and Wildcoast in Baja, Mexico.

5.5.1 Costa Rica

NMFS has provided funding to support leatherback nesting beach work on the eastern Pacific coast of Costa Rica to evaluate nesting and to reduce the loss of nests via poaching of eggs. These efforts also benefit green and olive ridley turtles that use the same beaches. Sea turtle conservationists are currently working to protect the species.

6 Effects of the Action on Species and Critical Habitat

Under the ESA, “effects of the action” means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR

402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

The following sections assess the effects that are expected from the proposed action, the extent of those effects, and the overall impact of those effects on sea turtle populations. The analyses in this opinion are based on an implicit understanding that the listed species considered in this opinion are threatened or endangered with local or global extinction by a wide array of human activities and natural phenomena as outlined in the *Status of the Species and the Environmental Baseline* section of this Opinion.

6.1 Conservative Decisions- Providing the Benefit of the Doubt to the Species

The analysis in this section is based upon the best available commercial and scientific data on sea turtle biology and the effects of the proposed action. In keeping with the direction from the U.S. Congress to provide the "benefit of the doubt" to threatened and endangered species [House of Representatives Conference Report No. 697, 96th Congress, Second Session, 12 (1979)], determinations will provide the most conservative outcome for listed species.

Sea turtles interact with longlines through entanglement or hooking in the fishing gear. Turtles that become entangled in longline gear may drown when they are forcibly submerged, or they may be injured by the hooks and entangling lines. Sea turtles are air-breathing reptiles, and when forcibly submerged by longline gear, they undergo respiratory and metabolic stress that can lead to severe disturbance of acid-base balance. 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 rapidly consume oxygen stores. This triggers an activation of anaerobic glycolysis and subsequently disturbs the acid-base balance. The rapidity and extent of the physiological changes that occur during forced submergence are likely functions of the intensity of struggling as well as the length of submergence (Lutcavage and Lutz 1997). Although sea turtles are able to conduct lengthy voluntary dives, if they are hooked and entangled in longline gear and unable to surface within a certain period of time, they will eventually die. Different sea turtle species likely have different physiological responses to lengthy forced submergence because of different average body sizes and corresponding oxygen capacities. Repeated capture of the same individual turtle, particularly within a short time-period, also causes harm. Turtles that are not allowed enough time to recuperate from the first capture or suffer multiple injuries as a result of multiple captures are likely to be in a worse relative condition. 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 or more). Turtles are probably more susceptible to lethal metabolic acidosis if they experience multiple captures because they would not have had time to process lactic acid loads (Lutcavage and Lutz 1997). The anticipated number of recaptures is unknown.

Turtles hooked by longline gear can be also be injured or killed by the hooking event, depending on whether they are hooked internally or externally and whether the hook sets deep in their tissue. Longline gear can also have long-term effects on a turtle's ability to swim, forage, migrate, and breed although these long-term effects are difficult to monitor or measure.

The longline fisheries are required to follow specific sea turtle handling protocols to ensure animals are de-hooked if possible, as much gear as possible is removed from the animals, and attempts are made to resuscitate comatose turtles. Research activities support the objective in recovery plans to monitor and reduce incidental mortality in fisheries, and the activities authorized by the proposed action would only occur if they would not compromise the health of the subject animal just captured in a longline fishery.

6.2 Effect of the Research Activities

Tables 1-3 list the number of animals of each species that would be affected by the proposed action. The effects of the proposed research activities under Permit No. 18688 discussed in this section are expected to be comparable to those reported by other NMFS researchers. Tagging leatherbacks using pygal attachments is less common but, nonetheless, has been done (see Permit 15634). The researchers to conduct pygal tagging on leatherbacks would be fully trained per the Observer Program's February 2015 protocol.

6.2.1 Handling, Measuring, and Photography

Handling, measuring, and photographing procedures are simple and not invasive, and NMFS does not expect that individual turtles would normally experience more than short-term stresses as a result of these activities based on adherence to Observer Program procedures (NMFS PIRO 2009) and the protocol in the permit application. No injury is expected from these activities, and turtles would be worked up as quickly as possible to minimize stresses resulting from their capture. NMFS researchers have taken measurements on thousands of turtles with no apparent ill effects. These activities are currently conducted by several researchers permitted by NMFS to work in the Pacific Islands Region with no reported difficulties or injuries to sea turtles (NMFS PIRO 2010). These activities would not injure or compromise the animal and would not add appreciably to the stress the animal would experience during other proposed activities.

6.2.2 Flipper Tagging

Flipper tagging activities are minimally invasive. All tag types have some negative implications associated with them, especially concerning tag retention. Plastic flipper tags can become brittle, break, and fall off underwater, and titanium tags can bend during implantation and, thus, not close properly leading to tag loss. Tag malfunction can result from rusted or clogged applicators or applicators that are worn from heavy use (Balazs 1999). Turtles whose tags have failed are retagged if recaptured, which subjects them to additional effects of tagging. Turtles may experience some discomfort, including pain, during the application of external (flipper) tags. The discomfort appears highly variable among individuals (Balazs 1999). Most barely notice the tagging, but some exhibit a marked response. NMFS expects the stresses to be minimal and temporary and that the small wound site would heal completely because the proposed tagging methods have been regularly employed in sea turtle research with little lasting impact on the individuals tagged and handled based on observations and resightings (Balazs 1999; NMFS PIRO 2010). No problems with tagging have been reported by any NMFS permit holders. The NMFS Southeast Fisheries Science Center Galveston Laboratory flipper-tagged and PIT-tagged up to 56 loggerheads per year since 1999 and held the animals for approximately three years after tagging. Turtles were held in a laboratory setting, remained healthy, and were later released. Hence, the NMFS SEFSC suggests that problems associated with tagging are unlikely if a turtle is tagged and released using proper techniques. Additionally, the NMFS SEFSC has used Inconel (metal) to flipper tag turtles, all of which exhibited normal behavior shortly after being tagged and swam normally once released. Of the close to 1,000 tag recaptures encountered by the NMFS SEFSC Beaufort Laboratory, no turtles show any adverse effects of being tagged in this manner (NMFS SEFSC 2008). Therefore, NMFS does not know of any problems affecting sea turtles associated with flipper tagging.

6.2.3 Tissue Sampling

The researchers would be required to follow procedures, identified in permit conditions, designed to minimize the risk of either introducing a new pathogen into a population or amplifying the rate of transmission from animal to animal of an endemic pathogen during handling and sampling. Individual turtles are not expected to experience more than short-term stresses during tissue sampling. Southeast Fisheries Science Center researchers who examined turtles caught two to three weeks after sample collection noted the collection site was almost completely healed (NMFS SEFSC 2008). During tissue biopsying using sterile techniques, NMFS SEFSC researchers have encountered no infections or mortality resulting from this procedure (NMFS SEFSC 2008). NMFS expects that the collection of a tissue sample would cause minimal additional stress or discomfort to the turtle beyond that experienced during other proposed activities.

6.2.4 Transmitter Attachment

Carapace-mounted transmitters would be attached to the turtles’ scutes. A low-heat-producing adhesive would be used to attach equipment to prevent harm to the animal. The permit would require that the researchers provide adequate ventilation around the turtle's head during the attachment of all transmitters. To prevent skin or eye injury due to the chemicals in the adhesive, transmitter attachment procedures would not take place in the water.

Transmitters, as well as biofouling of the instrument, attached to the carapace of turtles increase hydrodynamic drag and affect lift and pitch. At small flow angles representative of straight-line swimming, a transmitter mounted on the carapace increased drag by 27 to 30 percent, reduced lift by less than 10 percent, and increased pitch moment by 11 to 42 percent (Watson and Granger 1998). Therefore, this type of transmitter attachment would negatively affect the swimming energetics of the turtle, but NMFS does not know of research to quantify translation into effects on feeding. However, based on the results of hardshell sea turtles equipped with this tag setup, no evidence indicates that transmitters result in any serious injury to these species (NMFS PIRO 2010). Attachment of satellite, sonic, or radio tags with epoxy is a commonly used and permitted technique by NMFS. Although attachments increase the risk of entanglement, such transmitters are unlikely to become entangled due to their streamlined profile and would typically be shed after about one year without posing any long-term risks to the turtle.

For leatherback turtles, pop-up satellite tags would be attached to the carapace by drilling a hole through the pygal process. NMFS Southwest Fisheries Science Center used the same method to tag nesting female leatherbacks in Costa Rica and Papua New Guinea. The tags remained attached for two to eight months, and the short tether and breakaway tether pin minimized potential for entanglement. The effects of this technique on leatherbacks are similar to those described for hard-shell species that had the tether attached through a hole drilled through the carapace. Researchers who have used the pygal process attachment technique on leatherbacks have not experienced any difficulty deploying pop-up satellite tags. Occasional bleeding occurs but is rare and minor, and the minor injury results in only temporary pain or discomfort (NMFS PIRO 2010). Infection and disease transmission are unlikely because researchers would adhere to permit conditions required during tag attachment. Subsequent sightings of re-nesting leatherbacks with tags in the pygal process showed no signs of necrosis within a nesting season, and one turtle that was re-sighted years after initial attachment and tag shedding showed complete healing of the pygal process without scarring. However, NMFS could not locate any results of controlled laboratory testing or field testing of large sample sizes with robust published data discussing the long-term effects of this technique. Additionally, no data exist on the in-water hydrodynamic drag effects of this type of tag, but the drag may be less than other carapace-mounted transmitters (Jones et al. 2011).

6.2.5 Release and Salvage

Live turtles would be released under safe conditions near the surface of the water, and no adverse effects would occur. Salvage would involve carcasses and have no effect on the sea turtle species involved.

6.3 Risk Analysis

Actions that result in mortality affect listed species through the loss of individual animals and also through the loss of the reproductive potential to the population. Similarly, serious injuries to a listed species can also affect its reproductive potential. Adverse effects on reproductive potential may reduce the likelihood of survival and recovery of species. However, mortality, delayed mortality, and serious injury are not expected under research Permit No. 18688.

The effects of the proposed research activities temporary stress, discomfort, and pain, and a small increase in risk of entanglement. Such effects have the potential to elicit short-term changes in individual sea turtle behavior but are not likely to result in long-term effects on those individuals (NMFS PIRO 2010). Hence we would not expect long-term effects populations. The data generated by the applicants over the duration of these studies would provide beneficial information that will be important to the management and recovery of threatened and endangered species (Sakamoto et al. 1997; Parker et al. 2001; Chaloupka et al. 2004b). The information collected as a direct result of permit issuance will be available to achieve goals identified in recovery plans, such as monitoring and reducing incidental mortality in fisheries. Therefore, issuance of the permit would benefit sea turtles and would not likely appreciably reduce numbers, distribution, or reproduction or reduce the likelihood of survival and recovery of these sea turtle species.

6.4 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

The proposed action (Section 2) and its effect described as occurring within the action area (in the *Environmental Baseline* above) are also expected to occur in the future. NMFS is unaware of any proposed or anticipated changes in these actions that would substantially change the impacts that they have on the sea turtles covered by this Opinion. Because tagging does not result in a detectable effect on sea turtle species, the accumulation of tagged sea turtles over time would not affect the sea turtle species. Thus, the present occurring activities in the action area are expected to continue at the present levels of intensity in the near future. No other future non-Federal activities in the action area have been identified that have the potential to affect sea turtles.

6.5 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 6.4) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 4).

The Status of the Species discussion describes how human-induced factors, such as commercial fisheries, direct harvest, and modification or degradation of habitat, outside of the action area adversely affect listed sea turtles. Impacts occurring in terrestrial habitats for turtles have generally resulted in the loss of eggs, hatchlings, or nesting females, and impacts occurring in aquatic habitat have caused the mortality of juvenile, subadult, and adult sea turtles through entanglement or capture in fishing gear, ingestion of debris, or pollution.

Turtle mortalities have likely adversely affected the ability of populations to maintain or increase their numbers, and the loss of reproductive adults reduces future reproductive potential. Species, such as sea turtles, with delayed maturity are especially vulnerable to increases in mortality, particularly of life stages with higher reproductive value (juvenile, subadult, and adult). Green turtles may not reach sexual maturity until 50 years of age, and the age of sexual maturity of most sea turtles species is currently unknown. Success of development from an egg to a sexually mature adult sea turtle varies among species, populations, and the degree of threats faced during each life stage. No turtle mortalities are expected or authorized under permit 18688.

Research that would be authorized under Permit No. 18688 is summarized in Table 1-3. Handling of all turtles would be limited to minimize harm. Due to the protective research protocols and special conditions in the permit, turtles would likely experience only short-term, non-lethal increases in stress during the research activities. Such interactions would not affect the turtles' abilities to reproduce and contribute to the maintenance or recovery of the species. Effects on the turtles include minor injury and some discomfort during research activity procedures and harassment of individuals that may raise levels of stressor hormones. Based on past observations of similar research, effects are expected to dissipate within approximately one day (NMFS PIRO 2010). NMFS does not believe the proposed activities would cause any adverse cumulative effects to the ESA-listed sea turtle species.

NMFS does not expect the proposed research activities to appreciably reduce any sea turtle species' likelihoods of survival and recovery by adversely affecting their birth rates, death rates, or recruitment rates. In particular, NMFS does not expect the proposed research permit to affect the reproductive success of adult female turtles, the survival of young turtles, or the number of young turtles that recruit annually into the breeding populations. The proposed action would not affect critical habitat for sea turtles. The results of the proposed research would likely contribute to our understanding of the habitat, foraging ecology, growth rate, and population dynamics of these species, particularly in the Pacific Ocean.

The sea turtles discussed in this opinion are ESA-listed worldwide. However, given the vulnerability of Atlantic populations, the loss of 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, and would reduce abundance of these species. Thus, the species' likelihoods of surviving and recovering in the wild would be reduced with the loss of the Pacific populations.

7 CONCLUSION

After reviewing the current status of the green, leatherback, loggerhead, olive ridley, and hawksbill sea turtles, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, NMFS's biological opinion is that the proposed action would not appreciable reduce the likelihood of survival or recovery green, leatherback, loggerhead, olive ridley, and hawksbill sea turtles or to destroy or adversely modify their designated critical habitats.

8 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, 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. Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

The permit is for the directed take of sea turtles for research purposes in the waters of the Pacific Ocean; no incidental take of ESA-listed species is anticipated or authorized. This opinion does not authorize any take of other ESA-listed species or immunize any actions from the prohibitions of section 9(a) of the ESA.

9 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

The ESA Interagency Cooperation Division recommends that the Permits and Conservation Division review permit reports and any scientific papers that are based on the research authorized by Permit 18688. Further, a summary of the scientific findings should be provided annually to the ESA Interagency Cooperation Division to ensure that the assumptions in this opinion remain valid.

10 REINITIATION OF CONSULTATION

This concludes formal consultation for the issuance of Permit No. 18688 and its effects on green, leatherback, loggerhead, olive ridley, and hawksbill sea turtles. As 50 CFR 402.16 states, 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 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 that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

11 References

11.1 Federal Register Notices Cited

35 FR 8491. June 2, 1970. Conservation of endangered species and other fish or wildlife. Federal Register 35(106): 8491-8498.

43 FR 32800. July 28, 1978. Listing and protecting loggerhead sea turtles and "threatened species" and populations of green and olive ridley sea turtles as threatened species or "endangered species." Federal Register 43(146): 32800-32811.

76 FR 58868. September 22, 2011. Endangered and threatened species; determination of nine distinct population segments of loggerhead sea turtles as endangered or threatened. Federal Register 76(184): 58868-58952.

77 FR 45571. August 1, 2012. Endangered and threatened wildlife; 90-day finding on a petition to delist the green turtle in Hawaii and notice of status review. Federal Register 77(148): 45571-45571.

79 FR 39856. July 10, 2014. Endangered and threatened species: critical habitat in the Northwest Atlantic Ocean loggerhead sea turtle distinct population segment (DPS) and determination regarding critical habitat for the North Pacific Ocean loggerhead DPS. Federal Register 79(132): 39856-39912.

79 FR 56573. September 22, 2014. Endangered species; File No. 18688. Federal Register 79(183): 56573-56574.

80 FR 15271. March 23, 2015. Endangered and threatened species; identification and proposed listing of eleven distinct population segments of green sea turtles (*Chelonia mydas*) as endangered or threatened and revision of current listings. Federal Register 80(55): 15271-15337.

11.2 Other Citations

50 CFR 222.24(a). 1998. *Code of Federal Regulations*, Title 50, *Wildlife and Fisheries*, Part 222.24(a), Procedures for issuance of permits. Washington, D.C.

50 CFR 223.206. 2011. *Code of Federal Regulations*, Title 50, *Wildlife and Fisheries*, Part 223.206, Exception to prohibitions relating to sea turtles. Washington, D.C.

50 CFR 226.207. 2013. *Code of Federal Regulations*, Title 50, *Wildlife and Fisheries*, Part 226.207, Critical habitat for leatherback turtles (*Dermochelys coriacea*). Washington, D.C.

50 CFR 226.208. 2011. *Code of Federal Regulations*, Title 50, *Wildlife and Fisheries*, Part 226.208, Critical habitat for green turtle. Washington, D.C.

50 CFR 226.209. 2013. *Code of Federal Regulations*, Title 50, *Wildlife and Fisheries*, Part 226.209, Critical habitat for hawksbill turtle. Washington, D.C.

50 CFR 226.223. 2014. *Code of Federal Regulations*, Title 50, *Wildlife and Fisheries*, Part 226.223, Critical habitat for the Northwest Atlantic Ocean Distinct Population Segment of the loggerhead sea turtle (*Caretta caretta*). Washington, D.C.

50 CFR 402.16. 2002. *Code of Federal Regulations*, Title 50, *Wildlife and Fisheries*, Part 402.16, Reinitiation of formal consultation. Washington, D.C.

Aguilar, R., J. Mas, and Z. Pastor. 1995. Impact of Spanish swordfish longline fisheries on the loggerhead sea turtle *Caretta caretta* population in the western Mediterranean. Pages 86-89 *in* Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation, 25-29 February 1992, Jekyll Island, Georgia. NOAA Technical Memorandum NMFS-SEFSC-361.

Aguirre, A. A., T. R. Spraker, G. H. Balazs, and B. Zimmerman. 1998. Spirorchidiasis and fibropapillomatosis in green turtles from the Hawaiian Islands. Journal of Wildlife Diseases 34: 91-98.

Alfaro-Shigueto, J., J. Mangel, and P. Dutton. 2006. Loggerhead turtle bycatch in Peru. Pages 43-44 *in* Proceedings of the Second Western Pacific Sea Turtle Cooperative Research & Management Workshop. Volume II: North Pacific Loggerhead Sea Turtles. Western Pacific Regional Fishery Management Council. Honolulu, Hawaii.

Alfaro-Shigueto, J., M. Van Bressem, D. Montes, K. Onton, D. Vega and K. Van Waerebeek. 2002. Turtle mortality in fisheries off the coast of Peru. Pages 86-89 *in* Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation, 28 February to 4 March 2000, Orlando, Florida.

Alfaro-Shigueto J., J. C. Mangel, F. Bernedo, P. H. Dutton, J. A. Seminoff, and B. J. Godley. 2011. Small-scale fisheries of Peru: a major sink for marine turtles in the Pacific. Journal of Applied Ecology 48: 1432-1440.

Arauz, R. 1996. A description of the central American shrimp fisheries with estimates of incidental capture and mortality of sea turtles. Pages 5-9 i*n* Proceedings of the Fifteenth Annual Symposium on Sea Turtle Biology and Conservation, 20-25 February 1995, Hilton Head, South Carolina. NOAA Technical Memorandum NMFS-SEFSC-387.

Arauz, R., O. Rodriguez, R. Vargas and A. Segura. 2000. Incidental capture of sea turtles by Costa Rica's longline fleet. Pages 62-64 *in* Proceedings of the Nineteenth Annual Sea Turtle Symposium, 2-6 March 1999, South Padre Island, Texas. NOAA Technical Memorandum NMFS-SEFSC-443.

Arenas, P. and M. Hall. 1992. The association of sea turtles and other pelagic fauna with floating objects in the eastern tropical Pacific Ocean. Pages 7-10 *in* Proceedings of the Eleventh Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-302.

Arias-Coyotl, E., J.A. Diaz and C.D. Trejo. 2003. Clutch frequency of the Michoacan black sea turtle. Page 141 *in* Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation, 4-7 April 2002, Miami, Florida. NOAA Technical Memorandum NMFS-SEFSC-503.

Avens, L. and L.R. Goshe. 2007. Comparative skeletochronological analysis of Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) humeri and scleral ossicles. Marine Biology 152(6): 1309-1317.

Balazs, G.H. 1978. A hawksbill turtle in Kaneohe Bay, Oahu. Elepaio 38(11): 128-129.

Balazs, G.H. 1994. Homeward bound: satellite tracking of Hawaiian green turtles from nesting beaches to foraging pastures. Pages 205-208 *in* Proceedings of the Thirteenth Annual Symposium on Sea Turtle Biology and Conservation, 23-27 February 1993, Jekyll Island, Georgia. NOAA Technical Memorandum NMFS-SEFSC-341.

Balazs, G.H. 1999. Factors to Consider in the Tagging of Sea Turtles. *In*: Eckert KL, Bjorndal KA, Abreu-Grobois FA, Donnelly M, editors. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No 4.

Balazs, G. 2006. Pelagic research of Pacific loggerhead sea turtles in partnership with Japan and Taiwan. Pages 31-33 *in* Proceedings of the Second Western Pacific Sea Turtle Cooperative Research & Management Workshop. Volume II: North Pacific Loggerhead Sea Turtles. Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

Balazs, G. and M. Chaloupka. 2004. Thirty year recovery trend in the once depleted Hawaiian green sea turtle stock. Biological Conservation 117: 491-498.

Balazs, G.H. and D. Ellis. 1996. Satellite telemetry of migrant male and female green turtles breeding in the Hawaiian Islands. Page 19 *in* Abstract, Sixteenth Annual Symposium on Sea Turtle Biology and Conservation, February 28-March 2, 1996, Hilton Head, South Carolina.

Balazs, G.H., P. Craig, B.R. Winton and R.K. Miya. 1994. Satellite telemetry of green turtles nesting at French Frigate Shoals, Hawaii and Rose Atoll, American Samoa. Page 184 *in*: Fourteenth Annual Symposium, Sea Turtle Biology and Conservation, 1-5 March 1994, Hilton Head, South Carolina.

Bartlett, G. 1989. Juvenile *Caretta* off Pacific coast of Baja California. Sea Turtle Center Newsletter 3(3): 1-2.

Beavers, S.C. and E.R. Cassano. 1996. Movements and dive behavior of a male sea turtle (*Lepidochelys olivacea*) in the eastern tropical Pacific. Journal of Herpetology 30(1): 97-104.

Benson, S.R., P.H. Dutton, C. Hitipeuw, J. Bakarbessy, and D. Parker. 2007a. Post-nesting migrations of leatherback turtles (*Dermochelys coriacea*) from Jamursba-Medi, Bird's Head Peninsula, Indonesia. Chelonian Conservation and Biology 6(1): 150-154.

Benson, S.R., T. Eguchi, D.G. Foley, K.A. Forney, H. Bailey, C. Hitipeuw, B.P. Samber, R.F. Tapilatu, V. Rei, P. Ramohia, J. Pita, and P.H. Dutton. 2011. Large-scale movements and high-use areas of western Pacific leatherback turtles, *Dermochelys coriacea*. Ecosphere 2(7): art84. doi:10.1890-ES11-00053.1

Benson, S.R., K.M. Kisokau, L. Ambio, V. Rei, P.H. Dutton, and D. Parker. 2007b. Beach use, internesting movement, and migration of leatherback turtles, *Dermochelys coriacea*, nesting on the north coast of Papua New Guinea. Chelonian Conservation and Biology 6(1): 7-14.

Berkson, H. 1967. Physiological adjustments to deep diving in the Pacific green turtle (*Chelonia mydas agassizii*). Comparative Biochemistry and Physiology 21: 507-524.

Bhaskar, S. 1985. Mass nesting by leatherbacks in Irian Jaya. Pages 15-16 *in* World Wildlife Fund International monthly report, January 1985.

Binckley, C.A., J.R. Spotila, K.S. Wilson, and F.V. Paladino. 1998. Sex determination and sex ratios of Pacific leatherback turtles, *Dermochelys coriacea*. Copeia 2: 291-300.

Bjorndal, K.A. 1997. Foraging ecology and nutrition of sea turtles. *In*: Lutz, P.L. and J.A. Musick (Eds.), The Biology of Sea Turtles. CRC Press, Boca Raton, Florida.

Bjorndal, K.A. and A.B. Bolten. 2010. Hawksbill sea turtles in seagrass pastures: success in a peripheral habitat. Marine Biology 157(1): 135-145.

Bjorndal, K.A., A.B. Bolten, and M.Y. Chaloupka. 2003. Survival probability estimates for immature green turtles *Chelonia mydas* in the Bahamas. Marine Ecology Progress Series 252: 273-281.

Bjorndal, K.A., K.J. Reich, and A.B. Bolten. 2010. Effect of repeated tissue sampling on growth rates of juvenile loggerhead turtles *Caretta caretta*. Diseases of Aquatic Organisms 88: 271-273.

Blumenthal, J.M., T.J. Austin, C.D.L. Bell, J.B. Bothwell, A.C. Broderick, G. Ebanks-Petrie, J.A. Gibb, K.E. Luke, J.R. Olynik, M.F. Orr, J.L. Solomon, and B.J. Godley. 2009. Ecology of hawksbill turtles, *Eretomochelys imbricata*, on a western Caribbean foraging ground. Chelonian Conservation and Biology 8(1): 1-10.

Bolten, A.B., J.A. Wetherall, G.H. Balazs, and S.G. Pooley. 1996. Status of marine turtles in the Pacific Ocean relevant to incidental take in the Hawaii-based pelagic longline fishery. NOAA Technical Memorandum NMFS-SWFSC-230. 167 pp.

Bowen, B.W., F.A. Abreu-Grobois, G.H. Balazs, N. Kamezaki, C.J. Limpus, and R.J. Ferl. 1995. Trans-Pacific migrations of the loggerhead turtle (*Caretta caretta*) demonstrated with mitochondrial DNA markers. Proceedings of the National Academy of Science 92: 3731-3734.

Bowen, B.W., A.L. Bass, S. Chow, M. Bostrom, K.A. Bjorndal, A.B. Bolten, T. Okuyama, B.M. Bolker, S. Epperly, E. LaCasella, D. Shaver, M. Dodd, S.R. Hopkins-Murphy, J.A. Musick, M. Swingle, K. Rankin-Baransky, W. Teas, W.W. Witzell, and P.H. Dutton. 2004. Natal homing in juvenile loggerhead turtles (*Caretta caretta*). Molecular Ecology 13: 3797-3808.

Bowlby, C.E., G.A. Green, and M.L. Bonnell. 1994. Observations of leatherback turtles offshore of Washington and Oregon. Northwestern Naturalist 75(1): 33-35.

Boyle, M.C., N.N. FitzSimmons, C.J. Limpus, S. Kelez, X. Velez-Zuazo, and M. Waycott. 2009. Evidence for transoceanic migrations by loggerhead sea turtles in the southern Pacific Ocean. Proceedings of the Royal Society Biological Sciences Series B 276(1664): 1993-1999.

Brill, R.W., G. H. Balazs, K. N. Holland, R. K. C. Chang, S. Sullivan, J. C.George. 1995. Daily movements, habitat use, and submergence intervals of normal and tumor-bearing juvenile green turtles (*Chelonia mydas* L.) within a foraging area in the Hawaiian Islands. Journal of Experimental Marine Biology and Ecology. 185(2): 203-218.

Brito, J.L. 1998. The marine turtle situation in Chile. Pages 12-13 *in* Proceedings of the Seventeenth Annual Sea Turtle Symposium, 4-8 March 1997, Orlando, Florida. NOAA Technical Memorandum NMFS-SEFC-415.

Broderick, A.C., M.S. Coyne, F. Glen, W.J. Fuller, and B.J. Godley. 2006. Foraging site fidelity of adult green and loggerhead turtles. Page 83 *in* Abstracts, Twenty-Sixth Annual Symposium on Sea Turtle Biology and Conservation, Athens, Greece.

Byles, R.A. 1988. Behavior and ecology of sea turtles from Chesapeake Bay, Virginia. Ph.D. dissertation, The College of William and Mary in Virginia. 138 pp.

Byrne, R., J. Fish, T.K. Doyle, and J.D.R. Houghton. 2009. Tracking leatherback turtles (*Dermochelys coriacea*) during consecutive inter-nesting intervals: further support for direct transmitter attachment. Journal of Experimental Marine Biology and Ecology 377(2): 68-75.

Cardona, L., P. Campos, Y. Levy, A. Demetropoulos, and D. Margritaoulis. 2010. Asynchrony between dietary and nutritional shifts during the ontogeny of green turtles (*Chelonia mydas*) in the Mediterranean. Journal of Experimental Marine Biology and Ecology 393(1-2): 83-89.

Carr, A.F. 1952. Handbook of Turtles. Ithaca, New York: Cornell University Press.

Carr, A.F. 1986. RIPS, FADS, and little loggerheads. BioScience 36(2): 92-100.

Carr, A., M. H. Carr, and A. B. Meylan. 1978. The ecology and migration of sea turtles, 7. The west Caribbean turtle colony. Bulletin of the American Museum of Natural History, New York 162(1): 1-46.

Carretta, J.V. and K.A. Forney. 1993. Report of the two aerial surveys for marine mammals in California coastal waters utilizing a NOAA DeHavilland Twin Otter aircraft, March 9-April 7, 1991 and February 8-April 6, 1992. NOAA Technical Memorandum NMFS-SWFSC-185. 84 pp.

Carruthers, E.H., D.C. Schneider, and J.D. Neilson. 2009. Estimating the odds of survival and identifying mitigation opportunities for common bycatch in pelagic longline fisheries. Biological Conservation 142(11): 2620-2630.

Casale, P., P. Nicolosi, D. Freggi, M. Turchetto, and R. Argano. 2003. Leatherback turtles (*Dermochelys coraicea*) in Italy and in the Mediterranean basin. Herpetological Journal 13: 135-139.

Caurant, F., P. Bustamante, M. Bordes, and P. Miramand. 1999. Bioaccumulation of cadmium, copper and zinc in some tissues of three species of marine turtle stranded along the French Atlantic coasts. Marine Pollution Bulletin 38(12): 1085-1091.

Caut, S., E. Guirlet, and M. Girondot. 2010. Effect of tidal overwash on the embryonic development of leatherback turtles in French Guiana. Marine Environmental Research 69(4): 254-261.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Prepared by Cetacean and Turtle Assessment Program, University of Rhode Island for Bureau of Land Management, Washington, DC. Contract AA551-CT8-48. 538 pp.

Chacón-Chaverri, D. and K.L. Eckert. 2007. Leatherback sea turtle nesting at Gandoca Beach in Caribbean Costa Rica: management recommendations from fifteen years of conservation. Chelonian Conservation and Biology 6(1): 101-110.

Chaloupka, M., K. A. Bjorndal, G. H. Balazs, A. B. Bolten, L. M. Ehrhart, C. J. Limpus, H. Suganuma, S. Troëng, and M. Yamaguchi. 2008. Encouraging outlook for recovery of a once severely exploited marine megaherbivore. Global Ecology and Biogeography 17: 297-304.

Chaloupka, M. and C. Limpus. 2005. Estimates of sex- and age-class-specific survival probabilities for a southern Great Barrier Reef green sea turtle population. Marine Biology 146(6): 1251-1261.

Chaloupka, M., C. Limpus, and J. Miller. 2004. Green turtle somatic growth dynamics in a spatially disjunct Great Barrier Reef metapopulation. Coral Reefs 23: 325-335.

Chaloupka, M., D. Parker, and G. Balazs. 2004b. Modeling post-release mortality of loggerhead sea turtles exposed to the Hawaii-based pelagic longline fishery. Marine Ecology Progress Series 1: 1-8.

Chaloupka, M. Y., and J. A. Musick. 1997. Age growth and population dynamics. Pages 233-276 i*n* The Biology of Sea Turtles. CRC Press: Boca Raton, Florida.

Chan, E.H. and H.C. Liew. 1996. Decline of the leatherback population in Terengganu, Malaysia, 1956-1995. Chelonian Conservation and Biology 2(2): 196-203.

Cheng, I.J. 2002. Current sea turtle research and conservation in Taiwan. Pages 185-189 *in* Proceedings of the Western Pacific Sea Turtle Cooperative Research and Management Workshop, February 5-8, 2002, Honolulu, Hawaii.

Cheng, I. and Chen, T. 1997. The incidental capture of five species of sea turtles of coastal setnet fisheries in the eastern waters of Taiwan. Biological Conservation 82: 235-239.

Cheng, I. J., C. T. Huang, P. Y. Hung, B. Z. Ke, C. W. Kuo, and C. Fong. 2009. Ten years of monitoring the nesting ecology of the green turtle, *Chelonia mydas*, on Lanyu (Orchid Island), Taiwan. Zoological Studies 48(1): 83-94.

Cliffton, K., D.O. Cornejo, and R. Felger. 1982. Sea turtles of the Pacific coast of Mexico. Pages 199-209 *in* Biology and Conservation of Sea Turtles. Smithsonian Institution Press: Washington, DC.

Collard, S.B. 1990. Leatherback turtles feeding near a watermass boundary in the eastern Gulf of Mexico. Marine Turtle Newsletter 50: 12-14.

Conant, T.A., P.H. Dutton, T. Eguchi, S.P. Epperly, C.C. Fahy, M.H. Godfrey, S.L. MacPherson, E.E. Possardt, B.A. Schroeder, J.A. Seminoff, M.L. Snover, C.M. Upite, and B.E. Witherington. 2009. Loggerhead sea turtle *(Caretta caretta)* 2009 status review under the U.S. Endangered Species Act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service, August 2009. 222 pp.

Cornelius, S.E., R. Arauz, J. Fretey, M.H. Godfrey, R. Marquez-M., and K. Shanker. 2007. Effects of land-based harvest of *Lepidochelys*. Pages 231-251 *in* Biology and Conservation of Ridley Sea Turtles, P.T. Plotkin (Ed.).

Cornelius, S.E. and D.C. Robinson. 1986. Post-nesting movements of female olive ridley turtles tagged in Costa Rica. Vida Silvestre Neotropical 1(1): 12-23.

Crognale, M.A., S.A. Eckert, D.H. Levenson, and C.A. Harms. 2008. Leatherback sea turtle *Dermochelys coriacea* visual capacities and potential reduction of bycatch by pelagic longline fisheries. Endangered Species Research 5: 249-256.

Crouse, D.T. 1999. The consequences of delayed maturity in a human-dominated world. American Fisheries Society Symposium 23: 195-202.

Cruz, R.D. 2002. Marine turtle distribution in the Philippines. Pages 57-65 *in* Proceedings of the Western Pacific Sea Turtle Cooperative Research and Management Workshop, February 5-8, 2002, Honolulu, Hawaii. I. Kinan (Ed.).

Davenport, J., J. Wrench, J. McEvoy, and V. Carnacho-Ibar. 1990. Metal and PCB concentrations in the “Harlech” leatherback. Marine Turtle Newsletter 48: 1-6.

Dermawan, A. 2002. Marine turtle management and conservation in Indonesia. Pages 67-75 *in* Proceedings of the Western Pacific Sea Turtle Cooperative Research and Management Workshop, February 5-8, 2002, Honolulu, Hawaii.

Dethmers, K. and D. Broderick. 2003. Green turtle fisheries in Australasia: assessing the extent of their impact using mtDNA markers. Pages 41-43 *in* Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation, 4-7 April 2002, Miami, Florida. NOAA Technical Memorandum NMFS-SEFSC-503.

Dodd, C.K., Jr. 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). U.S. Fish and Wildlife Service Biological Report 88(14). 110 pp.

Donoso, M. and P.H. Dutton. 2010. Sea turtle bycatch in the Chilean pelagic longline fishery in the southeastern Pacific: opportunities for conservation. Biological Conservation 143: 2672-2684.

Dutton, P.H., G.H. Balazs, and A.E. Dizon. 1998. Genetic stock identification of sea turtles caught in the Hawaii-based pelagic longline fishery. Pages 45-46 *in* Proceedings of the Seventeenth Annual Symposium on Sea Turtle Biology and Conservation. 4-8 March 1997, Orlando, Florida. NOAA Technical Memorandum NMFS-SEFSC-415.

Dutton, P.H., G.H. Balazs, and A.E. Dizon. 2000. Genetic stock origin of sea turtles caught in the Hawaii-based longline fishery. Pages 120-121 *in* Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. 2-6 March 1999, South Padre Island, Texas. NOAA Technical Memorandum NMFS-SEFSC-443.

Dutton, P.H., S.R. Benson, and S.A. Eckert. 2006. Identifying origins of leatherback turtles from Pacific foraging grounds off central California, USA. Page 228 *in* Proceedings of the Twenty-Third Annual Symposium on Sea Turtle Biology and Conservation. 17-21 March 2003, Kuala Lumpur, Malaysia. NOAA Technical Memorandum NMFS-SEFSC-536.

Dutton, P.H., C. Hitipeuw, M. Zein, S.R. Benson, G. Petro, J. Pita, V. Rei, L. Ambio, and J. Bakarbessy. 2007. Status and genetic structure of nesting populations of leatherback turtles (Dermochelys coriacea) in western Pacific. Chelonian Conservation and Biology 6(1): 47-53.

Eckert, K.A. 1992. Five year status reviews of sea turtles listed under the Endangered Species Act of 1973: Hawksbill Sea Turtle (*Eretmochetys imbricata)***,** U.S. Fish and Wildlife Service P.O. No. 20181-l-0060. 20 pp.

Eckert, K.L. 1993. The biology and population status of marine turtles in the North Pacific Ocean. Final Report to National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu, Hawaii.

Eckert, S.A. 1997. Distant fisheries implicated in the loss of the world's largest leatherback nesting population. Marine Turtle Newsletter. No 78: 2-7.

Eckert, S.A. 1998. Perspectives on the use of satellite telemetry and electronic technologies for the study of marine turtles, with reference to the first year-long tracking of leatherback sea turtles. Pages 46-48 *in* Proceedings of the Seventeenth Annual Symposium on Sea Turtle Biology and Conservation. 4-8 March 1997, Orlando, Florida. NOAA Technical Memorandum NMFS-SEFSC-415.

Eckert, S.A. 1999. Habitats and migratory pathways of the Pacific leatherback sea turtle. Final report to the National Marine Fisheries Service, Office of Protected Resources. Hubbs Sea World Research Institute Technical Report 99-290. 15 pp.

Eckert, S.A. 2002. Distribution of juvenile leatherback sea turtle *Dermochelys coriacea* sightings. Marine Ecology Progress Series 230: 289-293.

Eckert, S.A. 2006. High-use oceanic areas for Atlantic leatherback sea turtles (*Dermochelys coriacea*) as identified using satellite telemetered location and dive information. Marine Biology 149(5): 1257-1267.

Eckert, S.A., D. Bagley, S. Kubis, L. Ehrhart, C. Johnson, K. Stewart, and D. DeFreese. 2006. Internesting and postnesting movements and foraging habitats of leatherback sea turtles (*Dermochelys coriacea*) nesting in Florida. Chelonian Conservation and Biology 5(2): 239-248.

Eckert, S.A., K.L. Eckert, P. Pongamia and G.H. Koopman. 1989. Diving and foraging behavior of leatherback sea turtles *Dermochelys coriacea.* Canadian Journal of Zoology 67: 2834-2840.

Eckert, S.A., H.-C. Liew, K.L. Eckert, and E.-H. Chan. 1996. Shallow water diving by leatherback turtles in the South China Sea. Chelonian Conservation and Biology 2(2): 237-243.

Eckert, S.A., D.W. Nellis, K.L. Eckert, and G.L. Kooyman. 1986. Diving patterns of two leatherback sea turtles (Dermochelys coriacea) during internesting intervals at Sandy Point, St. Croix, U.S. Virgin Islands. Herpetologica 42(3): 381-388.

Eisenberg, J.F. and J. Frazier. 1983. A leatherback turtle (*Dermochelys coriacea*) feeding in the wild. Journal of Herpetology 17(1): 81-82.

EPA (U.S. Environmental Protection Agency). 2011. Marine debris in the North Pacific: a summary of existing information and identification of data gaps. November.

Ernst, L.H. and R.W. Barbour. 1972. Turtles of the United States. University of Kentucky Press: Lexington, Kentucky.

Ferraroli, S., S.A. Eckert, and Y. Le Maho. 2004. Satellite tracking of leatherback turtles nesting in French Guiana. Page 168 *in* Proceedings of the Twenty-First Annual Symposium on Sea Turtle Biology and Conservation. Philadephia, Pennsylvania. NOAA Technical Memorandum NMFS-SEFSC-528.

Finkbeiner, E.M., B.P. Wallace, J.E. Moore, R.L. Lewison, L.B. Crowder, and A.J. Read. 2011. Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between 1990 and 2007. Biological Conservation 144(11): 2719-2727.

Fitzsimmons, N. N, A. D. Tucker, and C. J. Limpus. 1995. Long-term breeding histories of male green turtles and fidelity to a breeding ground. Marine Turtle Newletter 68: 2-4.

Flint, M., J. Patterson-Kane, P. Mills, and C. Limpus. 2009. A veterinarian's guide for sea turtle post mortem examination and histological investigation. University of Queensland. ISBN 978-1-8649995-9-4.

Foley, A.M., P.H. Dutton, K.E. Singel, A.E. Redlow, and W.G. Teas. 2003. The first records of olive ridleys in Florida, USA. Marine Turtle Newsletter 101: 23-25.

Fossette, S., C. Girard, T. Bastian, B. Calmettes, S. Ferraroli, P. Vendeville, F. Blanchard, and J-Y. Georges. 2009. Thermal and trophic habitats of the leatherback turtle during the nesting season in French Guiana. Journal of Experimental Marine Biology and Ecology 378: 8-14.

Frair, W., R.G. Ackman, and N. Mrosovsky. 1972. Body temperature of *Dermochelys coriacea*: warm turtle from cold water. Science 177(4051): 791-793.

Frazier, J., R. Arauz, J. Chevalier, A. Formia, J. Fretey, M.H. Godfrey, R. Marquez-M., B. Pandav, and K. Shanker. 2007. Human-turtle interactions at sea. Pages 253-295 in Biology and Conservation of Ridley Sea Turtles, P.T. Plotkin (Ed.). Johns Hopkins University Press: Baltimore, Maryland.

Fretey, J. 1999. Distribution of the turtles of the genus *Lepidochelys* Fitzinger, 1842. I. The western Atlantic. Biogeographica 75(3): 97-111.

Fretey, J., A. Formia, J. Tomas, J.F. Dontaine, A. Billes, and H. Angoni. 2005. Presence, nesting, and conservation of Lepidochelys olivacea in the Gulf of Guinea. Page 172 *in* Proceedings of the Twenty-First Annual Symposium on Sea Turtle Biology and Conservation, 24-28 February 2001, Philadelphia, Pennsylvania. NOAA Technical Memorandum NMFS-SEFSC-528.

Fritts, T.H. 1982. Plastic bags in the intestinal tracts of leatherback marine turtles. Herpetological Review 13(3): 72-73.

Fujihara, J., T. Kunito, R. Kubota, and S. Tanabe. 2003. Arsenic accumulation in livers of pinnipeds, seabirds and sea turtles: subcellular distribution and interaction between arsenobetaine and glycine betaine. Comparative Biochemistry and Physiology C Toxicology and Pharmacology 136(4): 287-296.

Gaos, A.R., F.A. Abreu-Grobois, J. Alfaro-Shigueto, D. Amorocho, R. Arauz, A. Baquero, R. Briseño, D. Chacón, C. Dueñas, C. Hasbún, M. Liles, G. Mariona, C. Muccio, J.P. Muñoz, W.J. Nichols, M. Peña, J.A. Seminoff, M. Vásquez, J. Urteaga, B. Wallace, I.L. Yañez, and P. Zárate. 2010. Signs of hope in the eastern Pacific: international collaboration reveals encouraging status for a severely depleted population of hawksbill turtles *Eretomochelys imbricata*. Oryx 44(4): 595-601.

García-Fernández, A.J., P. Gómez-Ramírez, E. Martínez-López, A. Hernández-García, P. María-Mojica, D. Romero, P. Jiménez, J.J. Castillo, and J.J. Bellido. 2009. Heavy metals in tissues from loggerhead turtles (Caretta caretta) from the southwestern Mediterranean (Spain). Ecotoxicology and Environmental Safety 72(2): 557-563.

Gardner, S.C., S.L. Fitzgerald, B.A. Vargas, and L.M. Rodriguez. 2006. Heavy metal accumulation in four species of sea turtles from the Baja California Peninsula, Mexico. Biometals 19(1): 91-99.

Gardner, S.C., M.D. Pier, R. Wesselman, and J.A. Juarez. 2003. Organochlorine contaminants in sea turtles from the eastern Pacific. Marine Pollution Bulletin 46(9): 1082-1089.

Gill, B.J. 1997. Records of turtles and sea snakes in New Zealand, 1837-1996. New Zealand Journal of Marine and Freshwater Research 31(4): 477-486.

Gilman, E. (Ed.). 2009. Proceedings of the Technical Workshop on Mitigating Sea Turtle Bycatch in Coastal Net Fisheries. 20-22 January 2009, Honolulu, U.S.A. Western Pacific Regional Fishery Management Council, IUCN, Southeast Asian Fisheries Development Center, Indian Ocean – South-East Asian Marine Turtle MoU, U.S. National Marine Fisheries Service, Southeast Fisheries Science Center: Honolulu; Gland, Switzerland; Bangkok; and Pascagoula, USA.

Gless, J.M., M. Salmon, and J. Wyneken. 2008. Behavioral response of juvenile leatherbacks *Dermochelys coriacea* to lights used in the longline fishery. Endangered Species Research 5: 239-247.

Godley, B.J., A.C. Broderick, R. Frauenstein, F. Glen, and G.C. Hays. 2002. Reproductive seasonality and sexual dimorphism in green turtles. Marine Ecology Progress Series 226: 125-133.

Godley, B.J., A.C. Broderick, and S. Moraghan. 1999. Short-term effectiveness of passive integrated transponder (PIT) tags used in the study of Mediterranean marine turtles. Chelonian Conservation and Biology 3(3): 477-479.

Goff, G.P., and J. Lien. 1988. Atlantic leatherback turtles, *Dermochelys coriacea*, in cold water off Newfoundland and Labrador. Canadian Field-Naturalist 102: 1-5.

Grant, G.S., P. Craig, and G.H. Balazs. 1997. Notes on juvenile hawksbill and green turtles in American Samoa. Pacific Science 51(1): 48-53.

Green, G.A., J.J. Brueggeman, R.A. Grotefendt, C.E. Bowlby, M.L. Bonnell, and K.C. Balcomb III. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Prepared for Minerals Management Service, OCS Study MMS 91-0093. 100 pp.

Greer, A.E.J., J.D.J. Lazell, and R.M. Wright. 1973. Anatomical evidence for a counter-current heat exchanger in the leatherback turtle (*Dermochelys coriacea*). Nature 244: 181.

Hamann, M., C. Limpus, G. Hughes, J. Mortimer, and N. Pilcher. 2006. Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South-East Asia. IOSEA Marine Turtle MoU Secretariat, Bangkok.

Harvey, J., S. Benson, and T. Graham. 2006. Foraging ecology of leatherbacks in the California Current. Page 192 *in* Book of Abstracts for the Twenty-Sixth Annual Symposium on Sea Turtle Biology and Conservation, 3-8 April 2006, Island of Crete, Greece.

Hatase, H., M. Kinoshita, T. Bando, N. Kamezaki, K. Sato, Y. Matsuzawa, K. Goto, K. Omuta, Y. Nakashima, H. Takeshita, and W. Sakamoto. 2002. Population structure of loggerhead turtles, *Caretta caretta*, nesting in Japan: bottlenecks on the Pacific population. Marine Biology 141: 299-305.

Hatase, H., K. Sato, M. Yamaguchi, K. Takahashi, and K. Tsukamoto. 2006. Individual variation in feeding habitat use by adult female green sea turtles (*Chelonia mydas*): are they obligately neritic herbivores? Oecologia 149(1): 52-64.

Hawkes, L.A., A.C. Broderick, M.H. Godfrey, and B.J. Godley. 2007. Investigating the potential impacts of climate change on a marine turtle population. Global Change Biology 13: 1-10.

Hays, G.C., M.R. Farquhar, P. Luschi, S.L.H. Teo, and T.M. Thys. 2009. Vertical niche overlap by two ocean giants with similar diets: ocean sunfish and leatherback turtles. Journal of Experimental Marine Biology and Ecology 370(1-2): 134-143.

Hays, G.C., J.D.R. Houghton, and A.E. Myers. 2004. Endangered species: Pan-Atlantic leatherback turtle movements. Nature 429(6991): 522.

Hazel, J., I.R. Lawler, and M. Hamann. 2009. Diving at the shallow end: green turtle behavior in near-shore foraging habitat. Journal of Experimental Marine Biology and Ecology 371(1): 84-92.

Heberer, C.F. 1997. Estimation of bycatch and discard rates for pelagic fish species captured in the tuna longline fishery of the Federated States of Micronesia. Master's Thesis, University of Puerto Rico.

Heithaus, M.R. and M.D. Lawrence. 2002. Feeding strategies and tactics. Pages 412-422 *in* Encyclopedia of Marine Mammals. Academic Press: San Diego, California.

Hien, T.M. 2002. Status of sea turtle conservation in Vietnam. Pages 191-194 *in* Proceedings of the Western Pacific Sea Turtle Cooperative Research and Management Workshop, 5-8 February 2002, Honolulu, Hawaii.

Hillis, Z. and A.L. Mackay. 1989. Research report on nesting and tagging of hawksbill sea turtles *Eretmochelys imbricata* at Buck Island Reef National Monument, U.S. Virgin Islands, 198788. National Park Service, purchase order PX 5380-8-0090. 52 pp.

Hirth, H.F. 1980. Some aspects of the nesting behavior and reproductive biology of sea turtles. American Zoologist 20: 507-523.

Hirth, H. F. 1997. Synopsis of the biological data on the green turtle *Chelonia mydas* (Linnaeus 1758). Prepared for U.S. Fish and Wildlife Service; Biological Report 97(1). 120 pp.

Hodge, R.P. and B.L. Wing. 2000. Occurrences of marine turtles in Alaska waters: 1960-1998. Herpetological Review 31(3): 148-151.

Horrocks, J.A. and N.M. Scott. 1991. Nest site location and nest success in the hawksbill turtle *Eretmochelys imbricata* in Barbados, West Indies. Marine Ecology Progress Series 69: 1-8.

Howell, E.A., D.R. Kobayashi, D.M. Parker, G.H. Balazs, and J.J. Polovina. 2008. TurtleWatch: a tool to aid in the bycatch reduction of loggerhead turtles *Caretta caretta* in the Hawaii-based pelagic longline fishery. Endangered Species Research 5: 267-278.

Hughes, G.R., P. Luschi, R. Mencacci, and F. Papi. 1998. The 7000-km oceanic journey of a leatherback turtle tracked by satellite. Journal of Experimental Marine Biology and Ecology 229: 209-217.

Hughes, D.A. and J.D. Richard. 1974. The nesting of the Pacific ridley turtle *Lepidochelys olivacea* on Playa Nancite, Costa Rica. Marine Biology 24(2): 97-107.

Hulin, V., V. Delmas, M. Girondot, M.H. Godfrey, and J.M. Guillon. 2009. Oecologia 160(3): 493-506.

I-Jiunn, C. 2009. Changes in diving behavior during the interesting period by green turtles. Journal of Experimental Marine Biology and Ecology 381(1): 18-24.

Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC). 2012. Conservation status and habitat use of sea turtles in the eastern Pacific Ocean. Accessed on December 23, 2014 at http://www.iattc.org/Meetings/Meetings2012/May/PDFs/Conservation-status-and-habitat-use-of-sea-turtles-in-the-EPO-ENG.pdf. 28 pp.

Inter-American Tropical Tuna Commission (IATTC). 1999. Annual Report of the IATTC of 1997. La Jolla, California. 310 pp.

Inter-American Tropical Tuna Commission (IATTC). 2001. Annual Report of the IATTC of 1999. La Jolla, California. 184 pp.

Inter-American Tropical Tuna Commission (IATTC). 2002. Annual report of the IATTC of 2001. La Jolla, California. 148 pp.

Inter-American Tropical Tuna Commission (IATTC). 2006. Compliance with IATTC Measures in 2005. 7th Meeting of the Permanent Working Group on Compliance, June 22, 2006. Busan, Korea. Document COM-7-04 REV.

Ischer, T., K. Ireland, D. T. Booth. 2009. Locomotion performance of green turtle hatchlings from the Heron Island Rookery, Great Barrier Reef. Marine Biology 156(7): 1399-1409.

Iwamoto, T., M. Ishii, Y. Nakashima, H. Takeshita, and A. Itoh. 1985. Nesting cycles and migrations of the loggerhead sea turtle in Miyazaki, Japan. Japanese Journal of Ecology 35: 505-511.

James, M.C., S.A. Eckert, and R.A. Myers. 2005. Migratory and reproductive movements of male leatherback turtles (Dermochelys coriacea). Marine Biology 147(4): 845-853.

James, M.C., S.A. Sherrill-mix, K. Martin, and R.A. Myers. 2006. Canadian waters provide critical foraging habitat for leatherback sea turtles. Biological Conservation 133(3): 347-357.

Jones, T.T., B.L. Bostrom, M. Carey, B. Imlach, J. Mickelson, P. Ostafichuk, S. Eckert, P. Opay, Y. Swimmer, J.A. Seminoff, D.R. Jones. 2011. Determining transmitter drag and best practice attachment procedures for sea turtle biotelemetry studies. NOAA Technical Memorandum NMFS-SWFSC-480.

Juárez-Cerón, A. and L. Sarti-Martínez. 2003. Juvenile *Lepidochelys olivacea* in the open sea. Pages 239-240 *in* Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation, 4-7 April 2002, Miami, Florida. NOAA Technical Memorandum NMFS-SEFSC-503.

Jupiter, S., M. Mills, J. Comley, A. Batisbasaga, and A. Jenkins. 2010. Fiji marine ecological gap assessment: interim progress report. Accessed at https://www.nceas.ucsb.edu/~frazier/Fiji/Marine percent20Ecological percent20Gap percent20Assessment percent20Summary percent20Report percent20Apr10 percent20v2 percent20nfc.pdf on December 29, 2014. 26 pp.

Kamezaki, N., Y. Toji, and Y. Matsuzawa. 2002. Current status of Japanese loggerhead turtle nesting and beach environment. Sea Turtle Association of Japan, Osaka. 157 pp.

Kelez, S., X. Velez-Zuazo, and C.M. Bravo. 2003. Current status of sea turtles along the northern coast of Peru: preliminary results. Pages 264-265 *in* Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation, 4-7 April 2002, Miami, Florida. NOAA Technical Memorandum NMFS-SEFSC-503.

Keller, J.M., J.R. Kucklick, and P.D. McClellan-Green. 2004. Organochlorine contaminants in loggerhead sea turtle blood: extraction techniques and distribution among plasma and red blood cells. Archives of Environmental Contamination and Toxicology 46(2): 254-264.

Kobayashi, D.R., J.J. Polovina, D.M. Parker, N. Kamezaki, I.J. Cheng, I. Uchida, P.H. Dutton, G.H. Balazs. 2008. Pelagic habitat characterization of loggerhead sea turtles, *Caretta caretta*, in the North Pacific (1997-2006): insights from satellite tracking and remotely sensed data. Journal of Experimental Marine Biology and Ecology 356(1-2): 96-114.

Kopitsky, K. R.L. Pitman, and P. Dutton. 2003. Living on the edge: pelagic distribution and habitat of olive ridleys in the Eastern Tropical Pacific. Page 27 *in* Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation. 4-7 April 2002, Miami, Florida. NOAA Technical Memorandum NMFS-SEFSC-503.

Laveti, Merewalesi and K. MacKay. 2009. Does Fiji's Turtle Moratorium Work? Marine Turtle Newsletter 123:12-15.

Leblanc, A. M. and T. Wibbels. 2009. Effect of daily water treatment on hatchling sex ratios in a turtle with temperature-dependent sex determination. Journal of Experimental Zoology Part A-Ecological Genetics and Physiology 311A(1): 68-72.

Lewison, R.L., S.A. Freeman, and L.B. Crowder. 2004. Quantifying the effects of fisheries on threatened species: the impact of pelagic longlines on loggerhead and leatherback sea turtles. Ecology Letters 7: 221-231.

Limpus, C.J. 1982. The status of Australian sea turtle populations. Pages 297-303 *in* K.A. Bjorndal (Ed.), Biology and Conservation of Sea Turtles. Smithsonian Institution Press: Washington, DC. 583 pp.

Limpus, C.J. 1985. A study of the loggerhead turtle, *Caretta caretta*, in eastern Australia. Ph.D. dissertation, University of Queensland, Brisbane, Australia. 212 pp.

Limpus, C. 2002. Conservation and research of sea turtles in the Pacific region: an overview. Pages 41-50 *in* Proceedings of the Western Pacific Sea Turtle Cooperative Research and Management Workshop. Western Pacific Regional Fisheries Management Council.

Limpus, C. and M. Chaloupka. 1997. Nonparametric regression modelling of green sea turtle growth rates (southern Great Barrier Reef). Marine Ecology Progress Series 149: 23-34.

Limpus, C.J. and D.J. Limpus. 2003. Loggerhead turtles in the equatorial and southern Pacific Ocean: a species in decline. Chapter 12, pages 199-209 *in* Loggerhead Sea Turtles. Smithsonian Institution: Washington, D.C.

Limpus, C.J. and J.D. Miller. 2000. Final report for Australian hawksbill turtle population dynamics project. A project funded by the Japan Bekko Association to Queensland Parks and Wildlife Service. 147 pp.

Lopez-Mendilaharsu, M., C.F.D. Rocha, P. Miller, A. Domingo, and L. Prosdocimi. 2009. Insights on leatherback turtle movements and high-use areas in the southwest Atlantic Ocean. Journal of Experimental Marine Biology and Ecology 378(1-2): 31-39.

Luschi, P., J.R.E. Lutjeharms, P. Lambardi, R. Mencacci, G.R. Hughes, and G.C. Hays. 2006. A review of migratory behavior of sea turtles off southeastern Africa. South African Journal of Science 102: 51-58.

Lutcavage, M.E. and P.L. Lutz. 1997. Diving physiology. Pages 387 – 410 *in*: P.L. Lutz and J.A. Musick (Eds.), Biology and conservation of sea turtles. CRC Press; Boca Raton, Florida.

Lux, J., R. Reina, and L. Stokes. 2003. Nesting activity of leatherback turtles (*Dermochelys coriacea*) in relation to tidal and lunar cycles at Playa Grande, Costa Rica. Pages 215-216 *in* Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation, 4-7 April 2002, Miami, Florida. NOAA Technical Memorandum NMFS-SEFSC-503.

Márquez, M.R. 1990. Sea turtles of the world. An annotated and illustrated catalogue of sea turtle species known to date. FAO Species Catalog, FAO Fisheries Synopsis, Vol. 11, Document No. 125. 81 pp.

Mazaris, A.D., G. Matsinos, and J.D. Pantis. 2009. Evaluating the impacts of coastal squeeze on sea turtle nesting. Ocean and Coastal Management 52(2): 139-145.

McKenzie, C., B.J. Godley, R.W. Furness, and D.E. Wells. 1999. Concentrations and patterns of organochlorine contaminants in marine turtles from Mediterranean and Atlantic waters. Marine Environmental Research 47: 117-135.

McKeown, A. 1977. Marine Turtles of the Solomon Islands. Honiara, Ministry of Natural Resources, Fisheries Division. 47 pp.

McMahon, C.R. and G.C. Hays. 2006. Thermal niche, large-scale movements and implications of climate change for a critically endangered marine vertebrate. Global Change Biology 12(7): 1330-1338.

Meylan, A.B. 1988. Spongivory in hawksbill turtles: a diet of glass. Science 239: 393-395.

Meylan, A.B. 1999. International movements of immature and adult hawksbill turtles (*Eretmochelys imbricata*) in the Caribbean region. Chelonian Conservation and Biology 3(2): 189-194.

Meylan, A.B., B.W. Bowen, and J.C. Avise. 1990. A genetic test of the natal homing versus social facilitation models for green turtle migration. Science 248(4956): 724-727.

Meylan, A.B., and M. Donnelly. 1999. Status justification for listing the hawksbill turtle (*Eretmochelys imbricata* as critically endangered on the 1996 IUCN Red List of Threatened Animals. Chelonian Conservation and Biology 3(2): 200-204.

Mortimer, J.A. 1982. Factors influencing beach selection by nesting sea turtles. Pages 45-51 *in* K. Bjorndal (Ed.), Biology and Conservation of Ridley Sea Turtles. Smithsonian Institution Press: Washington, DC.

Mrosovsky, N. 1994. Sex ratios of sea turtles. Journal of Experimental Zoology 270: 16-27.

Mrosovsky, N., P.H. Dutton, and C.P. Whitmore. 1984. Sex ratios of two species of sea turtle nesting in Suriname. Canadian Journal of Zoology 62(11): 2227-2239.

Mrosovsky, N., G.D. Ryan, and M.C. James. 2009. Leatherback turtles: the menace of plastic. Marine Pollution Bulletin 58(2): 287-289.

Musick, J.A. and C.J. Limpus. 1997. Habitat utilization and migration in juvenile sea turtles. Pages 137-163 *in* P.L. Lutz and J.A. Musick (Eds.), The Biology of Sea Turtles. CRC Press: Boca Raton, Florida.

NMFS (National Marine Fisheries Service). 2004. Biological Opinion on effects of Proposed Regulatory Amendments to the Fisheries Management Plan for the Pelagic Fisheries of the Western Pacific Region. Pacific Islands Region. February 23.

NMFS (National Marine Fisheries Service). 2006. Biological Opinion on effects of the U.S. tuna purse seine fishery in the western and central Pacific Ocean on listed sea turtles and marine mammals. Pacific Islands Region. November 1.

NMFS (National Marine Fisheries Service). 2008. Biological Opinion on effects of the Implementation of Bottomfish Fishing Regulations within Federal Waters of the Main Hawaiian Islands. Pacific Islands Region. March 18.

NMFS (National Marine Fisheries Service). 2009. Biological Opinion on effects of the Continued Authorization of Pelagic Troll and Handline Fisheries, as Managed under the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region. Pacific Islands Region. September 1.

NMFS (National Marine Fisheries Service). 2010. Biological Opinion on effects of Measures to Reduce Interactions between green sea turtles and the American Samoa-based longline fishery – implementation of an amendment to the Fishery Ecosystem Plan for pelagic fisheries of the western Pacific region. Pacific Islands Region. September 16.

NMFS (National Marine Fisheries Service). 2013. Correction to Biological Opinion (originally issued on January 30, 2012) on continued operation of the Hawaii-based shallow-set pelagic longline fishery, as authorized under Amendment 18 to the Fishery Management Plan for pelagic fisheries of the western Pacific region. Pacific Islands Region. May 28.

NMFS (National Marine Fisheries Service). 2014. Biological Opinion on continued operation of the Hawaii-based deep-set pelagic longline fishery. Pacific Islands Region. September 19.

NMFS PIRO (National Marine Fisheries Service Pacific Islands Regional Office). 2009. Hawaii Longline Observer Program Field Manual. Version LM.01.10.

NMFS PIRO (National Marine Fisheries Service Pacific Islands Regional Office). 2010. Final report for scientific research Permit No. 1514.

NMFS SEFSC (National Marine Fisheries Service Southeast Fisheries Science Center). 2001. Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the Western North Atlantic. U.S. Department of Commerce, National Marine Fisheries Service, Miami, FL, SEFSC Contribution PRD-00/01-08; Parts I-III and Appendices I-V1.

NMFS SEFSC (National Marine Fisheries Service Southeast Fisheries Science Center). 2008. Sea Turtle Research Techniques Manual. NOAA Technical Memorandum DRAFT, 82 pp.

NMFS and USFWS (National Marine Fisheries Service and U.S. Fish and Wildlife Service). 1995. Status reviews for sea turtles listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland. 139 pp.

NMFS and USFWS (National Marine Fisheries Service and U.S. Fish and Wildlife Service). 1998a. Recovery Plan for U.S. Pacific Populations of the Green Turtle. Prepared by the Pacific Sea Turtle Recovery Team. National Marine Fisheries Service and U.S. Fish and Wildlife Service; Silver Spring, Maryland, and Arlington, Virginia.

NMFS and USFWS (National Marine Fisheries Service and U.S. Fish and Wildlife Service). 1998b. Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle (*Eretmochelys imbricata*). National Marine Fisheries Service, Silver Spring, Maryland.

NMFS and USFWS (National Marine Fisheries Service and U.S. Fish and Wildlife Service). 1998c. Recovery Plan for U.S. Pacific Populations of the Loggerhead Turtle. Prepared by the Pacific Sea Turtle Recovery Team.

NMFS and USFWS (National Marine Fisheries Service and U.S. Fish and Wildlife Service). 1998d. Recovery Plan for U.S. Pacific Populations of the Olive Ridley Turtle. Prepared by the Pacific Sea Turtle Recovery Team.

NMFS and USFWS (National Marine Fisheries Service and U.S. Fish and Wildlife Service). 2007a. Green Sea Turtle (*Chelonia mydas*) 5-Year Review: Summary and Evaluation. August.

NMFS and USFWS (National Marine Fisheries Service and U.S. Fish and Wildlife Service). 2007c. Loggerhead Sea Turtle (*Caretta caretta*) 5-Year Review: Summary and Evaluation. August.

NMFS and USFWS (National Marine Fisheries Service and U.S. Fish and Wildlife Service). 2013a. Hawksbill Sea Turtle (*Eretmochelys imbricata)* 5-Year Review: Summary and Evaluation. June.

NMFS and USFWS (National Marine Fisheries Service and U.S. Fish and Wildlife Service). 2013b. Leatherback Sea Turtle (*Dermochelys coriacea*) 5-Year Review: Summary and Evaluation. November.

NMFS and USFWS (National Marine Fisheries Service and U.S. Fish and Wildlife Service). 2014. Olive Ridley Sea Turtle (*Lepidochelys olivacea*) 5-Year Review: Summary and Evaluation. June.

Nichols, W.J., A. Resendiz, J.A. Seminoff, and B. Resendiz. 2000. Transpacific migration of a loggerhead turtle monitored by satellite telemetry. Bulletin of Marine Science 67(3): 937-947.

Nishimura, W. 1994. Internesting interval and nest frequency for loggerhead turtles on Inakahama Beach, Yakushima Island, Japan. Marine Turtle Newsletter 67: 21-22.

Nishimura, W. and S. Nakahigashi. 1990. Incidental capture of sea turtles by Japanese research and training vessels: results of a questionnaire. Marine Turtle Newsletter. 51:1-4.

Okuyama, J., O. Abe, H. Nishizawa, M. Kobayashi, K. Yoseda, and N. Arai. 2009. Ontogeny of the dispersal movement of green turtle (*Chelonia mydas*) hatchlings. Journal of Experimental Marine Biology and Ecology 379(1-2): 43-50.

OMB No. 0648-0084. National Marine Fisheries Service Endangered Species and Marine Mammals. Scientific Research and Enhancement Permits. Expires August 31, 2016.

Oros, J., O.M. Gonzalez-Diaz, and P. Monagas. 2009. High levels of polychlorinated biphenyls in tissues of Atlantic turtles stranded in the Canary Islands, Spain. Chemosphere 74(3): 473-478.

Pandav, B. and C.S. Kar. 2000. Reproductive span of olive ridley turtles at Gahirmatha rookery, Orissa, India. Marine Turtle Newsletter 87: 8-9.

Parker, D.M., G.H. Balazs, S. Murakawa, and J. Polovina. 2001. Post-hooking survival of sea turtles taken by the pelagic longline fishing in the North Pacific. Pages 50-52 *in* Proceedings of the Twenty-First Annual Sea Turtle Symposium, 24-28 February 2001, Orlando, Florida. NOAA Technical Memorandum NMFS-SEFSC 528.

Parker, D.M., W. Cooke, and G.H. Balazs. 2002. Dietary components of pelagic loggerhead turtles in the North Pacific Ocean. Pages 148-149 *in* Proceedings of the Twentieth Annual Sea Turtle Symposium, 29 February to 4 March 2000, Orlando, Florida. NOAA Technical Memorandum NMFS-SEFSC 447.

Parker, D.M., P.H. Dutton, K. Kopitsky and R.L. Pitman. 2003. Movement and dive behavior determined by satellite telemetry for male and female olive ridley turtles in the Eastern Tropical Pacific. Pages 48-49 *in* Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation, 4-7 April 2002, Miami, Florida. NOAA Technical Memorandum NMFS-SEFSC 503.

Parsons, J.J. 1972. The hawksbill turtle and the tortoise shell trade. Pages 45-60 *in* Études de géographie tropicale offertes a Pierre Gourou. Paris: Mouton.

Peckham, S.H., D. Maldonado-Diaz, V. Koch, A. Mancini, A. Gaos, M.T. Tinker, and W.J. Nichols. 2008. High mortality of loggerhead turtles due to bycatch, human consumption and strandings at Baja California Sur, Mexico, 2003 to 2007. Endangered Species Research 5: 171-183.

Peckham, H. and W.J. Nichols. 2003. Why did the turtle cross the ocean? Pelagic red crabs and loggerhead turtles along the Baja California coast. Pages 47-48 *in* Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation, 4-7 April 2002, Miami, Florida. NOAA Technical Memorandum NMFS-SEFSC 503.

Peckham, H. and W.J. Nichols. 2006. An integrated approach to reducing mortality of north Pacific loggerhead turtles in Baja California, SUR, Mexico. Pages 49-57 *in* Proceedings of the Second Western Pacific Sea Turtle Cooperative Research & Management Workshop. Volume II: North Pacific Loggerhead Sea Turtles. Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

Peckham, S.H., D.M. Diaz, A. Walli, G. Ruiz, L.B. Crowder, and W.J. Nichols. 2007. Smallscale fisheries bycatch jeopardizes endangered Pacific loggerhead turtles. PLoS ONE 2(10):e1041.

Petersen, S.L., M.B. Honig, P.G. Ryan, R. Nel, and L.G. Underhill. 2009. Turtle bycatch in the pelagic longline fishery off southern Africa. African Journal of Marine Science 31(1): 87-96.

Pitman, R.L. 1990. Pelagic distribution and biology of sea turtles in the eastern tropical Pacific. Pages 143-148 *in* Proceedings of the Tenth Annual Workshop on Sea Turtles Biology and Conservation, 20-24 February 1990, Hilton Head Island, South Carolina. NOAA Technical Memorandum NMFS-SEFSC-278.

Pitman, R.L. 1992. Sea turtle associations with flotsam in the eastern tropical Pacific Ocean. Page 94 *in* Proceedings of the Eleventh Annual Workshop on Sea Turtle Biology and Conservation, 26 February to 2 March 1991, Jekyll Island, Georgia. NOAA Technical Memorandum NMFS-SEFSC-302.

Plotkin, P.T. (Ed.). 1995. National Marine Fisheries Service and U.S. Fish and Wildlife Service status reviews for sea turtles listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland.

Plotkin, P. 2003. Adult migrations and habitat use. Pages 225-241 *in* P.L. Lutz, J.A. Musick, and J.A. Wyneken (Eds.), Biology of Sea Turtles, Volume II. CRC Press: Boca Raton, Florida.

Plotkin, P. and J. Bernardo. 2003. Investigations into the basis of the reproductive behavioral polymorphism in *Lepidochelys olivacea*. Page 29 *in* Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation, 4-7 April 2002, Miami, Florida. NOAA Technical Memorandum NMFS-SEFSC-503.

Plotkin, P.T., R.A. Byles, and D.C. Owens. 1994a. Migratory and reproductive behavior of *Lepidochelys olivacea* in the eastern Pacific Ocean. Page 138 *in* Proceedings of the Thirteenth Annual Symposium on Sea Turtle Biology and Conservation, 23-27 February 1993, Jekyll Island, Georgia. NOAA Technical Memorandum NMFS-SEFSC-341.

Plotkin, P.T., R.A. Byles and D.W. Owens. 1994b. Post-breeding movements of male olive ridley sea turtles *Lepidochelys olivacea* from a nearshore breeding area. Page 119 *in* Proceedings of the Fourteenth Annual Symposium, Sea Turtle Biology and Conservation, 1-5 March 1994, Hilton Head, South Carolina. NOAA Technical Memorandum NMFS-SEFSC-351.

Plotkin, P.T., D.W. Owens, R.A. Byles, and R. Patterson. 1996. Depature of male olive ridley turtles (*Lepidochelys olivacea*) from a nearshore breeding ground. Herpetologica 52(1): 1-7.

Plotkin, P.T., D.C. Rostal, R.A. Byles, and D.W. Owens. 1997. Reproductive and developmental synchrony in female *Lepidochelys olivacea*. Journal of Herpetology 31(1): 17-22.

Polovina, J.J., G.H. Balazs, E.A. Howell, D.M. Parker, M.P. Seki, and P.H. Dutton. 2008. Foraging hot spots and migration corridors for loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles in the oceanic North Pacific. Page 84 *in* Proceedings of the Twenty-Fourth Annual Symposium on Sea Turtle Biology and Conservation, 22-29 February 2004, San Jose, Costa Rica. NOAA Technical Memorandum NMFS-SEFSC-567.

Polovina, J.J., E. Howell, D.M. Parker, G.H. Balazs. 2003. Dive-depth distribution of loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles in the central North Pacific: Might deep longline sets catch fewer turtles? Fishery Bulletin 101(1): 189-193.

Polovina, J.J., G.H. Balazs, E.A. Howell, D.M. Parker, M.P. Seki, and P.H. Dutton. 2004. Forage and migration habitat of loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles in the central North Pacific Ocean. Fisheries Oceanography 13(1): 36-51.

Polovina, J., I. Uchida, G. Balazs, E.A. Howell, D. Parker, and P. Dutton. 2006. The Kuroshio Extension Bifurcation Region: a pelagic hotspot for juvenile loggerhead sea turtles. Deep-Sea Research II 53: 326-339.

Pritchard, P.C.H. 1971. The leatherback or leathery turtle, *Dermochelys coriacea*. International Union for the Conservation of Nature, Monograph Number 1: 39 pp.

Pritchard, P.C.H. 1982a. Marine turtles of the South Pacific. Pages 253-262 *in* K.A. Bjorndal (Ed.), Biology and Conservation of Sea Turtles. Smithsonian Institution Press: Washington, D.C. 583 pp.

Pritchard, P.C.H. 1982b. Nesting of the leatherback turtle (*Dermochelys coriacea*) in Pacific Mexico, with a new estimate of the world population status. Copeia 1982: 741-747.

Pritchard, P.C.H. 1997. Evolution, phylogeny, and current status. Pages 1-28 *in* P.L. Lutz and J.A. Musick (Eds.), The Biology of Sea Turtles. CRC Press: Boca Raton, Florida.

Pritchard, P.C.H. P. Bacon, F. Berry, A. J. Fletemeyer, R. Gallagher, S. Hopkins, Lankford, R. M., L. W. Pringle, Jr., H. Reichart, and R. 1983. Manual of sea turtle research and conservation techniques, 2nd ed. and G.H. eds. Prepared for the Atlantic Sea Symposium, Center for Environmental Education, Washington, DC.

Putrawidjaja, M. 2000. Marine turtles in Irian Jaya, Indonesia. Marine Turtle Newsletter 90: 8-10.

Reid, K.A., D. Margaritoulis, and J.R. Speakman. 2009. Incubation temperature and energy expenditure during development in loggerhead sea turtle embryos. Journal of Experimental Marine Biology and Ecology 378: 62-68.

Renaud, M.L. and J.A. Carpenter. 1994. Movements and submergence patterns of loggerhead turtles (*Caretta caretta*) in the Gulf of Mexico determined through satellite telemetry. Bulletin of Marine Science 55(1): 1-15.

Resendiz, A., B. Resendiz, W.J. Nichols, J.A. Seminoff, and N. Kamezaki. 1998. First confirmed east-west transpacific movement of a loggerhead sea turtle, *Caretta caretta*, released in Baja California, Mexico. Pacific Science 52(2): 151-153.

Richardson, J.I., R. Bell, and T.H. Richardson. 1999. Population ecology and demographic implications drawn from an 11-year study of nesting hawksbill turtles, *Eretmochelys imbricata*, at Jumby Bay, Long Island, Antigua, West Indies. Chelonian Conservation and Biology 3(2): 244-250.

Ross, J.P. 1979. Historical decline of loggerhead, ridley, and leatherback sea turtles. Pages 189-195 *in* K.A. Bjorndal (Ed.), Biology and Conservation of Sea Turtles. Smithsonian Institution Press: Washington, D.C. 1995.

Saba, V.S., P. Santidrian-Tomillo, R.D. Reina, J.R. Spotila, J.A. Musick, D.A. Evans, and F.V. Paladino. 2007. The effect of the El Niño Southern Oscillation on the reproductive frequency of eastern Pacific leatherback turtles. Journal of Applied Ecology 44(2): 395-404.

Saeki, K., H. Sakakibara, H. Sakai, T. Kunito, and S. Tanabe. 2000. Aresenic accumulation in three species of sea turtles. Biometals 13(3): 241-250.

Sale, A. and P. Luschi. 2009. Navigational challenges in the oceanic migrations of leatherback sea turtles. Proceedings of the Royal Society Biological Sciences Series B 276(1674): 3737-3745.

Sale, A., P. Luschi, R. Mencacci, P. Lambardi, G.R. Hughes, G.C. Hays, S. Benvenuti, and F. Papi. 2006. Long-term monitoring of leatherback turtle diving behavious during oceanic movements. Journal of Experimental Marine Biology and Ecology 328(2): 197-210.

Sakamoto, W., T. Bando, N. Arai, and N. Baba. 1997. Migration paths of the adult female and male loggerhead turtles *Caretta caretta* determined through satellite telemetry. Fisheries Science 63: 547-552.

Sakamoto, W., K. Sato, H. Tanaka, and Y. Naito. 1993. Diving patterns and swimming environmental of two loggerhead turtles during internesting. Nippon Suisan Gakkaishi 59(7): 1129-1137.

Sakamoto, W., I. Uchida, and K. Kureba. 1990. Deep diving behavior of the loggerhead turtle near the frontal zone. Nippon Suisan Gakkaishi 56: 1435-1443.

Santana Garcon, J., A. Grech, J. Moloney, and M. Hamann. 2010. Relative exposure index: an important factor in sea turtle nesting distribution. Aquatic Conservation: Marine and Freshwater Ecosystems 20: 140-149.

Sarti Martinez, L. A.R. Barragan, D.G. Munoz, N. Garcia, P. Huerta, and F. Vargas. 2007. Conservation and Biology of the leatherback turtle in the Mexican Pacific. Chelonian Conservation and Biology 6(1): 70-78.

Sato, K., Y. Masuzawa, H. Tanaka, T. Bando, S. Minamikawa, W. Sakamoto, and Y. Naito. Internesting intervals of loggerhead turtles, *Caretta caretta*, affected by their body temperatures. Page 89 *in* Proceedings of the Seventeenth Annual Symposium on Sea Turtle Biology and Conservation, 4-8 March 1997, Orlando, Florida. NOAA Technical Memorandum NMFS-SEFSC-415.

Schofield, G., C.M. Bishop, K.A. Katselidis, P. Dimopoulos, J.D. Pantis, and G.C. Hays. 2009. Microhabitat selection by sea turtles in a dynamic thermal marine environment. Journal of Animal Ecology 78(1): 14-21.

Seminoff, J.A. 2002. Global status of the green turtle (*Chelonia mydas*): A summary of the 2001 stock assessment for the IUCN Red List Programme. Presented at the Western Pacific Sea Turtle Cooperative Research and Management Workshop, 5-8 February 2002, Honolulu, Hawaii.

Seminoff, J.A. 2004. MSTG global assessment of green turtles for the IUCN Red List. Submitted to IUCN Species Survival Commission, April 2004. http://www.iucnmtsg.org/red_list/cm/MTSG_Chelonia_mydas_Assessment_April-2004.pdf.

Seminoff, J.A., T.T. Jones, A. Resendiz, W.J. Nichols, and M.Y. Chaloupka. 2003. Monitoring green turtles (*Chelonia mydas*) at a coastal foraging area in Baja California, Mexico: multiple indices to describe population status. Journal of the Marine Biological Association of the United Kingdom 83(6): 1355-1362.

Seminoff, J.A., A. Resendiz S. Hidalgo, and W.J. Nichols. 2002. Diet of the East Pacific green turtle, *Chelonia mydas*, in the central Gulf of California, México. Journal of Herpetology 36: 447-453

Seminoff, J.A., C.D. Allen, G.H. Balazs, P.H. Dutton, T. Eguchi, H.L. Haas, S.A. Hargrove, M.P. Jensen, D.L. Klemm, A.M. Lauritsen, S.L. MacPherson, P. Opay, E.E. Possardt, S.L. Pultz, E.E. Seney, K.S. Van Houtan, and R.S. Waples. 2015. Status Review of the Green Turtle (*Chelonia mydas*) under the U.S. Endangered Species Act. NOAA Technical Memorandum, NOAA-NMFS-SWFSC-539. 571 pp.

Shillinger, G.L., A.M. Swithenbank, S.J. Bograd, H. Bailey, M.R. Castelton, B.P. Wallace, J.R. Spotila, F.V. Paladino, R. Piedra, and B.A. Block. 2010. Identification of high-use internesting habitats for eastern Pacific leatherback turtles: role of the environment and implications for conservation. Endangered Species Research 10: 215-232.

Snover, M.L. 2008. Assessment of the population-level impacts of potential increases in marine turtle interactions resulting from a Hawaii Longline Association proposal to expand the 216 Hawaii-based shallow-set fishery. NOAA/NMFS/PIFSC Internal Report IR-08-010. 30 pp.

Southwood, A.L., R.D. Andrews, M.E. Lutcavage, F.V. Paladino, N.H. West, R.H. George, and D.R. Jones. 1999. Heart rates and diving behavior of leatherback sea turtles in the Eastern Pacific Ocean. Journal of Experimental Biology 202(9): 1115-1125.

Spotila, J. 2004. Sea Turtles: A Complete Guide to Their Biology, Behavior, and Conservation. Johns Hopkins University Press: Baltimore, Maryland. 240 pp.

Spotila, J.R., A.E. Dunham, A.J. Leslie, A.C. Steyermark, P.T. Plotkin and F.V. Paladino. 1996. Worldwide population decline of *Dermochelys coriacea*: Are leatherback turtles going extinct? Chelonian Conservation and Biology 2(2): 209-222.

Spotila, J. R., R. D. Reina, A. C. Steyermark, P. T. Plotkin, and F. V. Paladino. 2000. Pacific leatherback turtles face extinction. Nature 405: 529-530.

Standora, E.A., J.R. Spotila, J.A. Keinath, and C.R. Shoop. 1984. Body temperatures, diving cycles, and movement of a subadult leatherback turtle, *Dermochelys coriacea*. Herpetologica 40: 169-176.

Stamper, M.A., C.W. Spicer, D.L. Neiffer, K.S. Mathews, and G.J. Fleming. 2009. Morbidity in a juveniles green sea turtle (*Chelonia mydas*) due to ocean-borne plastic. Journal of Zoo and Wildlife Medicine 40(1): 196-198.

Starbird, C.H., Z. Hillis-Starr, J.T. Harvey, S.A. Eckert. 1999. Internesting movements and behavior of hawksbill turtles (*Eretmochelys imbricata*) around Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands. Chelonian Conservation and Biology 3(2): 237-243.

Stinson, M. 1984. Biology of sea turtles in San Diego Bay, California and the Northeastern Pacific Ocean. Master's Thesis, San Diego State University, California.

Storelli, M.M., G. Barone, and G.O. Marcotrigiano. 2007. Polychorinated biphenyls and other chlorinated organic contaminants in the tissues of Mediterranean loggerhead turtle *Caretta caretta*. Science of the Total Environment 373(2-3): 456-463.

Suárez, A., P.H. Dutton, and J. Bakarbessy. 2000. Letaherback (Dermochelys coriacea) nesting on the north Vogelkop coast of Irian Jaya, Indonesia. Page 260 *in* Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation, 2-6 March 1999, South Padre Island, Texas. NOAA Technical Memorandum NMFS-SEFSC-443.

TEWG (Turtle Expert Working Group). 2007. An Assessment of the Leatherback Turtle Population in the Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-555. 116 pp.

Threlfall, W. 1978. First record of the Atlantic leatherback turtle (*Dermochelys coriacea*) from Labrador. Canadian Field-Naturalist 92(3): 287.

Tiwari, M., K. A. Bjorndal, A. B. Bolten, and B. M. Bolker. 2005. Intraspecific application of the mid-domain effect model: spatial and temporal nest distributions of green turtles, *Chelonia mydas*, at Tortuguero, Costa Rica. Ecology Letters 8(9): 918-924.

Tiwari, M., K. A. Bjorndal, A. B. Bolten, and B. M. Bolker. 2006. Evaluation of density-dependent processes and green turtle *Chelonia mydas* hatchling production at Tortuguero, Costa Rica. Marine Ecology Progress Series 326: 283-293.

Tomás, J., P. Gozalbes, J.A. Raga, and B.J. Godley. 2008. Bycatch of loggerhead sea turtles: insights from 14 years of stranding data. Endangered Species Research 5: 161-169.

Trinidad, H. and J. Wilson. 2000. The bio-economics of sea turtle conservation and use in Mexico: history of exploitation and conservation policies for the olive ridley (*Lepidochelys olivacea*). 17 pp *in* Microbehavior and Macroresults: Tenth Biennial Conference of the International Institute of Fisheries Economics and Trade Presentations.

Troëng, S. and M. Chaloupka. 2007. Variation in adult annual survival probability and remigration intervals of sea turtles. Marine Biology 151(5): 1721-1730.

Tuato'o-Bartley, N., T.E. Morrell, and P. Craig. 1993. Status of sea turtles in American Samoa in 1991. Pacific Science 47(3): 25-221.

van Dam, R.P. and C.E. Diez. 1997. Diving behavior of immature hawksbill turtles (*Eretmochelys imbricata*) in a Caribbean reef habitat. Coral Reefs 16(2): 133-138.

van Dam, R. and L. Sarti. 1989. Sea turtle biology and conservation on Mona Island, Puerto Rico. Report for 1989. Chelonia, Sociedad Herpetologica de Puerto Rico.

Vicente, V.P. 1994. Spongivory in Caribbean hawksbill turtles, *Eretmochelys imbricata*: Data from stranded specimens. Pages 185-188 *in* Proceedings of the Thirteenth Annual Symposium on Sea Turtle Biology and Conservation, Jekyll Island, Georgia. NOAA Technical Memorandum NMFS-SEFSC-341.

Wallace, B.P., L. Avens, J. Braun-McNeill, and C.M. McClellan. 2009. The diet composition of immature loggerheads: insights on trophic niche, growth rates, and fisheries interactions. Journal of Experimental Marine Biology and Ecology 373(1): 50-57.

Watson, W., and R. Granger. 1998. Hydrodynamic Effect of a Satellite Transmitter on a Juvenile Green Turtle (*Chelonia mydas*). The Journal of Experimental Biology 201: 2497-2502.

Weidner, D. and J. Serrano. 1997. South America: Pacific, Part A, Section 1 (Segments A and B) in Latin America, World swordfish fisheries: an analysis of swordfish fisheries, market trends and trade patterns, Vol. IV. National Marine Fisheries Service; Silver Spring, Maryland, November, 1997.

Wetherall, J.A. 1997. Mortality of sea turtles in the Hawaii longline fishery: A preliminary assessment of population impacts. H-97-07. Southwest Fisheries Science Center Administrative Report H-93-18. National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu Laboratory; Honolulu, Hawaii.

Wetherall, J.A., G.H. Balazs, R.A. Tokunaga and M.Y.Y. Yong. 1993. Bycatch of marine turtles in North Pacific high-seas driftnet fisheries and impacts on the stocks. *In*: Ito, J., et al. (eds.), INPFC Symposium on biology, distribution, and stock assessment of species caught in the high seas driftnet fisheries in the North Pacific Ocean. Bulletin 53(III):519-538. Inter. North Pacific Fish. Comm., Vancouver, Canada.

Wibbels, T. 2003. Critical approaches to sex determination in sea turtles. Pages 103-134 in The Biology of Sea Turtles, Vol. 2, P.L. Lutz, J.A. Musick, and J. Wyneken (Eds.). CRC Press: Boca Raton, Florida.

Wilkinson, C. 2002. Status of Coral Reefs of the World: 2000. Global Coral Reef Monitoring Network, Australian Institute of Marine Science. 388 pp.

Wing, B.L. and R.P. Hodge. 2002. Occurrence terminology for marine turtles. Marine Turtle Newsletter 95: 15-16.

Witherington, B.E. 1992. Behavioral responses of nesting sea turtles to artificial lighting. Herpetologica 48(1): 31-39.

Witherington, B.E. and K.A. Bjorndal. 1991. Influences of wavelength and intensity on hatchling sea turtle phototaxis: implications for sea-finding behavior. Copeia 1991(4): 1060-1069.

Witherington, B., R. Herren, and M. Bresette. 2006. *Caretta caretta* – loggerhead sea turtle. Chelonian Research Monographs 3: 74-89.

Witzell, W.N. 1981. Predation on juvenile green sea turtles, *Chelonia mydas*, by a grouper, *Promicrops lanceolatus* (Pisces; Serranidae), in the kingdom of Tonga, South Pacific. Bulletin of Marine Science 31(4): 935-936.

Witzell, W.N. 1983. Synopsis of biological data on the hawksbill sea turtle, *Eretmochelys imbricata* (Linnaeus, 1766). FAO Fisheries Synopsis No. 137, FAO, Rome. 78 pp.

Yañez, I.L., A.R. Gaos, and R.M. Arauz. 2010. Eastern Pacific leatherback, green and olive ridley sea turtle nesting at Playa Naranjo; first census in eight years. Page 193 *in* Proceedings of the Twenty-Eighth Annual Symposium on Sea Turtle Biology and Conservation. 22-26 January 2008, Loreto, Baja California Sur, Mexico. NOAA Technical Memorandum NMFS-SEFSC-602.

Zug, G.R., G.H. Balazs, J.A. Wetherall, D.M. Parker and S.K.K. Murakawa. 2002. Age and growth of Hawaiian green turtles (*Chelonia mydas*): an analysis based on skeletrochronology. Fishery Bulletin 100: 117-127.

Zug, G. R. and R. E. Glor. 1998. Estimates of age and growth in a population of green sea turtles (*Chelonia mydas*) from the Indian River lagoon system, Florida: a skeletochronological analysis. Canadian Journal of Zoology 76: 1497-1506.