NOAA's National Marine Fisheries Service
Endangered Species Act Section 7 Consultation

Biological Opinion

Agencies: NOAA's National Marine Fisheries Service-Office of Protected Resources-Permits, Conservation, and Education Division

Activities Considered: Issuance of permit to Lisa Ballance, NMFS Southwest Fisheries Science Center (Permit number 16803)

Consultation Conducted by: NOAA's National Marine Fisheries Service-Office of Protected Resources-Endangered Species Division

Approved by: _____

Date: OCT 0 3 2012

Section 7(a)(2) of the Endangered Species Act (ESA)(16 U.S.C. 1531 *et seq.*) requires that each federal agency shall ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When the action of a federal agency "may affect" a listed species or critical habitat designated for them, that agency is required to consult with either the NOAA's National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service, depending upon the listed resources that may be affected. For the actions described in this document, the action agency is the NMFS' Office of Protected Resources-Permits and Conservation Division (Permits Division), which proposes to authorize capture, tagging, and biological sampling of green, loggerhead, and olive ridley sea turtles in San Diego Bay. The consulting agency for these proposals is the NMFS' Office of Protected Resources – Endangered Species Act Interagency Cooperation Division (Endangered Species Division).

This document represents the NMFS' biological opinion (Opinion) of the effects of the proposed actions on endangered and threatened species and designated critical habitat and has been prepared in accordance with section 7 of the ESA. This Opinion is based on information provided in the application, draft permit, recovery plans for green, loggerhead, and olive ridley sea turtles, monitoring reports from prior research, other information provided by the applicant, and other biological opinions involving similar sea turtle research.

Consultation history

On June 11, 2012, the Permits Division published a notice in the Federal Register soliciting public comment on their intent to issue the proposed permit.

On June 22, 2012, NMFS' Endangered Species Division received a request for formal consultation from the Permits Division to authorize Permit Number 16803, Lisa Ballance, NMFS Southwest Fisheries Science Center.

Description of the proposed actions

The proposed action is the issuance of a scientific research permit (file no. 16803) to Lisa Ballance, NMFS Southwest Fisheries Science Center, pursuant to section 10(a)(1)(a) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 *et seq*.), to conduct directed scientific research on green (*Chelonia mydas*), loggerhead (*Caretta caretta*), and olive ridley sea turtles (*Lepidochelys olivacea*). The purposes of the proposed permit generally involve monitoring the population size of San Diego Bay green sea turtles, identifying and mitigating threats to the population, and increasing public awareness of sea turtles. Specific purposes include determining the abundance, size ranges, growth, sex ratio, health status, diving behavior, local movements, habitat use, and migration routes of sea turtles in San Diego Bay. The proposed permit would authorize the applicant to capture sea turtles via tangle net, handle and restrain them, as well as conduct flipper and PIT tagging, lavage, morphometric measurements, blood, skin, and scute sampling, and inject individuals with tetracycline. Also permitted would be application of biotelemetry (satellite, sonic, and CritterCam) tags.

Capture , handling, and restraint

Sea turtles will be captured by entanglement nets. Researchers would stretch nets (100 meter [m] by 6 m with 30 centimeter [cm] mesh) across shallow mud-bottom regions of San Diego Bay. Two or more boats would monitor the nets for signs of turtle entanglement which, if observed, would result in researchers immediately relocating to the entanglement location. If entanglements have not been detected, personnel would walk along the net's length every 30 minutes to ensure no entanglements go undetected for a period that could risk sea turtle drowning. Once a turtle is detected in the net, personnel would immediately bring it aboard a research vessel, disentangle it, and transport it to shore (100-500 m away) for research procedures. All the investigators and personnel involved would be experienced in capturing and handling sea turtles and would undertake a number of precautions. Individuals will be covered with a tarp as sun protection. Just before deployment to shore, turtles would be placed in a restraint harness. Onshore, turtles would then be placed on a tire or tarp; more active individuals would be placed in a restraint box. Procedures are expected to take up to 2.5 hours per turtle from time of capture. Researchers would initially examine captured sea turtles for signs of injury, vigor, and behavior. Injured and abnormally-behaving sea turtles would be immediately referred to the chief scientist and possibly to the on-call veterinarian for care. Equipment would be disinfected between individuals and individuals exhibiting signs of fibropapillomatosis would be handled with separate equipment. Further restrictions on handling are provided for in the conditions of the proposed permit (see below). Release would be accomplished by lowering sea turtles into the water near the capture site followed by release and subsequent monitoring of swimming and diving ability. If turtles are still visible and not swimming or diving normally one hour post-release, they would be recaptured and transferred to a rehabilitation facility under separate authority (§222.310 U.S.C. 1539 (a)(1)(A)).

Flipper and PIT Tagging

All captured sea turtles would be examined for the presence of a flipper or PIT tag. If absent, turtles would be equipped with Inconel flipper tags attached to the trailing edge of the left or right front flippers and/or a PIT tag inserted intramuscularly into the foreflipper or shoulder, enabling future identification of the individual. Tags come sterilized or would be disinfected prior to implantation. The tagging site would also be sterilized with alcohol or Betadine. The

anticipated duration of flipper tag attachment is two to four years (although some individuals retain the tag for 30 years or more) while the PIT tag is permanent baring amputation.

Morphometrics

Morphometrics may be recorded for all captured sea turtles. Turtles would be measured using a soft measuring tape to collect curved carapace, plastron, and tail lengths. Calipers would be used to measure straight carapace lengths, width, and body depth. Turtles would be weighed using a tripod for lifting the animals and a digital scale would record weight. Animals would be restrained in a harness designed specifically for lifting turtles during the weighing process.

Blood and scute sampling, biopsy

Blood and tissue sampling would be conducted only by trained personnel using new sterile disposable needles on each turtle. Only individuals that are adequately immobilized would be subject to blood sampling. Blood would be collected from the dorsal cervical sinus using a 20-21 gauge needle after the site had been disinfected with Betadine or alcohol. No more than four attempts would be made to collect blood; two from the left and right sides, respectively. No more than 1% of blood volume and less than 5 ml/kg of blood would be collected.

Scute samples would be taken from one or more of the eight posterior marginal scutes of the carapace. Keratin would be scraped from the radial edge, where the dorsal and ventral surfaces form a thin edge and the keratin and underlying tissue can be discriminated. In order to obtain the 'core' sample that is needed to separate the various keratin layers from, a disposable stainless steel biopsy tool would be used to obtain 0.2 to 0.5 g of the scute by moving the tool parallel to the edge (Reich et al., 2007). Scute sampling would not go through to living tissue or draw blood.

Skin samples would also be biopsied using a sterile 6 mm biopsy punch or forceps and razor and the area cleansed with Betadine or alcohol.

Lavage

Researchers would lavage the esophagus of some animals immediately after capture in order to collect stomach samples for analysis (Forbes and Limpus, 1993; Seminoff et al., 2002a). This procedure involves inserting a length of 3/4 inch diameter soft plastic tubing down the esophagus to the lower esophagus (where recently ingested food is located prior to it entering the stomach) and flushing it with clean seawater poured into the tubing. The length of the water tube is not inserted beyond the border of the carapace to the throat (i.e. the tubes do not enter the stomach). Contents are caught in a separate basin. The procedure takes 5-10 minutes. Only researchers with training and long-term experience with this technique would conduct lavage efforts.

Ultrasound

Ultrasonography would be used to measure the depth of the subcutaneous fat layer to quantify nutritional condition of captured turtles. A portable veterinary ultrasound machine (Sonosite Vet 180 Plus, C60 5-2 MHz transducer) would be used to obtain images of the subcutaneous fat and underlying musculature at five anatomical sites: right shoulder, central neck, left shoulder, right hip, and left hip. Ultrasound gel would be applied to the skin and the probe would be held against the skin for several seconds until an image is obtained.

Tetracycline injection

Researchers would inject tetracycline in the dorsal shoulder musculature to calibrate bone growth over the turtle's life if the turtle strands dead. Individuals would be weighed in order to calculate the proper dosage (dosage = weight (kilograms) x 25 (milligrams[mg]/kg) / concentration (mg/milliliters [ml]), (SEFSC, 2008)). Prior to injection, verification of the products expiration date and concentration will be conducted. Turtles with a standard carapace length of greater than 70 cm would have the dosage split into two equal volumes in each shoulder (SEFSC, 2008). Injections would be made with a 18 gauge needle and not to exceed 10 ml per site after scrubbing the site with Betadine or alcohol (SEFSC, 2008). Following injection, the site will be wiped again with Betadine or alcohol.

Buccal and cloacal sampling

Buccal sampling may also be performed intermittently using a stainless steel pry bar to carefully open the turtle's mouth followed by a canine mouth gag to hold the mouth (Forbes and Limpus, 1993). The soft tissue portion of the buccal area would be swabbed with a Whatman® Omni Swab for approximately six seconds. Cloacal samples would be collected by insertion of another Whatman® Omni Swab approximately 5 millimeter [mm] into the cloaca for about six seconds. Both swabbing methods involve gentle scraping of the epithelium with the swab.

Satellite tagging

Several types of attached devices are proposed for use, including ultrasonic transmitters, time-depth recorders, CritterCam video recorders, and satellite transmitters. Design and placement of telemetry devices was made considering recent studies of telemetry device drag and best-practice procedures (Todd et al., 2011). Ultrasonic transmitters would be Sonotronics™ model CHP-87-L (9 cm long, 1.8 cm wide, 11.5 grams [g] weight) that transmit at 35-40 kHz (well beyond the expected hearing range of sea turtles, their predators, and prey). These transmitters would be attached to the carapace with fiberglass or epoxy resin (Balazs, 1999a; Mitchell, 2000). The attachment area on the carapace would be cleaned and lightly sanded to remove algae. A non-toxic compound such as plumbers putty or elastomer would be used to "cushion" the transmitter and hold it in place during the attachment procedure. A thin coat of laminating resin or epoxy resin would be applied to the carapace and transmitter and 4-5 strips of fiberglass cloth would be pasted over the transmitter to attach it. Previous experience supports attachment durations of six months with this methodology, although up to one year may pass before removal. If a non-functional tag is encountered during a recapture, it would be removed and the resin cleaned from the carapace with a scrapper and sand paper. Turtles with these transmitters would be tracked via a 17-foot long Boston Whaler with a 75 horsepower outboard motor using hand-held sonic receivers and a directional hydrophone. However, approaches would not be attempted closer than 10-20 m.

Time depth recorder model MK-9 (Wildlife Computers; 6.7 cm by 1.7 cm by 1.7 cm; 30 g weight) would be housed in a 20 cm long, 7 cm diameter nearly neutrally buoyant foam drogue and applied to sea turtles as well. The device would transit at 140 MHz, again well beyond the hearing range of sea turtles, their predators, and prey. The tag would be connected to the sea turtle via an automatically releasing mechanism, one end of which would be attached to the sea turtle's carapace with a nylon mesh apron and 5-minute quickset epoxy. The release mechanism, which would be magnesium based, would corrode and separate the plate from the carapace within about 10 days.

CritterCam devices would involve a Hi-8 video camera with a time-depth recorder enclosed in a 10.1 cm by 31.7 cm cylinder transmitting with the same parameters specified for the time depth recorder device. The device would be weighted so as to be almost neutrally buoyant. Only large turtles would be outfitted with this device such that the device (2.0 kg) does not constitute more than 3% of the individual's body weight. Attachment would be on the crown of the carapace with a plate attached in the same manner as described above for the time depth recorder; the automatic release mechanism would also be the same as described above.

Satellite transmitters could be one of several devices of various dimensions with various capabilities. However, only one satellite tag would be deployed on a given turtle at a time, although some of these individuals may also receive ultrasonic tags or CritterCam. Satellite tags would be attached in the same manner as described for ultrasonic tags. Individuals would be held for up to two hours to facilitate resin curing.

Permit Conditions

I. Number and kind(s) of protected species, location(s) and manner of taking

1. The table in the proposed permit outlines the number of protected species, by species, authorized to be taken, as well as the locations and manner in which they may be taken.

2. Researchers must immediately stop permitted activities and the permit holder must contact the Chief of the NMFS Permits Division for written permission to resume:

    a. If serious injury or mortality of protected species occurs.

    b. If authorized take is exceeded, including accidental takes of protected species not listed in each permit.

3. Researchers working under the permit may collect visual images (*e.g.*, photographs, video) in addition to the photo-identification or behavioral photo-documentation authorized in appendix 1 of the permit as needed to document the permitted activities, provided the collection of such images does not result in takes.

4. The permit holder may use visual images and audio recordings collected under his permit, including those authorized in appendix 1 of the permit, in printed materials (including commercial or scientific publications) and presentations provided the images and recordings are accompanied by a statement indicating that the activity was conducted pursuant to the permit. This statement must accompany the images and recordings in all subsequent uses or sales.

5. Upon written request from the permit holder, approval for photography, filming, or audio recording activities not essential to achieving the objectives of the permitted

activities, including allowing personnel not essential to the research (*e.g.*, a documentary film crew) to be present, may be granted by the Permits Division Chief.

a. The permit holder submits a request to the Permits Division specifying the location and nature of the activity, approximate dates, and number and roles of individuals for which permission is sought.

b. Non-essential photography, filming, or recording activities will not influence the conduct of permitted activities or result in takes of protected species.

c. Persons authorized to accompany the researchers for the purpose of such non-essential activities will not be allowed to participate in the permitted activities.

d. The permit holder and researchers do not require compensation from the individuals in return for allowing them to accompany Researchers.

6. Researchers must comply with the following conditions related to the manner of taking:

a. Capture methods

i. Entanglement and seine netting:

a. Nets used to catch turtles must be of large enough mesh size to diminish bycatch of other species.

b. Seine net pulls must not exceed 30 minutes.

c. Entanglement nets must have highly visible buoys attached to the float line of each net and spaced at intervals of every 10 yards or less.

d. Entanglement nets must be checked at intervals of less than 30 minutes, and more frequently whenever turtles or other organisms are observed in the net. If water temperatures are $\leq 10^{o}$C or $\geq 30^{o}$C, nets must be checked at less than 20-minute intervals. "Net checking" is defined as a complete and thorough visual check of the net either by snorkeling the net in clear water or by pulling up on the top line such that the full depth of the net is viewed along the entire length.

e. The float line of entanglement nets must be observed at all times for movements that indicate an animal has encountered the net. When this occurs the net must be immediately checked.

f. Researchers must plan for unexpected circumstances or demands of the research activities and have the ability and resources to meet net checking requirements at all times (*e.g.* if one animal is very entangled and requires extra time and effort to remove from the net, researchers must have sufficient staff and resources to continue checking the rest of the net at the same time).

b. General handling, resuscitation, and release

i. Researchers must handle turtles according to procedures specified in 50 CFR 223.206(d)(1)(i), using care when handling live animals to minimize any possible injury. Appropriate resuscitation techniques on comatose turtles must be implemented prior to return to the water. Injured turtles must be transferred to a rehabilitation facility and allowed to recover before return to the wild. An experienced veterinarian, veterinary technician, or rehabilitation facility must be on call for emergencies.

ii. If an animal becomes highly stressed, injured, or comatose, researchers must contact a veterinarian immediately. Based on the instructions of the veterinarian, if necessary, the animal must be immediately transferred to the veterinarian or to a rehabilitation facility to receive veterinary care. In addition, 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 (death, permanent injury, recovery and return to wild, etc.) of the animal to the Chief, Permits Division.

iii. 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 working under separate research permits if their activities would further compromise the animal.

iv. While holding sea turtles, researchers must protect sea turtles from temperature extremes, provide adequate air flow, keep sea turtles moist (if appropriate), and keep the area surrounding the turtle free of materials that could be accidentally ingested.

v. During release, turtles must be lowered as close to the water's surface as possible to prevent injury.

vi. Researchers must carefully monitor newly released turtles' apparent ability to swim and dive in a normal manner. If a turtle is not behaving normally within one hour of release, the turtle must be recaptured and taken to a rehabilitation facility.

c. Handling and marking

i. Researchers must:

b. Clean and disinfect all equipment (tagging equipment, tape measures, etc.) and surfaces that comes in contact with sea turtles or their fluids between the processing of each turtle.

c. Maintain a separate set of sampling equipment for handling animals displaying fibropapillomas tumors or lesions. Equipment that comes in contact with the turtle must be cleaned and disinfected between the processing of each turtle.

d. Examine turtles for existing flipper and PIT tags before attaching or inserting new ones. If existing tags are found, the identification numbers must be recorded. Researchers must have PIT tag readers capable of reading 125, 128, 134.2, and 400 kHz tags.

e. Clean and disinfect:
   i. flipper tags (*e.g.*, to remove oil residue) before use,
   ii. tag applicators between sea turtles, and
   iii. the application site before the tag pierces the animal's skin.

f. PIT tagging: Use new, sterile tag applicators (needles). The application site must be cleaned and then scrubbed with a disinfectant (*e.g.*, Betadine) before the applicator pierces the animal's skin.

d. Sampling

i. Blood sampling

a. Blood samples must be taken by experienced personnel using new disposable needles on each animal. Collection sites must be scrubbed with alcohol or another antiseptic prior to sampling. Samples must not be taken if an animal cannot be adequately immobilized for blood sampling or conditions on the boat preclude the safety and health of the turtle. Attempts (needle insertions) to extract blood from the neck must be limited to a total of four, two on either side. A single sample must not exceed 3 ml per 1 kg of animal. Within a 45-day period, the cumulative blood volume taken from a turtle must not exceed the maximum safe limit of 3 ml/kg. If more than 50% of the limit is taken, in a single event or cumulatively from repeat sampling events, within 45 days, that turtle must not be re-sampled for 3 months from the last blood-sampling event. Researchers must, to the maximum extent practicable, attempt to determine if any of the turtles they blood sample may have been sampled within the past 3 months or will be

sampled within the next 3 months by other researchers. The permit holder must contact other researchers working in the area that could capture the same turtles to ensure that none of the above limits are exceeded.

ii. Biopsy sampling

a. A new biopsy punch must be used on each turtle. Sterile techniques must be used at all times. Samples must be collected from the neck or the trailing edge of a flipper. The tissue surface must be thoroughly swabbed once with both Betadine and alcohol, sampled, and then thoroughly swabbed again with just Betadine. The procedure area and hands must be clean.

iii. Gastric lavage

a. The actual lavaging of the turtle must not exceed three minutes. Once the samples have been collected, water must be turned off and water and food allowed to drain until all flow has stopped. The posterior of the turtles must be elevated slightly to assist in drainage. Researchers must thoroughly clean equipment prior to disinfection (viruses can remain protected in organic matter; the disinfectant can't get to them if they're protected in this matter). Disinfectants must be used according to label directions; however, exposure time should be increased for rough and/or porous items (a dip and rinse is not sufficient). Disinfection can be compromised (incomplete) if items are contaminated with debris and/or have rough or porous surfaces. Care must be taken that disinfecting solutions are clean and active and that proper rinsing occurs after disinfection. A separate set of equipment must be used for infected and non-infected animals.

e. Instrument tagging and marking

i. TDRs, VHF, sonic or satellite tags, or CritterCams:

a. Total combined weight of all transmitter attachments must not exceed 5% of the animal's body mass. Each attachment must be made so that there is no 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. 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. Critter cam's larger version may be used on animals 70 cm CCL or greater.

II. Qualifications, responsibilities, and designation of personnel

1. At the discretion of the permit holder, the following researchers may participate in the conduct of the permitted activities in accordance with their qualifications and the limitations specified herein:

    a. Principal investigator – Jeffrey Seminoff

    b. Co-investigator(s) – Robin LeRoux, Peter Dutton, and Tomoharu Eguchi

    c. Research assistants – personnel identified by the permit holder or principal investigator and qualified to act pursuant to conditions C.2, C.3, and C.4 of the permit

2. Individuals conducting permitted activities must possess qualifications commensurate with their roles and responsibilities. The roles and responsibilities of personnel operating under the permit are as follows:

    a. The permit holder is ultimately responsible for activities of individuals operating under the authority of the permit.

    b. The principal investigator (PI) is the individual primarily responsible for the taking, import, export and related activities conducted under the permit. The PI must be on site during activities conducted under the permit unless a co-investigator.

    c. Co-investigators (CIs) are individuals who are qualified to conduct activities authorized by the permit without the on-site supervision of the PI. CIs assume the role and responsibility of the PI in the PI's absence.

    d. Research assistants (RAs) are individuals who work under the direct and on-site supervision of the PI or a CI. RAs cannot conduct permitted activities in the absence of the PI or a CI.

3. Personnel involved in permitted activities must be reasonable in number and essential to conduct of the permitted activities. Essential personnel are limited to:

a. Individuals who perform a function directly supportive of and necessary to the permitted activity (including operation of vessels or aircraft essential to conduct of the activity);

b. Individuals included as backup for those personnel essential to the conduct of the permitted activity; and

c. Individuals included for training purposes.

4. Persons who require state or federal licenses to conduct activities authorized under the permit (*e.g.*, veterinarians, pilots) must be duly licensed when undertaking such activities.

5. Permitted activities may be conducted aboard vessels or aircraft, or in cooperation with individuals or organizations, engaged in commercial activities, provided the commercial activities are not conducted simultaneously with the permitted activities.

6. The permit holders cannot require or receive direct or indirect compensation from a person approved to act as PI, CI, or RA under this permit in return for requesting such approval from the Permits Division.

III. Reports

1. The permit holders must submit written annual, final, and incident reports to the Permits Division. Reports may be submitted

- through the online system at https://apps.nmfs.noaa.gov,
- by email attachment to the permit analyst for this permit, or
- by hard copy mailed or faxed to the Chief, Permits Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Suite 13705, Silver Spring, Maryland 20910; phone (301) 427-8401; fax (301) 713-0376.

2. Written incident reports related to serious injury and mortality events or to exceeding authorized takes, must be submitted to the Permits Division Chief within two weeks of the incident. The incident report must include a complete description of the events and identification of steps that will be taken to reduce the potential for additional research-related mortality or exceedence of authorized take. In addition to the written report, permit holders must contact the Permits Division by phone (301-427-8401) as soon as possible, but no later than within two business days of the incident.

3. An annual report must be submitted to the Permits Division Chief at the conclusion of each year for which the permit is valid. The report must include a tabular accounting of takes and a narrative description of activities and effects.

4. A final report must be submitted to the Permits Division Chief within 180 days after expiration of the permit, or, if the research concludes prior to permit expiration, within 180 days of completion of the research. The final report must follow the format in appendix 2 of the permit.

5. Research results must be published or otherwise made available to the scientific community in a reasonable period of time. Copies of technical reports, conference abstracts, papers, or publications resulting from permitted research must be submitted the Permits Division.

IV. Notification and coordination

1. Permit holders must provide written notification of planned field work at least two weeks prior to initiation of each field trip/season. If there will be multiple field trips/seasons in a permit year, a single summary notification may be submitted per year.

   a. Notification must include the
      - locations of the intended field study and/or survey routes
      - estimated dates of activities
      - number and roles of participants (for example: PI, CI, veterinarian, boat driver, safety diver, animal restrainer, Research Assistant "in training")

   b. Notification must be sent to the following Southwest Assistant Regional Administrator for Protected Resources at 501 West Ocean Blvd., Suite 4200, Long Beach, California 90802-4213; phone (562)980-4020; fax (562)980-4027; Email (*preferred*); SWR.research.notification@noaa.gov

2. To the maximum extent practical, the permit holder must coordinate permitted activities with activities of other permit holders conducting the same or similar activities on the same species, in the same locations, or at the same times of year to avoid unnecessary disturbance of animals. Contact the applicable regional office(s) listed in F.1.b of the permit for information about coordinating with other permit holders.

3. Researchers must comply with protocols provided by the regional administrators related to coordination of research, including additional measures deemed necessary to minimize unnecessary duplication, harassment, or other adverse impacts from multiple permit holders.

V. Observers and inspections

1. The Permits Division may review activities conducted pursuant to the permit. At the request of the Permits Division, permit holders must cooperate with any such review by:

    a. Allowing an employee of NOAA or other person designated by the NMFS Office of Protected Resources Director to observe permitted activities; and

    b. Providing all documents or other information relating to the permitted activities.

VI. Modification, suspension, and revocation

1. The permit is subject to suspension, revocation, modification, and denial in accordance with the provisions of subpart D [Permit Sanctions and Denials] of 15 CFR part 904.

2. The NMFS Office of Protected Resources Director may modify, suspend, or revoke a permit in whole or in part:

    a. In order to make the permit consistent with a change made after the date of permit issuance with respect to applicable regulation prescribed under section 4 of the ESA;

    b. In a case in which a violation of the terms and conditions of the permit is found;

    c. In response to a written request from the permit holder;

    d. If NMFS determines that the application or other information pertaining to the permitted activities (including, but not limited to, reports pursuant to section E of each permit and information provided to NOAA personnel pursuant to section G of each permit) includes false information; and

    e. If NMFS determines that the authorized activities will operate to the disadvantage of threatened or endangered species or are otherwise no longer consistent with the purposes and policy in section 2 of the ESA.

3. Issuance of the permit does not guarantee or imply that NMFS will issue or approve subsequent permits or amendments for the same or similar activities requested by the permit holders, including those of a continuing nature.

1. Penalties and permit sanctions

1. A person who violates a provision of the permit, the MMPA, ESA, or the regulations at 50 CFR 216 and 50 CFR 222-226 is subject to civil and criminal

penalties, permit sanctions, and forfeiture as authorized under the MMPA, ESA, and 15 CFR part 904.

Approach to the assessment

We approach section 7 analyses of agency actions through a series of steps. The first step identifies those aspects of proposed actions that are likely to have direct and indirect physical, chemical, and biotic effects on listed species or on the physical, chemical, and biotic environment of an action area. As part of this step, we identify the spatial extent of these direct and indirect effects, including changes in that spatial extent over time. The result of this step includes defining the *action area* for the consultation. The second step of our analyses identifies the listed resources that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our *exposure analyses*). In this step of our analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. Once we identify which listed resources are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (these represent our *response analyses*).

The final steps of our analyses – establishing the risks those responses pose to listed resources – are different for listed species and designated critical habitat (these represent our *risk analyses*). Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been listed, which can include true biological species, subspecies, or distinct population segments of vertebrate species. The continued existence of these "species" depends on the fate of the populations that comprise them. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them – populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

Our risk analyses reflect these relationships between listed species, the populations that comprise that species, and the individuals that comprise those populations. Our risk analyses begin by identifying the probable risks actions pose to listed individuals that are likely to be exposed to an action's effects. Our analyses then integrate those individual risks to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

We measure risks to listed individuals using the individual's "fitness," or the individual's growth, survival, annual reproductive success, and lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable lethal, sub-lethal, or behavioral responses to an action's effect on the environment (which we identify during our response analyses) are likely to have consequences for the individual's fitness.

When individual, listed plants or animals are expected to experience reductions in fitness in response to an action, those fitness reductions are likely to reduce the abundance, reproduction, or growth rates (or increase the variance in these measures) of the populations those individuals represent (see Stearns, 1992). Reductions in at least one of these variables (or one of the variables we derive from them) is a *necessary* condition for reductions in a population's

viability, which is itself a *necessary* condition for reductions in a species' viability. As a result, when listed plants or animals exposed to an action's effects are *not* expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (e.g., Anderson, 2000; Brandon, 1978; Mills and Beatty, 1979; Stearns, 1992). As a result, if we conclude that listed plants or animals are *not* likely to experience reductions in their fitness, we would conclude our assessment.

Although reductions in fitness of individuals is a *necessary* condition for reductions in a population's viability, reducing the fitness of individuals in a population is not always *sufficient* to reduce the viability of the population(s) those individuals represent. Therefore, if we conclude that listed plants or animals are likely to experience reductions in their fitness, we determine whether those fitness reductions are likely to reduce the viability of the populations the individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, variance in these measures, or measures of extinction risk). In this step of our analyses, we use the population's base condition (established in the *Environmental baseline* and *Status of listed resources* sections of this Opinion) as our point of reference. If we conclude that reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent, we would conclude our assessment.

Reducing the viability of a population is not always *sufficient* to reduce the viability of the species those populations comprise. Therefore, in the final step of our analyses, we determine if reductions in a population's viability are likely to reduce the viability of the species those populations comprise using changes in a species' reproduction, numbers, distribution, estimates of extinction risk, or probability of being conserved. In this step of our analyses, we use the species' status (established in the *Status of listed resources* section of this Opinion) as our point of reference. Our final determinations are based on whether threatened or endangered species are likely to experience reductions in their viability and whether such reductions are likely to be appreciable.

To conduct these analyses, we rely on all of the evidence available to us. This evidence consists of monitoring reports submitted by past and present permit holders, reports from NMFS Science Centers; reports prepared by natural resource agencies in States and other countries, reports from non-governmental organizations involved in marine conservation issues, the information provided by the Permits Division when it initiates formal consultation, and the general scientific literature.

We supplement this evidence with reports and other documents – environmental assessments, environmental impact statements, and monitoring reports – prepared by other federal and state agencies like the Minerals Management Service, U.S. Coast Guard, and U.S. Navy whose operations extend into the marine environment.

During the consultation, we conducted electronic searches of the general scientific literature using search engines, including Agricola, Ingenta Connect, Aquatic Sciences and Fisheries Abstracts, JSTOR, Conference Papers Index, First Search (Article First, ECO, WorldCat), Web of Science, Oceanic Abstracts, Google Scholar, and Science Direct.

We supplement these searches with electronic searches of doctoral dissertations and master's theses. These searches specifically try to identify data or other information that supports a particular conclusion as well as data that do not support that conclusion. When data were

equivocal or when faced with substantial uncertainty, our decisions are designed to avoid the risks of incorrectly concluding that an action would not have an adverse effect on listed species when, in fact, such adverse effects are likely (i.e., Type II error).

In this particular assessment, we identified the stressors associated with the action and evaluated which had a significant possibility of occurring based upon previous research. Of the probable stressors, we identified the species that were expected to co-occur with the effects of the action.

Action area

The proposed research under file no. 16803 will take place in nearshore waters of San Diego Bay, California year round.

Status of listed resources

The NMFS has determined that the actions considered in this Opinion may affect species listed in Table 1, which are provided protection under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.).

Table 1. Listed species in the action area.

Common name	Scientific name	Status
Green sea turtle-Pacific coast of Mexico population	*Chelonia mydas*	Endangered
Loggerhead sea turtle-North Pacific DPS	*Caretta caretta*	Endangered
Olive ridley sea turtle-Pacific coast of Mexico population	*Lepidochelys olivacea*	Endangered

Critical habitat has not been established in the proposed action area. We conclude that critical habitat will not be impacted by the proposed actions.

The biology and ecology of species with anticipated exposure below informs the effects analysis for this Opinion. Summaries of the global status and trends of each species presented provide a foundation for the analysis of species as a whole.

Green sea turtle

Distribution. Green sea turtles have a circumglobal distribution, occurring throughout tropical, subtropical waters, and, to a lesser extent, temperate waters.

Population designation. Populations are distinguished generally by ocean basin and more specifically by nesting location (Table 2).

Based upon genetic differences, two or three distinct regional clades may exist in the Pacific: western Pacific and South Pacific islands, eastern Pacific, and central Pacific, including the rookery at French Frigate Shoals, Hawaii (Dutton and Balazs, In review; Dutton et al., 1996). In the eastern Pacific, green sea turtles forage from San Diego Bay, California to Mejillones, Chile. Individuals along the southern foraging area originate from Galapagos Islands nesting beaches, while those in the Gulf of California originate primarily from Michoacán. Green turtles foraging in San Diego Bay and along the Pacific coast of Baja California originate primarily from rookeries of the Islas Revillagigedos (Dutton, 2003a).

Table 2. Locations and most recent abundance estimates of threatened green sea turtles as annual nesting females (AF), annual nests (AN), annual egg production (EP), and annual egg harvest (EH).

Location	Most recent abundance	Reference
Western Atlantic Ocean		
Tortuguero, Costa Rica	17,402-37,290 AF	(Troëng and Rankin, 2005)
Aves Island, Venezuela	335-443 AF	(Vera, 2007)
Galibi Reserve, Suriname	1,803 AF	(Weijerman et al., 1998)
Isla Trindade, Brazil	1,500-2,000 AF	(Moreira and Bjorndal, 2006)
Central Atlantic Ocean		
Ascension Island, UK	3,500 AF	(Broderick et al., 2006)
Eastern Atlantic Ocean		
Poilao Island, Guinea-Bissau	7,000-29,000 AN	(Catry et al., 2009)
Bioko Island, Equatorial Guinea	1,255-1,681 AN	(Tomas et al., 1999)
Mediterranean Sea		
Turkey	214-231 AF	(Broderick et al., 2002)
Cyprus	121-127 AF	(Broderick et al., 2002)
Israel / Palestine	1-3 AF	(Kuller, 1999)
Syria	100 AN	(Rees et al., 2005)
Western Indian Ocean		
Eparces Islands	2,000-11,000 AF	(Le Gall et al., 1986)
Comoros Islands	5,000 AF	S. Ahamada, pers. comm. 2001
Seychelles Islands	3,535-4,755 AF	J. Mortimer, pers. comm. 2002
Kenya	200-300 AF	(Okemwa and Wamukota, 2006)
Northern Indian Ocean		

Ras al Hadd, Oman	44,000 AN	S. Al-Saady, pers. comm. 2007
Sharma, Yemen	15 AF	(Saad, 1999)
Karan Island, Saudi Arabia	408-559 AF	(Pilcher, 2000)
Jana and Juraid Islands, Saudi Arabia	643 AN	(Pilcher, 2000)
Hawkes Bay and Sandspit, Pakistan	600 AN	(Asrar, 1999)
Gujarat, India	461 AN	(Sunderraj et al., 2006)
Sri Lanka	184 AF	(Kapurisinghe, 2006)
Eastern Indian Ocean		
Thamihla Kyun, Myanmar	<250,000 EH	(Thorbjarnarson et al., 2000)
Pangumbahan, Indonesia	400,000 EH	(Schulz, 1987)
Suka Made, Indonesia	395 AN	C. Limpus, pers. comm. 2002
Western Australia	3,000-30,000 AN	R. Prince, pers. comm. 2001
Southeast Asia		
Gulf of Thailand	250 AN	Charuchinda pers. comm. 2001
Vietnam	239 AF	(Hamann et al., 2006)
Berau Islands, Indonesia	4,000-5,000 AF	(Schulz, 1984)
Turtle Islands, Philippines	1.4 million EP	(Cruz, 2002)
Sabah Turtle Islands, Malaysia	8,000 AN	(Chan, 2006)
Sipadan, Malaysia	800 AN	(Chan, 2006)
Sarawak, Malaysia	2,000 AN	(Liew, 2002)
Enu Island (Aru Islands)	540 AF	Dethmers, in preparation
Terengganu, Malaysia	2,200 AN	(Chan, 2006)
Western Pacific Ocean		
Heron Island and southern Great Barrier Reef areas, Australia	5,000-10,000 AF	(Maison et al., 2010)

Raine Island and northern Great Barrier Reef areas, Australia	10,000-25,000 AF	(Limpus et al., 2003) (Maison et al., 2010)
Coringa-Herald National Nature Reserve, Australia	1,445 AF	(Maison et al., 2010)
Guam	45 AF	(Cummings, 2002)
Phoenix Islands, Kiribati	100-300 AF	(Maison et al., 2010)
Ogasawara Islands, Japan	500 AF	(Chaloupka et al., 2007) (Maison et al., 2010)
Micronesia	500-1,000 AF	(Maison et al., 2010)
Marshall Islands	100-500 AF	(Maison et al., 2010)
New Caledonia	1,000-2,000 AF	
Central and Eastern Pacific Ocean		
French Frigate Shoals, Hawaii	400 AF	(Balazs and Chaloupka, 2006)
Michoacán, Mexico	1,395 AF	C. Delgado, pers. comm. 2006
Central American Coast	184-344 AN	(López and Arauz, 2003)
Galapagos Islands, Ecuador	1,650 AF	(Zárate et al., 2006)

Growth and reproduction. Most green sea turtles exhibit particularly slow growth rates, which have been attributed to their largely plant-eating diet (Bjorndal, 1982). Growth rates of juveniles vary substantially among populations, ranging from <1 cm/year (Green 1993) to >5 cm/year (McDonald Dutton and Dutton, 1998), likely due to differences in diet quality, duration of foraging season (Chaloupka et al., 2004), and density of turtles in foraging areas (Balazs and Chaloupka, 2004; Bjorndal et al., 2000; Seminoff et al., 2002b). If individuals do not feed sufficiently, growth is stunted and apparently does not compensate even when greater-than-needed resources are available (Roark et al., 2009). In general, there is a tendency for green sea turtles to exhibit monotonic growth (declining growth rate with size) in the Atlantic and non-monotonic growth (growth spurt in mid size classes) in the Pacific, although this is not always the case (Balazs and Chaloupka, 2004; Chaloupka and Musick, 1997; Seminoff et al., 2002b). It is estimated that green sea turtles reach a maximum size just under 100 cm in carapace length (Tanaka, 2009). A female-bias has been identified from studies of green sea turtles (Wibbels, 2003).

Consistent with slow growth, age-to-maturity for green sea turtles appears to be the longest of any sea turtle species and ranges from ~20-40 years or more (Balazs, 1982; Chaloupka et al., 2004; Chaloupka and Musick, 1997; Frazer and Ehrhart, 1985b; Hirth, 1997b; Limpus and Chaloupka, 1997; Seminoff et al., 2002b; Zug et al., 2002; Zug and Glor, 1998). Estimates of

reproductive longevity range from 17 to 23 years (Carr et al., 1978; Chaloupka et al., 2004; Fitzsimmons et al., 1995). Considering that mean duration between females returning to nest ranges from 2 to 5 years (Hirth, 1997b), these reproductive longevity estimates suggest that a female may nest 3 to 11 seasons over the course of her life. Each female deposits 1-7 clutches (usually 2-3) during the breeding season at 12-14 day intervals. Mean clutch size is highly variable among populations, but averages 110-115 eggs/nest. Females usually have 2-4 or more years between breeding seasons, whereas males may mate every year (Balazs, 1983). Based on reasonable means of three nests per season and 100 eggs per nest (Hirth, 1997b), a female may deposit 9 to 33 clutches, or about 900 to 3,300 eggs, during her lifetime. Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al., 2010).

Once hatched, sea turtles emerge and orient towards 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). Factors in the ocean environment have a major influence on reproduction (Chaloupka, 2001; Limpus and Nicholls, 1988; Solow et al., 2002). It is also apparent that during years of heavy nesting activity, density dependent factors (beach crowding and digging up of eggs by nesting females) may impact hatchling production (Tiwari et al., 2005, 2006). Precipitation, proximity to the high tide line, and nest depth can also significantly affect nesting success (Cheng et al., 2009). Precipitation can also be significant in sex determination, with greater nest moisture resulting in a higher proportion of males (Leblanc and Wibbels, 2009). Green sea turtles often return to the same foraging areas following nesting migrations (Broderick et al., 2006; Godley et al., 2002). Once there, they move within specific areas, or home ranges, where they routinely visit specific localities to forage and rest (Godley et al., 2003; Makowski et al., 2006; Seminoff and Jones, 2006; Seminoff et al., 2002a; Taquet et al., 2006). It is also apparent that some green sea turtles remain in pelagic habitats for extended periods, perhaps never recruiting to coastal foraging sites (Pelletier et al., 2003).

In general, survivorship tends to be lower for juveniles and subadults than for adults. Adult survivorship has been calculated to range from 0.82-0.97 versus 0.58-0.89 for juveniles (Chaloupka and Limpus, 2005; Seminoff et al., 2003; Troëng and Chaloupka, 2007), with lower values coinciding with areas of human impact on green sea turtles and their habitats (Bjorndal et al., 2003; Campbell and Lagueux, 2005).

Migration and movement. Green sea turtles are highly mobile and undertake complex movements through geographically disparate habitats during their lifetimes (Musick and Limpus, 1997; Plotkin, 2003). The periodic migration between nesting sites and foraging areas by adults is a prominent feature of their life history. After departing as hatchlings and residing in a variety of marine habitats for 40 or more years (Limpus and Chaloupka, 1997), green sea turtles make their way back to the same beach from which they hatched (Carr et al., 1978; Meylan et al., 1990). At approximately 20-25 cm carapace length, juveniles leave pelagic habitats and enter benthic foraging areas (Bjorndal, 1997). Green sea turtles spend the majority of their lives in coastal foraging grounds. These areas include both open coastline and protected bays and lagoons. While in these areas, green sea turtles rely on marine algae and seagrass as their primary dietary constituents, although some populations also forage heavily on invertebrates. There is some evidence that individuals move from shallow seagrass beds during the day to deeper areas at night (Hazel, 2009). However, avoidance of areas of greater than 10 m when

moderate depths of 5-10 m with sea grass beds has been found, with speed and displacement from capture locations being similar at night as during the daytime (Senko et al., 2010a).

Habitat. 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. Stinson (1984) found green turtles to appear most frequently in U.S. coastal waters with temperatures exceeding 18º C. Further, green sea turtles seem to occur preferentially in drift lines or surface current convergences, probably because of the prevalence of cover and higher prey densities that associate with flotsam. For example, in the western Atlantic Ocean, drift lines commonly containing floating *Sargassum* spp. are capable of providing juveniles with shelter (NMFS and USFWS, 1998b). Underwater resting sites include coral recesses, the underside of ledges, and sand bottom areas that are relatively free of strong currents and disturbance. Available information indicates that green turtle resting areas are near feeding areas (Bjorndal and Bolten, 2000). Strong site fidelity appears to be a characteristic of juveniles green sea turtles along the Pacific Baja coast (Senko et al., 2010b).

Green sea turtles in the Gulf of Mexico tend to remain along the coast (lagoons, channels, inlets, and bays), with nesting primarily occurring in Florida and Mexico and infrequent nesting in all other areas (Landry and Costa, 1999; Meylan et al., 1995a; NMFS and USFWS, 1991; USAF, 1996). Foraging areas seem to be based upon seagrass and macroalgae abundance, such as in the Laguna Madre of Texas. However, green sea turtles may also occur in offshore regions, particularly during migration and development.

Feeding. While offshore and sometimes in coastal habitats, green sea turtles are not obligate plant-eaters as widely believed, and instead consume invertebrates such as jellyfish, sponges, sea pens, and pelagic prey (Godley et al., 1998; Hatase et al., 2006; Heithaus et al., 2002; Parker and Balazs, in press; Seminoff et al., 2002a). A shift to a more herbivorous diet occurs when individuals move into neritic habitats, as vegetable mater replaces an omnivorous diet at around 59 cm in carapace length off Mauritania (Cardona et al., 2009). 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). Foraging within seagrass ecosystems by green sea turtles can be significant enough to alter habitat and ecological parameters, such as species composition (Lal et al., 2010).

Diving. Based on the behavior of post-hatchlings and juvenile green turtles raised in captivity, we presume that those in pelagic habitats live and feed at or near the ocean surface, and that their dives do not normally exceed several meters in depth (Hazel et al., 2009; NMFS and USFWS, 1998b). Recent data from Australia indicate green sea turtles rarely dive deep, staying in upper 8 m of the water column (Hazel et al., 2009). Here, daytime dives were shorter and shallower than were nighttime dives. Also, time spent resting and dive duration increased significantly with decreases in seasonal water temperatures. The maximum recorded dive depth for an adult green turtle was just over 106 m (Berkson, 1967), while subadults routinely dive to 20 m for 9-23 min, with a maximum recorded dive of over 1 h (Brill et al., 1995; I-Jiunn, 2009). Green sea turtles along Taiwan may rest during long, shallow dives (I-Jiunn, 2009). Dives by females may be shorter in the period leading up to nesting (I-Jiunn, 2009).

Vocalization and hearing. Although very limited information is available regarding green turtle hearing, it is one of the few sea turtle species that have been studied. Based upon auditory brainstem responses green sea turtles have been measured to hear in the 50-1600 Hz range (Dow

et al., 2008) and 100-800 Hz (Bartol and Ketten, 2006) , although cochlear potential suggest a range between 60 and 1000 Hz (Ridgway et al., 1969). Maximum sensitivity has been found to be 200-400 Hz for subadults and 600-700 for juveniles (Bartol and Ketten, 2006; Ketten and Bartol, 2006). This is supported by cochlear potential estimates of 300-500 Hz from Ridgway et al. (1969). However, Dow et al. (2008) found best sensitivity between 50 and 400 Hz. Outside of this limited range, green turtles are much less sensitive to sound (Ridgway et al., 1969). This is similar to estimates for loggerhead sea turtles, which have most sensitive hearing between 250-1,000 Hz, with rapid decline above 1,000 Hz (Moein Bartol et al., 1999).

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) has classified the green turtle as "endangered."

No trend data are available for almost half of the important nesting sites, where numbers are based on recent trends and do not span a full green sea turtle generation, and impacts occurring over four decades ago that caused a change in juvenile recruitment rates may have yet to be manifested as a change in nesting abundance. The numbers also only reflect one segment of the population (nesting females), who are the only segment of the population for which reasonably good data are available and are cautiously used as one measure of the possible trend of populations.

Table 12 summarizes nesting abundance for 46 nesting sites worldwide. These include both large and small rookeries believed to be representative of the overall trends for their respective regions. Based on the mean annual reproductive effort, 108,761-150,521 females nest each year among the 46 sites. Overall, of the 26 sites for which data enable an assessment of current trends, 12 nesting populations are increasing, 10 are stable, and four are decreasing. Long-term continuous datasets of 20 years are available for 11 sites, all of which are either increasing or stable. Despite the apparent global increase in numbers, the positive overall trend should be viewed cautiously because trend data are available for just over half of all sites examined and very few data sets span a full green sea turtle generation (Seminoff, 2004b).

Pacific Ocean. Green turtles are thought to be declining throughout the Pacific Ocean, with the exception of Hawaii, from a combination of overexploitation and habitat loss (Eckert, 1993; Seminoff et al., 2002a). In the western Pacific, the only major (>2,000 nesting females) populations of green turtles occur in Australia and Malaysia, with smaller colonies throughout the area. Indonesian nesting is widely distributed, but has experienced large declines over the past 50 years. Hawaii 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% annual growth rate over >25 years (Chaloupka et al., 2008a). In the Eastern Pacific, mitochondrial DNA analysis has indicated three key nesting populations: Michoacán, Mexico; Galapagos Islands, Ecuador; and Islas Revillagigedos, Mexico (Dutton, 2003b). The number of nesting females per year exceeds 1,000 females at each site (NMFS and USFWS, 2007a). However, historically, >20,000 females per year are believed to have nested in Michoacán alone (Clifton et al., 1982; NMFS and USFWS, 2007a). Thus, the current number of nesting females is still far below historical levels. Datasets

over 25 years in Chichi-jima, Japan; Heron Island, Australia; and Raine Island, Australia, show increases in abundance (Chaloupka et al., 2008a).

Atlantic Ocean. Primary sites for green sea turtle nesting in the Atlantic/Caribbean include: (1) Yucatán Peninsula, Mexico; (2) Tortuguero, Costa Rica; (3) Aves Island, Venezuela; (4) Galibi Reserve, Suriname; (5) Isla Trindade, Brazil; (6) Ascension Island, United Kingdom; (7) Bioko Island, Equatorial Guinea; and (8) Bijagos Archipelago, Guinea-Bissau (NMFS and USFWS, 2007a). Nesting at all of these sites was considered to be stable or increasing with the exception of Bioko Island and the Bijagos Archipelago where the lack of sufficient data precludes a meaningful trend assessment for either site (NMFS and USFWS, 2007a). Seminoff (2004a) reviewed green sea turtle nesting data for eight sites in the western, eastern, and central Atlantic. Seminoff (2004a) concluded that all sites in the central and western Atlantic showed increased nesting, with the exception of nesting at Aves Island, Venezuela, while both sites in the eastern Atlantic demonstrated decreased nesting. These sites are not inclusive of all green sea turtle nesting in the Atlantic. However, other sites are not believed to support nesting levels high enough that would change the overall status of the species in the Atlantic (NMFS and USFWS, 2007a).

By far, the most important nesting concentration for green sea turtles in the western Atlantic is in Tortuguero, Costa Rica (NMFS and USFWS, 2007a). Nesting in the area has increased considerably since the 1970s and nest count data from 1999-2003 suggest nesting by 17,402-37,290 females per year (NMFS and USFWS, 2007a). The number of females nesting per year on beaches in the Yucatán, at Aves Island, Galibi Reserve, and Isla Trindade number in the hundreds to low thousands, depending on the site (NMFS and USFWS, 2007a).

The vast majority of green sea turtle nesting within the southeastern U.S. occurs in Florida (Johnson and Ehrhart, 1994; Meylan et al., 1995b). Green sea turtle nesting in Florida has been increasing since 1989 (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute Index Nesting Beach Survey Database). Since establishment of index beaches in 1989, the pattern of green turtle nesting shows biennial peaks in abundance with a generally positive trend during the ten years of regular monitoring. This is perhaps due to increased protective legislation throughout the Caribbean (Meylan et al., 1995b). A total statewide average (all beaches, including index beaches) of 5,039 green turtle nests were laid annually in Florida between 2001 and 2006, with a low of 581 in 2001 and a high of 9,644 in 2005 (NMFS and USFWS, 2007a). Data from index nesting beaches substantiate the dramatic increase in nesting. In 2007, there were 9,455 green turtle nests found just on index nesting beaches, the highest since index beach monitoring began in 1989. The number fell back to 6,385 in 2008, further dropping under 3,000 in 2009, but that consecutive drop was a temporary deviation from the normal biennial nesting cycle for green turtles, as 2010 saw an increase back to 8,426 nests on the index nesting beaches (FWC Index Nesting Beach Survey Database). Occasional nesting has been documented along the Gulf coast of Florida (Meylan et al., 1995b). More recently, green turtle nesting occurred on Bald Head Island, North Carolina; just east of the mouth of the Cape Fear River; on Onslow Island; and on Cape Hatteras National Seashore. In 2010, a total of 18 nests were found in North Carolina, 6 nests in South Carolina, and 6 nests in Georgia (nesting databases maintained on www.seaturtle.org). Increased nesting has also been observed along the Atlantic coast of Florida, on beaches where only loggerhead nesting was observed in the past (Pritchard, 1997). Recent modeling by Chaloupka et al. (2008a)using data sets of 25 years or more has resulted in an estimate of the Florida nesting stock at the Archie Carr National Wildlife

Refuge growing at an annual rate of 13.9%, and the Tortuguero, Costa Rica, population growing at 4.9%.

There are no reliable estimates of the number of immature green sea turtles that inhabit coastal areas of the southeastern U.S. However, information on incidental captures of immature green sea turtles at the St. Lucie Power Plant in St. Lucie County, Florida, shows that the annual number of immature green sea turtles captured by their offshore cooling water intake structures has increased significantly. Green sea turtle annual captures averaged 19 for 1977-1986, 178 for 1987-1996, and 262 for 1997-2001 (Florida Power and Light Company St. Lucie Plant, 2002). In the five years from 2002-2006, green sea turtle captures averaged 333 per year, with a high of 427 and a low of 267. More recent unpublished data shows 101 captures in 2007, 299 in 2008, 38 in 2009 (power output was cut—and cooling water intake concomitantly reduced—for part of that year) and 413 in 2010. Ehrhart et al. (2007) documented a significant increase in in-water abundance of green turtles in the Indian River Lagoon area.

Indian Ocean. One of the largest nesting sites for green sea turtles worldwide occurs on the beaches of Oman where an estimated 20,000 green sea turtles nest annually (Hirth, 1997a). Only the Comoros Island index site in the western Indian Ocean showed evidence of increased nesting (Seminoff, 2004a).

Natural threats. Herons, gulls, dogfish, and sharks prey upon hatchlings. Adults face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures drop below a threshold level, which can be lethal. For unknown reasons, the frequency of a disease called fibropapillomatosis is much higher in green sea turtles than in other species and threatens a large number of existing subpopulations. Extremely high incidence has been reported in Hawaii, where affliction rates peaked at 47-69% in some foraging areas (Murakawa et al., 2000). A to-date unidentified virus may aid in the development of fibropapillomatosis (Work et al., 2009). Predators (primarily of eggs and hatchlings) also include dogs, pigs, rats, crabs, sea birds, reef fishes, and groupers (Bell et al., 1994; Witzell, 1981). Green sea turtles with an abundance of barnacles have been found to have a much greater probability of having health issues (Flint et al., 2009).

Anthropogenic threats. Major anthropogenic impacts to the nesting and marine environment affect green sea turtle survival and recovery. At nesting beaches, green sea turtles rely on intact dune structures, native vegetation, and normal beach temperatures for nesting (Ackerman, 1997). Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al., 1998; Lutcavage et al., 1997b). These factors may directly, through loss of beach habitat, or indirectly, through changing thermal profiles and increasing erosion, serve to decrease the amount of nesting area available to nesting females, and may evoke a change in the natural behaviors of adults and hatchlings (Ackerman, 1997; Witherington et al., 2003, 2007). On the Pacific coast of Mexico in the mid-1970s, >70,000 green turtle eggs were harvested every night. 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). In addition to impacting the terrestrial zone, anthropogenic disturbances also threaten coastal marine habitats, particularly areas rich in seagrass and marine algae. These impacts include contamination from herbicides, pesticides, oil spills, and other chemicals, as well as structural degradation from excessive boat anchoring and dredging (Francour et al., 1999; Lee Long et al., 2000; Waycott et al., 2005). Ingestion of plastic

and other marine debris is another source of morbidity and mortality (Stamper et al., 2009). Green sea turtles stranded in Brazil were all found to have ingested plastics or fishing debris (n=34), although mortality appears to have results in three cases (Tourinho et al., 2009). Low-level bycatch has also been documented in longline fisheries (Petersen et al., 2009). Further, the introduction of alien algae species threatens the stability of some coastal ecosystems and may lead to the elimination of preferred dietary species of green sea turtles (De Weede, 1996). Very few green sea turtles are bycaught in U.S. fisheries (Finkbeiner et al., 2011). However, a legal fishery operates in Madagascar that harvested about 10,000 green turtles annually in the mid-1990s.

Sea level rise may have significant impacts upon green turtle nesting on Pacific atolls. These low-lying, isolated locations could be inundated by rising water levels associated with global warming, eliminating nesting habitat (Baker et al., 2006; Fuentes et al., 2010). Fuentes et al. (2010) predicted that rising temperatures would be a much greater threat in the long term to the hatching success of sea turtle turtles in general and green sea turtles along northeastern Australia particularly. Green sea turtles emerging from nests at cooler temperatures likely absorb more yolk that is converted to body tissue than do hatchlings from warmer nests (Ischer et al., 2009). Predicted temperature rises may approach or exceed the upper thermal tolerance limit of sea turtle incubation, causing widespread failure of nests (Fuentes et al., 2010). Although the timing of loggerhead nesting depends upon sea-surface temperature, green sea turtles do not appear to be affected (Pike, 2009).

Green sea turtles have been found to contain the organochlorines chlordane, lindane, endrin, endosulfan, dieldrin, DDT and PCB (Gardner et al., 2003; Miao et al., 2001). Levels of PCBs found in eggs are considered far higher than what is fit for human consumption (van de Merwe et al., 2009). The heavy metals copper, lead, manganese, cadmium, and nickel have also been found in various tissues and life stages (Barbieri, 2009). Arsenic also occurs in very high levels in green sea turtle eggs (van de Merwe et al., 2009). These contaminants have the potential to cause deficiencies in endocrine, developmental, and reproductive health, and depress immune function in loggerhead sea turtles (Keller et al. 2006; Storelli et al. 2007). Exposure to sewage effluent may also result in green sea turtle eggs harboring antibiotic-resistant strains of bacteria (Al-Bahry et al., 2009). DDE has not been found to influence sex determination at levels below cytotoxicity (Keller and McClellan-Green, 2004; Podreka et al., 1998). To date, no tie has been found between pesticide concentration and susceptibility to fibropapillomatosis, although degraded habitat and pollution have been tied to the incidence of the disease (Aguirre et al., 1994; Foley et al., 2005). Flame retardants have been measured from healthy individuals (Hermanussen et al., 2008). It has been theorized that exposure to tumor-promoting compounds produced by the cyanobacteria *Lyngbya majuscule* could promote the development of fibropapillomatosis (Arthur et al., 2008). It has also been theorized that dinoflagellates of the genus *Prorocentrum* that produce the tumorogenic compound okadoic acid may influence the development of fibropapillomatosis (Landsberg et al., 1999).

Critical habitat. On September 2, 1998, critical habitat for green sea turtles was designated in coastal waters surrounding Culebra Island, Puerto Rico (63 FR 46693). Aspects of these areas that are important for green sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for green sea turtle prey.

Loggerhead Sea Turtle-North Pacific DPS

Distribution. Loggerheads are circumglobal occurring throughout the temperate and tropical regions.

Population designations. As with other sea turtles, populations are frequently divided by nesting aggregation (Hutchinson and Dutton, 2007). On September 22, 2011, the NMFS designated nine distinct population segments (DPSs) of loggerhead sea turtles: South Atlantic Ocean and southwest Indian Ocean as threatened as well as Mediterranean Sea, North Indian Ocean, North Pacific Ocean, northeast Atlantic Ocean, northwest Atlantic Ocean, South Pacific Ocean, and southeast Indo-Pacific Ocean as endangered (75 FR 12598). We expect only the North Pacific DPS would be exposed during the proposed activities.

Pacific Ocean. Pacific Ocean rookeries are limited to the western portion of the basin. These sites include 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 (NMFS, 2006e). Genetics of Japanese nesters suggest that this subpopulation is comprised of genetically distinct nesting colonies (Hatase et al., 2002a). Almost all loggerheads in the North Pacific seem to stem from Japanese nesting beaches (Bowen et al. 1995; Resendiz et al. 1998). The fidelity of nesting females to their nesting beach allowed differentiation of these subpopulations and the loss of nesting at a beach means a significant loss of diversity and the beach is unlikely to be recolonized (NMFS, 2006e).

Reproduction and growth. Loggerhead nesting is confined to lower latitudes temperate and subtropic zones but absent from tropical areas (NMFS and USFWS, 1991b; NRC, 1990; Witherington et al., 2006b). The life cycle of loggerhead sea turtles can be divided into seven stages: eggs and hatchlings, small juveniles, large juveniles, subadults, novice breeders, first year emigrants, and mature breeders (Crouse et al., 1987). Hatchling loggerheads migrate to the ocean (to which they are drawn by near ultraviolet light Kawamura et al., 2009), where they are generally believed to lead a pelagic existence for as long as 7-12 years (NMFS, 2005). Loggerheads in the Mediterranean, similar to those in the Atlantic, grow at roughly 11.8 cm/yr for the first six months and slow to roughly 3.6 cm/yr at age 2.5-3.5. As adults, individuals may experience a secondary growth pulse associated with shifting into neritic habitats, although growth is generally monotypic (declines with age Casale et al., 2009a; Casale et al., 2009b). Individually-based variables likely have a high impact on individual-to-individual growth rates (Casale et al., 2009b). At 15-38 years, loggerhead sea turtles become sexually mature, although the age at which they reach maturity varies widely among populations (Casale et al., 2009b; Frazer and Ehrhart, 1985a; Frazer et al., 1994; NMFS, 2001; Witherington et al., 2006). However, based on new data from tag returns, strandings, and nesting surveys, NMFS (2001) estimated ages of maturity ranging from 20-38 years and benthic immature stage lasting from 14-32 years.

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, 1998d). Females usually breed every 2-3 years, but can vary from 1-7 years (Dodd, 1988; Richardson et al., 1978). Females lay an average of 4.1 nests per season (Murphy and Hopkins, 1984) , although recent satellite telemetry from nesting females along southwest

Florida support 5.4 nests per female per season, with increasing numbers of eggs per nest during the course of the season (Tucker, 2009). The authors suggest that this finding warrants revision of the number of females nesting in the region. The western Atlantic breeding season is March-August. Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al., 2010).

The Japanese rookeries are the most significant nesting sites for loggerheads in the North Pacific, with nesting occurring on the Japanese mainland, except for Hokkaido, as well as the Ryukyu Islands to the south (Kamezaki, 1989; Kamezaki et al., 2003; Sea Turtle Association of Japan, 2010; Uchida and Nishiwaki, 1995). Nesting generally occurs through summer and fall (April-August, peaking in July), with females returning every two to three years (Iwamoto et al., 1985). Nesting females lay at least three nests of 60-115 eggs per nest each season, with roughly two weeks between nests (Eckert, 1993; Iwamoto et al., 1985; Nishimura, 1994). Between nests, females appear to swim offshore into the Kuroshio Current, possibly to speed egg development (NMFS and USFWS, 1998f; Sato et al., 1998).

Migration and movement. Loggerhead hatchlings migrate offshore and become associated with *Sargassum* spp. habitats, driftlines, and other convergence zones (Carr, 1986). After 14-32 years of age, they shift to a benthic habitat, where immature individuals forage in the open ocean and coastal areas along continental shelves, bays, lagoons, and estuaries (Bowen et al., 2004; NMFS, 2001). Adult loggerheads make lengthy migrations from nesting beaches to foraging grounds (TEWG, 1998).

Individuals in the western Pacific also show wide-ranging movements. 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; Nichols, 2005; Polovina et al., 2006; Polovina et al., 2000; Resendiz et al., 1998). Adult loggerheads also reside in oceanic waters off Japan (Hatase et al., 2002b). Habitat use off Japan may further be partitioned by sex and size (Hatase et al., 2002b; Hatase and Sakamoto, 2004; Hatase et al., 2002c). Loggerheads returning to Japanese waters seem to migrate along nutrient-rich oceanic fronts (Kobayashi et al., 2008; Nichols et al., 2000; Polovina et al., 2000). Individuals bycaught and satellite tracked in Hawaii longline fisheries show 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 (Kobayashi et al., 2008; Nichols et al., 2000; Polovina et al., 2004). The Transition Zone Chlorophyll Front and Kuroshio Extension Current are likely important foraging areas for juvenile loggerheads (Polovina et al., 2004). 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., 2002c).

Gender, age, and survivorship. Although information on males is limited, several studies identified a female bias, although a single study has found a strong male bias to be possible (Dodd, 1988; NMFS, 2001; Rees and Margaritoulis, 2004).

Additionally, little is known about longevity, although Dodd (1988) estimated the maximum female life span at 47-62 years. Heppell et al. (2003) estimated annual survivorship to be 0.81 (southeast U.S. adult females), 0.78-0.91 (Australia adult females), 0.68-0.89 (southeast U.S.

benthic juveniles, and 0.92 (Australia benthic juveniles). Survival rates for hatchlings during their first year are likely very low (Heppell et al., 2003).

Feeding. Loggerhead sea turtles are omnivorous and opportunistic feeders through their lifetimes (Parker et al., 2005). Hatchling loggerheads feed on macroplankton associated with *Sargassum* spp. communities (NMFS and USFWS, 1991b). Pelagic and benthic juveniles forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd, 1988; Wallace et al., 2009). 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., 2002b). Sub-adult and adult loggerheads prey on benthic invertebrates such as gastropods, mollusks, and decapod crustaceans in hard-bottom habitats, although fish and plants are also occasionally eaten (NMFS and USFWS, 1998d). Stable isotope analysis and study of organisms on turtle shells has recently shown that although a loggerhead population may feed on a variety of prey, individuals composing the population have specialized diets (Reich et al., 2010; Vander Zanden et al., 2010).

Diving. Loggerhead diving behavior varies based upon habitat, with longer surface stays in deeper habitats than in coastal ones. Off Japan, dives were shallower than 30 m (Sakamoto et al., 1993). Routine dives can last 4–172 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). Loggerheads tagged in the Pacific over the course of 5 months showed that about 70% of dives are very shallow (<5 m) and 40% of their time was spent within 1 m of the surface (Polovina et al., 2003; Spotila, 2004b). During these dives, there were also several strong surface temperature fronts that individuals were associated with, one of 20° C at 28° N latitude and another of 17° C at 32° N latitude.

Vocalization and hearing. Information on the hearing capabilities of sea turtles is limited, but available information suggests auditory capabilities are centered in the low-frequency range (< 1 kHz), with hearing thresholds at about 132-140 dB (Lenhardt, 1994; Lenhardt et al., 1983; Moein Bartol and Ketten, 2006; Moein Bartol et al., 1999; O'Hara and Wilcox, 1990; Ridgway et al., 1969). There is some sensitivity to frequencies as low as 60 Hz, and probably as low as 30 Hz (L-DEO, 2006).

Status and trends. Loggerhead sea turtles were listed as threatened under the ESA of 1973 on July 28, 1978 (43 FR 32800). There is general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are doubts about the ability to estimate the overall population size (Bjorndal et al., 2005). An important caveat for population trends analysis based on nesting beach data is that this may reflect trends in adult nesting females, but it may not reflect overall population growth rates well. Adult nesting females often account for less than 1% of total population numbers. The global abundance of nesting female loggerhead turtles is estimated at 43,320–44,560 (Spotila, 2004a).

Pacific Ocean. Abundance has declined dramatically over the past 10-20 years, although loggerheads range widely from Alaska to Chile (NMFS and USFWS, 1998d). Pacific nesting is limited to two major locations, Australia and Japan, although low level nesting may occur outside of Japan in areas surrounding the South China Sea (Chan et al., 2007; Kamezaki et al., 2003). Eastern Australia supported one of the major global loggerhead nesting assemblages until recently (Limpus, 1985). Now, less than 500 females nest annually, an 86% 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; a 50-90% decline compared to historical estimates (Bolten et al., 1996; Dodd Jr., 1988; Kamezaki et al., 2003; STAJ, 2002). Nine major nesting beaches (greater than 100 nests per season) and six "submajor" beaches (10–100 nests per season) exists, including Yakushima island where 40% of nesting occurs (Kamezaki et al. 2003). Nesting declined from an initial peak of approximately 6,638 nests in 1990–1991, followed by a steep decline to a low of 2,064 nests in 1997 (Conant et al., 2009). During the past decade, nesting increased gradually to 5,167 nests in 2005 (Conant et al., 2009), declined and then rose again to a record high of 11,082 nests in 2008, and then 7,495 and 10,121 nests in 2009 and 2010, respectively (STAJ 2008, 2009, 2010).

In addition, loggerheads uncommonly occur in U.S. Pacific waters, and there have been no documented strandings of loggerheads on the Hawaiian Islands in nearly 20 years (1982-1999 stranding data). There are very few records of loggerheads nesting on any of the many islands of the central Pacific, and the species is considered rare or vagrant in this region (USFWS, 1998). Overall, Gilman (2009) estimated that the number of loggerheads nesting the Pacific has declined by 80% in the past 20 years.

Natural threats. Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures drop below a threshold level, which can pose lethal effects. Eggs are commonly eaten by raccoons and ghost crabs along the eastern U.S. (Barton and Roth, 2008). In the water, hatchlings are hunted by herons, gulls, dogfish, and sharks. Heavy loads of barnacles are associated with unhealthy or dead stranded loggerheads (Deem et al., 2009).

Anthropogenic threats. Anthropogenic threats impacting loggerhead nesting habitat are numerous: 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 (Baldwin, 1992; Margaritoulis et al., 2003; Mazaris et al., 2009b; USFWS, 1998). Surprisingly, beach nourishment also hampers nesting success, but only in the first year post-nourishment before hatching success increases (Brock et al., 2009). Loggerhead sea turtles face numerous threats in the marine environment as well, including oil and gas exploration, marine pollution, trawl, purse seine, hook and line, gill net, pound net, longline, and trap fisheries, underwater explosions, dredging, offshore artificial lighting, power plant entrapment, entanglement in debris, ingestion of marine debris, marina and dock construction and operation, boat collisions, and poaching. At least in the Mediterranean Sea, anthropogenic threats appear to disproportionally impact larger (more fecund) loggerheads (Bellido et al., 2010).

The major factors inhibiting their recovery include mortalities caused by fishery interactions and degradation of the beaches on which they nest. Shrimp trawl fisheries account for the highest number of captured and killed loggerhead sea turtles. Each year, various fisheries capture 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; Bolten et al., 1994; Carruthers et al., 2009; Howell et al., 2008; Marshall et al., 2009; Petersen et al., 2009; Tomás et al., 2008). Deliberate hunting of loggerheads for their meat, shells, and eggs has declined from previous exploitation levels, but still exists and hampers recovery efforts (Lino et al., 2010). In the

Pacific, loggerhead turtles are captured, injured, or killed in numerous Pacific fisheries including

- Japanese longline fisheries in the western Pacific Ocean and South China Seas
- direct harvest and commercial fisheries off Baja California, Mexico
- commercial and artisanal swordfish fisheries off Chile, Columbia, Ecuador, and Peru
- purse seine fisheries for tuna in the eastern tropical Pacific Ocean
- California/Oregon drift gillnet fisheries (NMFS, 2006e)

Wallace et al. (2010) estimated that between 1990 and 2008, at least 85,000 sea turtles were captured as bycatch in fisheries worldwide. This estimate is likely at least two orders of magnitude low, resulting in a likely bycatch of nearly half a million sea turtles annually (Wallace et al., 2010); many of these are expected to be loggerhead sea turtles.

Marine debris ingestion can be a widespread issue for loggerhead sea turtles. More than one-third of loggerheads found stranded or bycaught had injected marine debris in a Mediterranean study, with possible mortality resulting in some cases (Lazar and Gračan, 2010).

In the Pacific Ocean, between 2,600 and 6,000 loggerhead sea turtles are estimated to have been captured and killed in longline fisheries in 2000 (Lewison et al., 2004). Shallow-set Hawaii based longline fisheries likely captured and killed several hundred loggerhead sea turtles before their closure in 2001. Upon re-opened in 2004, with substantial modifications to protect sea turtles, these fisheries fewer than five loggerhead sea turtles likely experienced fisheries interaction each year. Between 2004 and 2008, shallow-set fisheries based out of Hawaii likely captured about 45 loggerhead sea turtles, killing about 10. Loggerhead sea turtles have also been and are expected to continue to be captured and killed in the deep-set based longline fisheries based out of Hawaii and American Samoa. Although the number of longline tuna vessels (a major component of fisheries in the region) has decreased by over half from 1970 to 2006 and a gill net moratorium is in place for the region, gill nets and longlines are a particular problem in the region, for particularly loggerhead sea turtles (Bowen et al., 1995; Kaplan, 2005; Lawson, 2008; Lewison et al., 2004; Polovina et al., 2000; Yokota et al., 2006). An estimated 30,000-75,000 loggerheads were captured as longline bycatch in the Pacific during 2000 (Lewison et al., 2004). Prior to the gill net moratorium, 16,000 sea turtles were bycaught in the western Pacific and 4,000 loggerheads in the North Pacific (Bowen et al., 1995).

Climate change may also have significant implications on loggerhead populations worldwide. In addition to potential loss of nesting habitat due to sea level rise, loggerhead sea turtles are very sensitive to temperature as a determinant of sex while incubating. 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, this can reduce genetic diversity, or even population viability, 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., 2009a; Schofield et al., 2009). Increasing ocean temperatures may also lead to reduced primary productivity and eventual food availability. This has been proposed as partial support for reduced nesting abundance for loggerhead sea turtles in Japan; a finding that could have broader implications for other populations in the future if individuals do not shift feeding habitat (Chaloupka et al., 2008b). Warmer temperatures may also decrease the energy needs of a developing embryo (Reid et al.,

2009).

Tissues taken from loggerheads sometimes contain very high levels of organochlorines chlorobiphenyl, chlordanes, lindane, endrin, endosulfan, dieldrin, PFOS, PFOA, DDT, and PCB (Alava et al., 2006; Corsolini et al., 2000; Gardner et al., 2003; Keller et al., 2005; Keller et al., 2004a; Keller et al., 2004b; McKenzie et al., 1999; Monagas et al., 2008; Oros et al., 2009; Perugini et al., 2006; Rybitski et al., 1995; Storelli et al., 2007). It appears that levels of organochlorines have the potential to suppress the immune system of loggerhead sea turtles and may affect metabolic regulation (Keller et al., 2004c; Keller et al., 2006; Oros et al., 2009). These contaminants could cause deficiencies in endocrine, developmental, and reproductive health (Storelli et al., 2007). It is likely that the omnivorous nature of loggerheads makes them more prone to bioaccumulating toxins than other sea turtle species (Godley et al., 1999; McKenzie et al., 1999).

Heavy metals, including arsenic, barium, cadmium, chromium, iron, lead, nickel, selenium, silver, copper, zinc, and manganese, have also been found in a variety of tissues in levels that increase with turtle size (Anan et al., 2001; Fujihara et al., 2003; Garcia-Fernandez et al., 2009; Gardner et al., 2006; Godley et al., 1999; Saeki et al., 2000; Storelli et al., 2008). These metals likely originate from plants and seem to have high transfer coefficients (Anan et al., 2001; Celik et al., 2006; Talavera-Saenz et al., 2007).

Loggerhead sea turtles have higher mercury levels than any other sea turtle studied, but concentrations are an order of magnitude less than many toothed whales (Godley et al., 1999; Pugh and Becker, 2001). Arsenic occurs at levels several fold more concentrated in loggerhead sea turtles than marine mammals or seabirds.

Also of concern is the spread of antimicrobial agents from human society into the marine environment. Loggerhead sea turtles may harbor antibiotic-resistant bacteria, which may have developed and thrived as a result of high use and discharge of antimicrobial agents into freshwater and marine ecosystems (Foti et al., 2009).

Critical habitat. The NMFS has not designated critical habitat for loggerhead sea turtles.

Olive ridley sea turtle

Distribution. Olive ridleys are globally distributed in tropical regions (>20º C) of the Pacific (southern California to Peru, and rarely in the Gulf of Alaska Hodge and Wing, 2000), Indian (eastern Africa and the Bay of Bengal), and Atlantic oceans (Grand Banks to Uruguay and Mauritania to South Africa Foley et al., 2003; Fretey, 1999; Fretey et al., 2005; Stokes and Epperly, 2006). Olive ridleys are uncommon in the western Pacific and western Indian Oceans, and most of the North Atlantic (Spotila, 2004a).

Population designations. Population designations are poorly known. Populations likely correspond somewhat to nesting beach location (Tables 3 and 4). Most olive ridleys nest synchronously in huge events called “arribadas”, with hundreds to thousands of females nesting over the course of three to seven days; other individuals nest alone, out of sequence with the arribada (Aprill, 1994b; Kalb and Owens, 1994).

Table 3. Recent estimates of olive ridley arribada size.

Country	Beach	Estimates of arribada size from one-time, most recent counts	References
Western Atlantic Ocean			
Suriname	Galibi Nature Reserve*	335 nests	(Hoekert et al., 1996)
French Guiana		1,716-3,257 females	(Kelle et al., 2009)
Eastern Pacific Ocean			
Nicaragua	Chacocente	42,541 nests	(López Carcache et al., in press)
Nicaragua	La Flor	1,300-9,000 turtles per arribada	(Ruiz, 1994)
Nicaragua	Masachapa	No estimate available	(Cornelius, 1982; Margaritoulis and Demetropoulos, 2003)
Nicaragua	Pochomil	No estimate available	(Cornelius, 1982; Margaritoulis and Demetropoulos, 2003)
Nicaragua	Boquita	No estimate available	(Cornelius, 1982)***
Costa Rica	Nancite	200-20,000 turtles per arribada	(Fonseca et al., 2009)
Costa Rica	Ostional	Average 50,000-200,000 turtles per arribada	(Chaves et al., 2005)
Panama	Isla Cañas	5,000-12,000 turtles per arribada	(Evans and Vargas, 1998)
Northern Indian Ocean			
India	Gahirmatha	1,000-100,000+ turtles per arribada	(Shanker et al., 2003)
India	Devi River	No estimate available	(Shanker et al., 2003)
India	Rushikulya	10,000-200,000 turtles per arribada	(Shanker et al., 2003)

* Large arribadas once occurred at these beaches but no longer do (Cliffton et al., 1982; Hoekert et al., 1996).

** These data represent total nests for season.

*** Masachapa, Pochomil, and Boquita were extant at the time of the Cornelius (1982) article. The status for Boquita is unknown.

Table 4. Locations of olive ridley arribada and solitary nesting beaches in the eastern Pacific and estimates of arribada sizes.

Country	Beach	Estimates of arribada size from one-time, most recent counts	References
Arribada			
Mexico	Mismaloya*	1,000-5,000 nests	(R. Briseño and A. Abreu, pers. comm. in NMFS and USFWS, 2007b)
Mexico	Tlacoyunque*	500-1,000 nests	(R. Briseño and A. Abreu, pers. comm. in NMFS and USFWS, 2007b)
Mexico	Chacahua*	10,000-100,000 nests	(R. Briseño and A. Abreu, pers. comm. in NMFS and USFWS, 2007b)
Mexico	La Escobilla	1,000,000+ nests	(Márquez et al., 2005)
Mexico	Moro Ayuta*	10,000-100,000 nests	(R. Briseño and A. Abreu, pers. comm. in NMFS and USFWS, 2007b)
Solitary			
Mexico	Entire Pacific coast		(R. Briseño and A. Abreu, pers. comm. in NMFS and USFWS, 2007b)

* Large arribadas once occurred at these beaches but no longer do (Cliffton et al., 1982; Hoekert et al., 1996).

Atlantic Ocean. Olive ridley distribution in the western North Atlantic occurs mostly along the northern coast of South America and adjacent waters. In the Caribbean, non-nesting individuals occur regularly near Isla Margarita, Trinidad, and Curacao, but are rare further west, such as in Puerto Rico, the Dominican Republic, and Cuba. In rare cases, olive ridleys are known to occur as far north as Puerto Rico, the Dominican Republic, and Cuba and as far south as Brazil (Moncada-G. 2000 as cited in NMFS, 2004a). Regular nesting occurs only in Guyana, Suriname, and French Guiana, with most foraging grounds likely nearby (Reichart 1989 as cited in LGL Ltd., 2007). Nesting occurs along the north coast of Venezuela (Sternberg, 1981). Olive ridleys likely occur in low numbers along western Africa.

Pacific Ocean. Typical distribution is from Peru to California, with rare Alaskan sightings. Peak arribada nesting in the eastern Pacific occurs at several beaches in Mexico, Nicaragua, Costa Rica, and Panama (NMFS and USFWS, 2007f). In Peru, they can be found along the entire coast but are most common in the north, although they are rare in the Galápagos (Kelez et al., 2009; Zárate et al., 2010). Olive ridley sea turtles were the most commonly sighted sea turtle during regional seismic surveys funded by the NSF (Hauser et al., 2008; Holst and Smultea, 2008; Holst et al., 2005; Smultea and Holst, 2003). Tagged Costa Rican nesters have been recovered as far south as Peru, as far north as Oaxaca, Mexico, and offshore to a distance of 2,000 km. Olive ridleys are the most common sea turtle in oceanic waters of the eastern tropical

Pacific but move into nearshore waters prior to breeding (Pitman, 1990). This species frequently basks at the surface, is accompanied by seabirds, and associates with floating debris, from logs to plastic debris to dead whales (Arenas and Hall, 1991a; Pitman 1992 as cited in NMFS, 2004a).

Eastern Pacific nests are most concentrated in southern Mexico and northern Costa Rica, with secondary nesting as far north as southern Baja California (Fritts et al., 1982) and as far south as Peru (Brown and Brown, 1982; Kelez et al., 2009). Nesting occurs year-round, but tends to peak from September through December (NMFS and USFWS, 1998e). Most females lay two clutches of 100-107 eggs with an inter-nesting period of 1–2 months and incubation lasting 50-60 days (Eckert, 1993; NMFS and USFWS, 1998e; Plotkin et al., 1994a). Internesting females tend to stay within 5 km of shore (Kalb and Owens, 1994).

Southern Hemisphere. Distribution is poorly known, but nesting colonies occur in the Philippines, Papua New Guinea, and northern Australia (Euroturtle, 2009; Spring, 1982). Solitary nesting beaches occur in Australia, Brunei, Malaysia, Indonesia, and Vietnam (Spotila, 2004b). Olive ridleys have been sighted in Fiji, Vanuatu, French Polynesia, the Solomon and Marshall islands, and Palau (SPREP, 2007). The occurrence of olive ridleys in Tonga and Kiribati is suspected but unconfirmed (SPREP, 2007).

Reproduction and growth. Little is known about olive ridley growth or reproduction. However, some beaches, such as Ostional Beach on the Pacific coast of Costa Rica, is known to have extremely low hatching success, particularly at the onset of the dry season onward, at least partly due to the high temperatures of nests (Valverde et al. 2010).

Migration and movement. 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 (Arenas and Hall, 1991b; Beavers and Cassano, 1996; Cornelius and Robinson, 1986; Pitman, 1991, 1993; Plotkin, 1994; Plotkin et al., 1994a; Plotkin et al., 1995). Reproductively active males and females migrate toward the coast and aggregate at nearshore breeding grounds near nesting beaches (Cornelius, 1986; Hughes and Richard, 1974; Kalb et al., 1995; Plotkin et al., 1991; Plotkin et al., 1996; Plotkin et al., 1997; Pritchard, 1969). Other males and females may not migrate to nearshore breeding aggregations at all (Kopitsky et al., 2000; Pitman, 1991). Some males appear to remain in oceanic waters, are non-aggregated, and mate opportunistically as they intercept females *en route* to near shore breeding grounds and nesting beaches (Kopitsky et al., 2000; Plotkin, 1994; Plotkin et al., 1994b; Plotkin et al., 1996). Their migratory pathways vary annually (Plotkin, 1994), there is no spatial and temporal overlap in migratory pathways among groups or cohorts of turtles (Plotkin et al., 1994a; Plotkin et al., 1995), and no apparent migration corridors exist. Olive ridleys may use water temperature more than any other environmental cue during migrations (Spotila, 2004a). Post-nesting migration routes from Costa Rica traverse more than 3,000 km out into the central Pacific (Plotkin et al., 1993; Plotkin et al., 1994a). Olive ridleys from different populations may occupy different oceanic habitats (Polovina et al., 2004; Polovina et al., 2003). Unlike other marine turtles that migrate from a breeding ground to a single feeding area, where they reside until the next breeding season, olive ridleys are nomadic migrants that swim hundreds to thousands of kilometers over vast oceanic areas (Plotkin, 1994; Plotkin et al., 1994a; Plotkin et al., 1995). Olive ridleys may associate with flotsam, which could provide food, shelter, and/or orientation cues (Arenas and Hall, 1991b). In the oceanic eastern tropical Pacific, olive ridley sea turtles are far more common than any other cheloniid (Pitman, 1990).

Feeding. 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, and algae (Márquez, 1990; Deraniyagala 1939, Carr 1961, Caldwell 1969, Fritts 1981, Cornelius and Robinson 1986, Mortimer 1982 - as cited in NMFS, 2004a).

Diving. Diving behavior remains somewhat of a mystery, but several studies have highlighted general insights. The average dive length for an adult female and male were reported to be 54.3 and 28.5 min, respectively (Plotkin 1994 in Lutcavage and Lutz 1997, as cited in NMFS and USFWS, 2007f). McMahon et al. (2007) reported a maximum dive duration of 200 min (± 20 min) in northern Australia. In the eastern tropical Pacific, diving rate is greater during daytime than at night (Beavers and Cassano, 1996; Parker et al., 2003). During nighttime however, dives are longer (up to 95 min). In the eastern tropical Pacific, at least 25% of olive ridley total dive time is spent in the permanent thermocline, located at 20–100 m (Parker et al., 2003).

Olive ridleys can dive and feed at considerable depths (80–300 m), although ~90% of their time is spent at depths <100 m (Polovina et al., 2003). At least 25% of their total dive time is spent in the permanent thermocline, located at 20–100 m (Parker et al., 2003). In the North Pacific Ocean, two olive ridleys tagged with satellite-linked depth recorders spent about 20% of their time in the top meter and about 10% of their time deeper than 100 m; 70% of the dives were no deeper than 5 m (Polovina et al., 2003).

Vocalization and hearing. Information on the hearing capabilities of sea turtles is limited, but available information supports low-frequency hearing centered below 1 kHz and a hearing threshold at 132-140 dB (Lenhardt, 1994; Lenhardt et al., 1983; Moein Bartol and Ketten, 2006; Moein Bartol et al., 1999; O'Hara and Wilcox, 1990; Ridgway et al., 1969).

Status and trends. Except for the Mexico breeding stock, olive ridley sea turtles were listed as threatened under the ESA on July 28, 1978 (43 FR 32800). The olive ridley is the most abundant sea turtle in the world (Pritchard, 1997). Worldwide, abundance of nesting female olive ridleys was estimated at two million (Spotila, 2004a). Eguchi et al. (2007) counted olive ridleys at sea, leading to an estimate of 1,150,000 – 1,620,000 turtles in the eastern tropical Pacific in 1998-2006

Atlantic Ocean. Nesting centers, such as around Surinam, have declined more than 80% since 1967. However, nesting along Brazil, Nicaragua, and Costa Rica appear to be increasing, although long-term data are lacking (NMFS and USFWS, 2007e).

Pacific Ocean. The eastern Pacific population is believed to number roughly 1.39 million (Eguchi et al., in preperation). Abundance estimates in recent years indicate that the Mismaloya and Moro Ayuta nesting populations appear to be stable and the nesting population at La Escobilla is increasing, although less than historical levels, which was roughly 10 million adults prior to 1950 (Cliffton et al., 1982; NMFS and USFWS, 2007b). By 1969, after years of adult harvest, the estimate was just over one million (Cliffton et al., 1982). Olive ridley nesting at La Escobilla rebounded from approximately 50,000 nests in 1988 to over 700,000 nests in 1994, and more than a million nests by 2000 (Márquez et al., 2005; Márquez et al., 1996). 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, 1998e). From 2006-2010, between 3,564 and 476,550 females nested here, with roughly

one0fifth of clutches harvested by locals (Valverde et al., 2012). At a nesting site in Costa Rica, an estimated 0.2% of 11.5 million eggs laid during a single arribada produced hatchlings (NMFS and USFWS, 1998e). 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, 2004a, b). Analysis of bycatch data off Costa Rica suggest a female-biased sex ration of roughly two females for every male (Arauz, 2001).

Indian Ocean. Arribada nesting populations are still large but are either in or near decline. Solitary nesting declines have been reported from Bangladesh, Myanmar, Malaysia, Pakistan, and southwest India (NMFS and USFWS, 2007e). However, solitary nesting in Indonesia may be increasing (Asrar, 1999; Dermawan, 2002; Islam, 2002; Krishna, 2005; Limpus, 1995; Thorbjarnarson et al., 2000).

Natural threats. Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. Natural predators of olive ridleys also include crabs, garrabos, iguanas, crocodiles, black vultures, coyotes, raccoons, and coatis (Aprill, 1994a). All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures drop below a threshold level, which can pose lethal effects.

Anthropogenic threats. Collection of eggs as well as adult turtles has historically led to species decline (NMFS and USFWS, 2007b). Harvests remain a concern for olive ridley recovery. In some locations, takes are now regulated or banned (with varying compliance), while harvests remain uncontrolled in other areas. Adult harvests are now largely banned, except along African coasts.

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). The nationwide ban on commercial sea turtles harvest in Mexico, enacted in 1990, has greatly aided olive ridley conservation, but the population is still seriously decremented and threatened with extinction (Groombridge, 1982). Several solitary and arribada nesting beaches experience (although banned) egg harvesting, which is causing declines (Cornelius et al., 2007). Approximately 300,000-600,000 eggs were seized each year from 1995-1998 (Trinidad and Wilson, 2000).

In India, uncontrolled mechanized fishing in areas of high sea turtle concentration, primarily illegally operated trawl fisheries, has resulted in large-scale mortality of adult olive ridley turtles during the last two decades. Since 1993, more than 50,000 olive ridleys have stranded along the coast, at least partially because of near-shore shrimp fishing (Shanker and Mohanty, 1999). In 2008, several hundred olive ridleys stranded dead along Orissa beaches coincident with trawl fisheries operating in the area (Das, 2008). Fishing in coastal waters off Gahirmatha was restricted in 1993 and completely banned in 1997 with the formation of a marine sanctuary around the rookery. However, mortality due to shrimp trawling reached a record high of 13,575 ridleys during the 1997 to 1998 season and none of the approximately 3,000 trawlers operating off the Orissa coast use turtle excluder devices in their nets despite mandatory requirements passed in 1997 (Pandav and Choudhury, 1999). Shrimp trawls off of Central America are estimated capture over 60,000 sea turtles annually, most of which are olive ridleys, and it is likely that tens of thousands of individuals are killed annually (Arauz 1996 as cited in NMFS and USFWS, 2007f). Olive ridleys in the eastern Pacific are also incidentally caught by purse seine fisheries and gillnet fisheries (Frazier et al., 2007). Wallace et al. (2010) estimated that between 1990 and 2008, at least 85,000 sea turtles were captured as bycatch in fisheries worldwide. This

estimate is likely at least two orders of magnitude low, resulting in a likely bycatch of nearly half a million sea turtles annually (Wallace et al., 2010); many of these turtles are expected to be olive ridley sea turtles.

There are additional impacts to the nesting and marine environment that affect olive ridleys. Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al., 1998; Lutcavage et al., 1997b). The presence of lights on or adjacent to nesting beaches alters the behavior of nesting adults and is often fatal to emerging hatchlings as they are attracted to light sources and drawn away from the water, with up to 50% of some olive ridley hatchlings disoriented upon emergence in some years (Karnad et al., 2009; Witherington, 1992; Witherington and Bjorndal, 1991). At sea, there are numerous potential threats including marine pollution, oil and gas exploration, lost and discarded fishing gear, changes in prey abundance and distribution due to commercial fishing, habitat alteration and destruction caused by fishing gear and practices, agricultural runoff, and sewage discharge (Frazier et al., 2007; Lutcavage et al., 1997b).

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 (Storelli et al., 2007), and are known to depress immune function in loggerhead sea turtles (Keller et al., 2006). 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). Females from sexual maturity through reproductive life should have lower levels of contaminants than males because females offload contaminants to their eggs. Newly emerged hatchlings have higher concentrations than are present when laid, suggesting that metals may be accumulated during incubation from surrounding sands (Sahoo et al., 1996).

Critical habitat. The NMFS has not designated critical habitat for olive ridley sea turtles.

Environmental baseline

By regulation, environmental baselines for Opinions include the past and present impacts of all state, federal, 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 that are contemporaneous with the consultation in process (50 CFR §402.02). The *Environmental baseline* for this Opinion includes the effects of several activities affecting the survival and recovery of ESA-listed sea turtle species in the action area.

Climate change

We primarily discuss climate change as a threat common to all species addressed in this Opinion, rather than in each of the species-specific narratives. As we better understand responses to climate change, we will address these effects in the relevant species-specific section.

In general, based on forecasts made by the Intergovernmental Panel on Climate Change, climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the near future (IPCC, 2000, 2001a, b, 2002). From 1906 to 2006, global surface temperatures have risen 0.74º C and continues at an accelerating pace; 11 of the 12 warmest years on record since 1850 have occurred since 1995 (Poloczanska et al., 2009). Furthermore, the Northern Hemisphere

(where a greater proportion of ESA-listed species occur) is warming faster than the Southern Hemisphere, although land temperatures are rising more rapidly than over the oceans (Poloczanska et al., 2009). The direct effects of climate change will result in increases in atmospheric temperatures, changes in sea surface temperatures, patterns of precipitation, and sea level. Oceanographic models project a weakening of the thermohaline circulation resulting in a reduction of heat transport into high latitudes of Europe, an increase in the mass of the Antarctic ice sheet, and a decrease in the Greenland ice sheet, although the magnitude of these changes remain unknown. Species that are shorter-lived, larger body size, or generalist in nature are liable to be better able to adapt to climate change over the long term versus those that are longer-lived, smaller-sized, or rely upon specialized habitats (Brashares, 2003; Cardillo, 2003; Cardillo et al., 2005; Issac, 2009; Purvis et al., 2000). Climate change is most likely to have its most pronounced affects on species whose populations are already in tenuous positions (Isaac, 2008). As such, we expect the risk of extinction to listed species to rise with the degree of climate shift associated with global warming.

Foraging is not the only potential aspect that climate change could influence. Acevedo-Whitehouse and Duffus (2009) proposed that the rapidity of environmental changes, such as those resulting from global warming, can harm immunocompetence and reproductive parameters in wildlife to the detriment of population viability and persistence. An example of this is the altered sex ratios observed in sea turtle populations worldwide (Fuentes et al., 2009a; Mazaris et al., 2008; Reina et al., 2008; Robinson et al., 2008). This does not appear to have yet affected population viabilities through reduced reproductive success, although nesting and emergence dates of days to weeks in some locations have changed over the past several decades (Poloczanska et al., 2009). Altered ranges can also result in the spread of novel diseases to new areas via shifts in host ranges (Simmonds and Eliott., 2009). It has also been suggested that increases in harmful algal blooms could be a result from increases in sea surface temperature (Simmonds and Eliott., 2009).

Changes in global climatic patterns will likely have profound effects on the coastlines of every continent by increasing sea levels and the intensity, if not the frequency, of hurricanes and tropical storms (Wilkinson and Souter 2008). A half degree Celsius increase in temperatures during hurricane season from 1965-2005 correlated with a 40% increase in cyclone activity in the Atlantic. Sea levels have risen an average of 1.7 mm/year over the 20th century due to glacial melting and thermal expansion of ocean water; this rate will likely increase. Based on computer models, these phenomena would inundate nesting beaches of sea turtles, change patterns of coastal erosion and sand accretion that are necessary to maintain those beaches, and would increase the number of turtle nests destroyed by tropical storms and hurricanes (Wilkinson and Souter 2008). The loss of nesting beaches, by itself, would have catastrophic effects on sea turtle populations globally if they are unable to colonize new beaches that form or if the beaches do not provide the habitat attributes (sand depth, temperature regimes, refuge) necessary for egg survival. In some areas, increases in sea level alone may be sufficient to inundate sea turtle nests and reduce hatching success (Caut et al., 2009). Storms may also cause direct harm to sea turtles, causing “mass” strandings and mortality (Poloczanska et al., 2009). Increasing temperatures in sea turtle nests alters sex ratios, reduces incubation times (producing smaller hatchling), and reduces nesting success due to exceeded thermal tolerances (Fuentes et al., 2009b; Fuentes et al., 2010; Fuentes et al., 2009c). Smaller individuals likely experience increased predation (Fuentes et al., 2009b)Climatic anomalies influencing the Marianas Islands include El Niño/Southern Oscillation (ENSO) and La Niña events (Giese and Carton, 1999;

Mantua and Hare, 2002a; NOAA, 2005a, b; Sugimoto et al., 2001; Trenberth, 1997). Although Guam and the Southern Marianas Islands do not appear to experience altered rainfall patterns during El Niño events, the Northern Marianas tend to experience drier dry seasons and wetter wet seasons (Pacific ENSO Applications Center, 1995). Sea surface temperature in the regions also increases due to a weakening of a high pressure system over the western Pacific, potentially influencing the distribution of fish (Kubota, 1987; Lehodey et al., 1997). Although typhoons tend to be more frequent during El Niño events (likely occurring at present), their tracks tend to be more to the northwest, away from the action area (Elsner and Liu, 2003; Saunders et al., 2000).

Periodic weather patterns such as El Niño, La Niña, and the Pacific decadal oscillation (PDO) can fundamentally change oceanographic conditions in the northeastern Pacific and the biology that is based upon it (Mundy and Cooney, 2005; Mundy and Olsson, 2005; Stabeno et al., 2004). Roughly every 3-7 years, El Niño can influence the northeastern Pacific (JOI/USSSP, 2003; Stabeno et al., 2004). Typical changes include increased winter air temperature, precipitation, sea level, and downwelling favorable conditions (Royer and Weingartner, 1999; Whitney et al., 1999). La Niña events tend to swing these conditions in the negative direction (Stabeno et al., 2004). However, sea surface temperatures (SSTs) can take 1 year to change following an El Niño event or change to varying degrees (Bailey et al., 1995; Brodeur et al., 1996a; Freeland, 1990; Royer, 2005). El Niño events in the winters of 1952-1953, 1957-1958, 1965-1966, and 1982-1983 were associated with strong downwelling anomalies, which reduces nutrient availability for plankton (Bailey et al., 1995; Thomas and Strub, 2001; Wheeler and Hill, 1999). Plankton diversity also shifts, as smaller plankton are better able to cope with reduced nutrient availability (Corwith and Wheeler, 2002; Sherr et al., 2005).

The PDO is the leading mode of variability in the North Pacific and operates over longer periods than either El Niño or La Niña and is capable of altering SST, surface winds, and sea level pressure (Mantua, 2002; Mantua and Hare, 2002b; Stabeno et al., 2004). Unlike El Niño and La Niña events, PDO events can persist for 20-30 years, are more prominent outside the tropics, and mechanisms controlling them are relatively unknown (Hare and Mantua, 2000; Mantua and Hare, 2002b; Minobe, 1997, 1999). During positive PDOs, the northeastern Pacific experiences above-average SSTs while the central and western Pacific Ocean undergoes below-normal SSTs (Mundy and Olsson, 2005; Royer, 2005). Warm PDO regimes, as with El Niño events, tends to decrease productivity along the U.S. west coast (Childers et al., 2005; Hare et al., 1999). However, during the 1977 warm phase of the PDO, euphausiid biomass remained the same and copepod abundance actually increased in the Pacific northwest; zooplankton biomass doubled in offshore waters of the Gulf of Alaska (Brodeur et al., 1996b; Brodeur and Ware, 1992; Francis and Hare, 1997; MacCall et al., 2005; McFarlane and Beamish, 1992). Opposite SST regimes occur during negative PDOs (Mundy and Olsson, 2005). Positive PDOs occurred from 1925-1946 and 1977-1999. Negative PDOs occurred from 1890-1924, 1947-1976, and 1999-present (Childers et al., 2005; Mantua et al., 1997; Minobe, 1997).

Scientific and research activities

Scientific research permits issued by the NMFS currently authorize studies listed species in the Pacific Ocean, which may extend into portions of the action area for the proposed actions. Authorized research on ESA-listed sea turtles includes capture, handling, and restraint, satellite, sonic, and PIT tagging, blood and tissue collection, lavage, ultrasound, and tetracycline injections. Research activities involve “takes” by harassment, with no authorized mortality.

Additional "take" is likely to be authorized in the future as additional permits are issued. It is noteworthy that although the numbers tabulated below represent the maximum number of "takes" authorized in a given year, monitoring and reporting indicate that the actual numbers of "takes" reach the number authorized. Therefore, it is unlikely that this level of exposure indicated below has or will occur in the near term. However, our analysis assumes that these "takes" will occur since they have been authorized. It is also noteworthy that these "takes" are distributed across the Pacific Ocean. Although sea turtles are generally wide-ranging, we do not expect many of the authorized "takes" to involve individuals who would also be "taken" under the proposed research.

Tables 5-7 describe the cumulative number of takes for each listed species in the action area authorized in scientific research permits.

Table 5. Green sea turtle takes in the North Pacific Ocean.

Year	Capture/handling /restraint	Satellite/sonic/ pit/flipper tagging	Blood/tissue collection	Lavage	Ultrasound	Tetracycline injection
2009	1,066	1,060	766	345	0	85
2010	1,123	1,117	823	380	45	120
2011	1,048	1,042	748	380	45	120
2012	1,498	1,492	1,148	430	45	120
2013	1,163	1,157	813	345	45	35
2014	1,057	1,057	707	295	45	35
Total	6,949	6,925	4,331	2,175	225	483

Permit numbers: 1514, 1537, 1556, 1581, 1591, 10027, 14097, 14381, 14510, 15661, and 15685.

Table 6. Loggerhead sea turtle takes in the North Pacific Ocean.

Year	Approach	Capture/ handling/ restraint	Satellite/ sonic/ flipper tagging	Blood/tissue collection	Lavage	Ultrasound	Tetra-cycline injection
2009	49	49	49	49	18	0	8
2010	111	111	111	111	24	9	14
2011	90	90	90	90	24	9	14
2012	90	90	90	90	24	9	14
2013	82	82	82	82	16	9	6
2014	82	82	82	82	16	9	6
Total	504	504	504	504	102	45	62

Permit numbers: 1514, 1591, 14097, 14381, and 14510.

Table 7. Olive ridley sea turtle takes in the Pacific Ocean.

Year	Approach	Capture/ handling/ restraint	Satellite/ sonic/ flipper tagging	Blood/tissue collection	Lavage	Ultrasound	Tetra-cycline injection
2009	351	351	351	351	58	0	8
2010	404	404	404	404	64	7	8
2011	361	361	361	361	64	7	8
2012	361	361	361	361	64	7	8
2013	353	353	353	353	56	7	0
2014	353	353	353	353	56	7	0
Total	2,183	2,183	2,183	2,183	362	35	32

Permit numbers: 1514, 1591, 14097, 14381, and 14510.

Effects of the proposed action

Pursuant to section 7(a)(2) of the ESA, federal agencies must ensure, through consultation with the NMFS, that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The proposed issuance of permit 16803 would authorize "takes" by harassment of sea turtles during the proposed research by Lisa Ballance and associated researchers by directed capture, restraint, and handling, flipper, PIT, and satellite tagging, blood draw, ultrasound, tetracycline injection, lavage, and biopsy. In this section, we describe the potential physical, chemical, or biotic stressors associated with the proposed actions, the probability of individuals of listed species being exposed to these stressors based on the best scientific and commercial evidence available, and the probable responses of those individuals (given probable exposures) based on the available evidence. As described in the *Approach to the Assessment* section, for any responses that would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, or lifetime reproductive success), the assessment would consider the risk posed to the viability of the population(s) those individuals comprise and to the listed species those populations represent. The purpose of this assessment and, ultimately, of this Opinion is to determine if it is reasonable to expect the proposed action to have effects on listed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

For this consultation, we are particularly concerned about behavioral and stress-based physiological disruptions that may result in animals that fail to feed or breed successfully or fail to complete their life history because these responses are likely to have population-level consequences as well as the potential for mortality. The ESA does not define harassment nor has the NMFS defined the term pursuant to the ESA through regulation. For this Opinion, we define harassment similar to the U.S. Fish and Wildlife Service's regulatory definition of "harass": an intentional or unintentional human act or omission that creates the probability of injury to an individual animal by disrupting one or more behavioral patterns that are essential to the animal's life history or its contribution to the population the animal represents.

Our analysis considers that behavioral harassment or disturbance is not limited to the "harassment" definition and may in fact occur in many ways. Fundamentally, if our analysis leads us to conclude that an individual changes its behavioral state (for example, from resting to traveling away from the approaching vessel or from traveling to evading), we consider the individual to have been harassed or disturbed. In addition, individuals may respond in a variety of ways, some of which have more significant fitness consequences than others. For example, evasion of an approaching vessel would be more significant than slow travel away from the same stressor due to increased metabolic demands, stress responses, and potential for habitat abandonment that this response could or would entail. As described in the *Approach to the assessment*, the universe of likely responses is considered in evaluating the fitness consequences to the individual and (if appropriate), the affected population and species as a whole to determine the likelihood of jeopardy.

Potential stressors

The assessment for this consultation identified several possible stressors associated with the proposed research activities, including:

1. vessel transit during proposed activities

2. capture of sea turtles in entanglement nets
3. handling and restraint of sea turtles following capture
4. application of flipper and/or PIT tags
5. application of satellite tag
6. blood sampling
7. tetracycline injection
8. lavage
9. fecal sampling
10. biopsy sampling
11. ultrasound

Based on a review of available information, this Opinion determined which of these possible stressors would be likely to occur and which would be discountable or insignificant. Vessel transit introduces significant sound energy into the marine environment and poses a risk for shipstrike of listed sea turtles. However, we are unaware of any communications or acoustic cues that sea turtles would miss as a result of sound energy introduced by vessels associated with the proposed research; we consider this aspect insignificant. Considering the level of vessel transit that researchers propose to undertake and levels of shipstrike known to occur, the risk of shipstrike is discountable. Fecal sampling will involve minimal physical contact with the individual and will not involve a significant amount of time. Therefore, we discount the effect of fecal sampling. Ultrasound procedures would involve handling and restraint, as well as imaging with a device emitting sound pulses well above the levels audible to sea turtles. Handling and restraint will be addressed separately and we otherwise believe ultrasound procedures will have a discountable effect on sea turtles.

Accordingly, this consultation focused on the following stressors likely to occur from the proposed activities and may adversely affect ESA-listed sea turtles: 1. capture of sea turtles in entanglement or cast nets, 2. handling and restraint of sea turtles following capture, 3. application of flipper, PIT, and satellite tags, 4. tissue sampling (blood and skin) and injection, and 5. lavage.

Exposure analysis

Exposure analyses identify the ESA-listed species that are likely to co-occur with the actions' effects on the environment in space and time, and identify the nature of that co-occurrence. The *Exposure analysis* identifies, as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the actions' effects and the population(s) or subpopulation(s) those individuals represent. The proposed permit identifies these parameters and would allow for capture, handling and restraint, flipper, PIT, and satellite tagging, as well as tissue sampling of blood, skin, and scute, tetracycline injections, morphometrics, and lavage (Table 8). Any sex from juvenile, subadult, or adult age classes could be exposed to any activity. In addition, the applicant is requesting to conduct multiple activities on any given animal. For example, an individual would likely be exposed to a minimum of capture, handling, and restraint, flipper and/or PIT tagging (if these tags are not already present), morphometrics (lengths and weight), blood sampling, satellite tagged, and biopsy, and may be additionally injected with tetracycline

and lavaged.

Table 8. Number of animals that could be exposed by manner and action under Permit No. 16803.

Species	Number of individuals taken annually	Action
Green sea turtle (*Chelonia mydas*)	50	Tangle net capture, restraint and handling, tagging (flipper, PIT, sonic, and/or satellite tag), biopsy, blood, scute, and/or skin sample, morphometrics, ultrasound, lavage, and tetracycline injection
Loggerhead sea turtle (*Caretta caretta*)	5	Tangle net capture, restraint and handling, tagging (flipper, PIT, sonic, and/or satellite tag), biopsy, blood, scute, and/or skin sample, morphometrics, ultrasound, lavage, and tetracycline injection
Olive ridley sea turtle (*Lepidochelys olivacea*)	5	Tangle net capture, restraint and handling, tagging (flipper, PIT, sonic, and/or satellite tag), biopsy, blood, scute, and/or skin sample, morphometrics, ultrasound, lavage, and tetracycline injection

Expected exposure levels for activity was determined by calculating means and standard deviations for each activity. Four standard deviations were added to each mean for which sufficient data were available to encompass a reasonably likely maximum exposure to similar activities in the future. Our final estimate was rounded up to the next factor of five to reflect analytical uncertainty. Results indicate that the Permit's Division's original estimates of green sea turtles are reasonably likely.

Although the permit authorizes take of up to five loggerhead and olive ridley sea turtles annually, we expect no more than two of each to be taken. This is because past performance data (capture, tagging, biopsy occurrences) from 1997-2012 does not show any activities on olive ridley or loggerhead sea turtles, although the Permit's Division proposes to allow five individuals of each of these species to be exposed to these activities. We acknowledge that significant variability occurs in the region that drives the abundance of marine species and that both loggerhead and olive ridley sea turtles can co-occur with the proposed activities. We believe it is reasonable to expect that one or two individuals (not five) of each species may be captured and exposed to the proposed activities per year (5 to ten over the life of the proposed permit).

A binomial analysis of the applicant's past performance and best estimated of population size indicate that a given individual may be exposed to some or all of these activities up to four times annually (most likely once) and up to 12 times over the life of the permit (most likely three times). Past performance also indicates that females are roughly twice as likely to be exposed as

males and 30% of captured individuals were juveniles. We expect roughly these same proportions of sex and age classes to be exposed under the proposed permit.

Response analysis

As discussed in the *Approach to the assessment* section of this Opinion, response analyses determine how listed resources are likely to respond after exposure to an action's effects on the environment or directly on listed species themselves. For the purposes of consultation, our assessments try to detect potential lethal, sub-lethal (physiological), and behavioral responses that might reduce the fitness of listed individuals. Ideally, response analyses consider and weigh evidence of adverse consequences as well as evidence suggesting the absence of such consequences and beneficial outcomes for the listed individuals.

There is mounting evidence that wild animals respond to human disturbance in the same way that they respond to predators (Beale and Monaghan, 2004; Frid, 2003; Frid and Dill, 2002; Gill et al., 2001; Harrington and Veitch, 1992; Lima, 1998; Romero, 2004). These responses manifest themselves as stress responses (in which an animal perceives human activity as a potential threat and undergoes physiological changes to prepare for a flight or fight response or more serious physiological changes with chronic exposure to stressors), interruptions of essential behavioral or physiological events, alteration of an animal's time budget, or some combinations of these responses (Frid, 2003; Frid and Dill, 2002; Romero, 2004; Sapolsky et al., 2000; Walker et al., 2005). These responses have been associated with abandonment of sites (Sutherland and Crockford, 1993), reduced reproductive success (Beale and Monaghan, 2004; Giese, 1996; Lordi et al., 2000; Mullner et al., 2004), reduced energy budget (Frid, 2003), and the death of individual animals (Bearzi, 2000; Daan, 1996; Feare, 1976). Stress is an adaptive response and does not normally place an animal at risk. However, distress involves a stress response resulting in a biological consequence to the individual. The mammalian and reptilian stress response involves the hypothalamic-pituitary-adrenal (HPA) axis being stimulated by a stressor, causing a cascade of physiological responses, such as the release of the stress hormones cortisol, adrenaline (epinephrine), glucocorticosteroids, and others (Busch and Hayward, 2009)(Gulland et al. 1999; Morton et al. 1995; St. Aubin and Geraci 1988; St. Aubin et al. 1996; Thomson and Geraci 1986)(Gregory and Schmid, 2001b). These hormones subsequently can cause short-term weight loss, the liberation of glucose into the blood stream, impairment of the immune and nervous systems, elevated heart rate, body temperature, blood pressure, and alertness, and other responses (Busch and Hayward, 2009; NMFS, 2006g)(Cattet et al. 2003; Delehanty and Boonstra 2009; Elftman et al. 2007; Fonfara et al. 2007; Kaufman and Kaufman 1994; Mancia et al. 2008; Moe and Bakken 1997; Noda et al. 2007; Thomson and Geraci 1986)(Dierauf and Gulland, 2001; Omsjoe et al., 2009). In some species, stress can also increase an individual's susceptibility to gastrointestinal parasitism (Greer et al. 2008). In highly-stressful circumstances, or in species prone to strong "fight-or-flight" responses, more extreme consequences can result, including muscle damage and death (Cowan and Curry, 1998, 2002, 2008; Herraez et al., 2007). The most widely-recognized indicator of vertebrate stress, cortisol, normally takes hours to days to return to baseline levels following a significantly stressful event, but other hormones of the HPA axis may persist for weeks (Dierauf and Gulland, 2001). Repeated exposure to stressors can negatively impact the health and viability of populations (Gregory and Schmid, 2001b).

Tangle net capture

Sea turtles captured during the course of proposed research would be captured in tangle nets that

present the possibility of stress (potentially severe) and mortality from drowning. Although corticosterone does not appear to increase with entanglement time for green and Kemp's ridley sea turtles (Snoddy et al., 2009), we expect capture to be a stressful experience as indicated by severe metabolic and respiratory imbalances resulting from forced submergence (Gregory and Schmid, 2001a; Harms et al., 2003; Stabenau and Vietti, 2003). We also expect behavioral responses (attempts to break loose of the netting via rapid swimming and biting) as well as physiological responses (release of stress hormones; (Gregory et al., 1996; Gregory and Schmid, 2001a; Harms et al., 2003; Hoopes et al., 2000; Stabenau and Vietti, 2003)).

Additional risk to sea turtles is involved with capturing sea turtles in entanglement nets due to forced submersion. Sea turtles forcibly submerged in any type of restrictive gear eventually suffer fatal consequences from prolonged anoxia and/or seawater infiltration of the lungs (Lutcavage et al., 1997a). Trawl studies have found that no mortality or serious injury occurred in tows of 50 minutes or less, but these increased rapidly to 70% after 90 minutes (Epperly et al., 2002; Henwood and Stuntz, 1987). However, metabolic changes that can impair a sea turtles' ability to function can occur within minutes of a forced submergence. Serious injury and mortality is likely due to acid-base imbalances resulting from accumulation of carbon dioxide and lactate in the bloodstream (Lutcavage et al., 1997a); this imbalance can become apparent in captured, submerged sea turtles after a few minutes (Stabenau et al., 1991). Recovery times can take 20 hours or more (Henwood and Stuntz, 1987). To minimize the effects of this type of capture, nets will be tended continuously and must be checked at intervals of 30 minutes. We do not expect any sea turtle to require extensive recovery, and the methodology proposed by the researcher (holding comatose or behaviorally abnormal sea turtles) should ensure sea turtles will have recovered from the effects of forced submergence before being released.

Over the past 15 years, the applicant has captured 185 sea turtles in the action area, none of which have died as a result of capture. We expect capture methodology, environmental conditions, and sea turtle biology to generally be the same during the life of the proposed permit as they have previously been. However, as a higher rate of fibropapillomatosis in green sea turtles has recently been documented in the Pacific, more unhealthy sea turtles may be captured under the proposed permit than in years past. Until we can better evaluate the significance and extent of this trend (if it is a trend), we expect mortality level to be the same as in previous years. Therefore, we anticipate no mortalities over the life of the proposed permit. A mortality would result in a review of activities by the Permit's Division and represent significant, new information, requiring re-initiation of this consultation.

Morphometrics, biopsy, flipper tagging, and PIT tagging

Once sea turtles have been captured, individuals will be handled and exposed to activities with varying degrees of invasiveness. Each sea turtle will be exposed to morphometric measurement, including at least seven measures of carapace size, as well as weight measurement. Although these activities are not considered invasive, we expect individual sea turtles to experience a continued stress response due to the handling and restraint necessary to conduct them. All sea turtles will also be scanned or visually inspected for PIT and flipper tags, respectively. If either of these is absent, then individuals will be tagged with them. Both procedures involve the implantation of tags in or through skin and/or muscle of the flippers. In addition to the stress sea turtles are expected to experience by handling and restraint associated with inspection, tagging,

and biopsy, we expect an additional stress response associated with the short-term pain experienced during tag implantation and biopsy (Balazs, 1999b). PIT tags will be covered in a material that encourages muscle fiber adherence to the tag, hindering migration away from the tagging site and into places where its impact may cause unintended effects. Based upon several hundred tagging events, behavioral responses may or may not be evident during tag implantation; when evident, behavioral responses are fleeting. Pain is expected to some degree, with some individuals expressing responses more overtly than others (Balazs, 1999a; McDonald and Dutton, 1996). We expect disinfection methods proposed by the applicant to mitigate risks from infection from both tagging and biopsy. Wounds are expected to heal without infection, as the applicant has observed over decades of previous work on green sea turtles in San Diego Bay. Tags are designed to be small, physiologically inert, and not hinder movement or cause chafing; we do not expect the tags themselves to negatively impact sea turtles (Balazs, 1999b). Previously tagged individuals have been routinely re-encountered in the action area, supporting continued use of the habitat by healthy individuals for years following these procedures.

Blood sampling

Sea turtles are also expected to experience a short-term stress response in association with the handling, restraint, and pain associated with blood sampling. Taking a blood sample from the sinuses in the dorsal side of the neck is a routine procedure (Owens, 1999), although it requires knowledgeable and experienced staff to do correctly and requires the animal to be restrained (DiBello et al., 2010; Wallace and George, 2007). According to Owens (1999), with practice, it is possible to obtain a blood sample 95% of the time and the sample collection time should be about 30 seconds in duration. The applicant has taken blood samples from several hundred sea turtles since 1991. No sea turtle mortalities have occurred during the applicant's blood sampling activities. Sample collection sites are always sterilized prior to needle insertions, which would be limited to two on either side of the neck. Bjorndal et al. (2010) found that repeated scute, blood, and skin sampling of the same individual loggerhead sea turtles did not alter growth, result in scarring, or apparently impact other physiological or health parameters.

Satellite tagging

Sea turtles exposed to satellite tagging will experience invasive activities, will be held for significant periods of time (roughly 2.5 hours) will be handled, restrained, and held in unfamiliar (and likely stressful) environments. Handling, restraint, sanding of carapace scutes, and transport are likely to cause some degree of stress response. The applicant proposes to use methods that will minimize adverse impacts to sea turtles, including use of low-heat producing epoxy, covering skin and eyes to prevent epoxy contact with these surfaces, ensuring adequate ventilation to prevent epoxy vapor accumulation, and shading individuals from the sun. Sea turtles are not capable of hearing the frequencies produced by tags nor are their predators or prey (Bartol et al., 1999; Casper et al., 2003; Casper and Mann, 2004; Lenhardt, 2003; Ridgeway et al., 1969). However, satellite tags have the potential to significantly increase hydrodynamic drag, reduce lift, and increase pitch (Watson and Granger, 1998). For example, tags like the ones proposed for use that caused the smallest amount of drag were still 1-14% for long-term tags and significant higher levels in temporary tags (Todd et al., 2011). Thus, monitoring of sea turtle movements and determination of altered movement is a significant monitoring component following tagging. To date, the applicant has not found tagged sea turtles to move in ways suggesting locomotory hindrance or altered behavior in the action area specifically as well as in other areas (Seminoff et al., 2006; Seminoff et al., 2002a). Ultrasonic transmitters appear to fall

off within six months. The applicant has noted that over 100 ultrasonic transmitters have been deployed in San Diego Bay and no adverse effects have been noted with numerous re-encounters of tagged individuals. Where larger turtles are outfitted with multiple, larger devices, the larger CritterCam will release within 36 hours.

Lavage

Lavage, or stomach flushing, is a standard practice to investigate the diet of sea turtles and fishes (Legler, 1977). This involves flushing fluids into and out of the esophagus and upper stomach region, removing food and prey in the process for analysis (Forbes, 1999). The procedure itself can result in damage to the jaws or esophagus if not performed correctly (Forbes, 1999). If water is injected too quickly, serious injury or death may result (Forbes, 1999). However, the applicant indicates that dozens of lavage procedures have been undertaken without any of these adverse effects noted. Reportedly, no more than 10 minutes should be involved with the procedure. Laparoscopy indicates no damage to the intestine and recapture of apparently healthy individuals support the process at least generally not causing adverse health effects (Forbes, 1999).

This action involves a metabolic cost to the target individual, as it deprives individuals of whatever prey had recently been swallowed, as well as the investment in initial gastric secretions involved with its digestion. If no prey are present, this cost is significantly reduced. This action can also benefit the individual by removing parasites in these areas.

Tetracycline injection

Tetracycline injections are performed in many species to establish tracers in bone growth so that once the animal dies, post-mortem procedures can determine the individual's growth rate (Coles et al., 2001). In addition, this antibiotic likely has a short term effect of boosting health by acting against many types of pathogenic bacteria, although a recent study showed significant bacterial resistance to oxytetracycline in sea turtles (Foti et al., 2009). A study of the pharmacokinetics of oxytetracycline in loggerhead sea turtles did not identify any negative effects (including lack of response at the injection site, food consumption, flipper movement, and activity) (Harms et al., 2004). However, a Kemp's ridley responded with skin exfoliation and ventral erythema after repeated injection; both conditions disappeared after oxytetracycline was discontinued (Harms et al., 2004). The applicant also indicates that oxytetracycline therapy can result in anorexia, vomiting, or diarrhea, mild inflammation at the injection site, photosensitivity reactions, and staining of developing bones and teeth (an intended effect), although such treatment involves more and higher doses than those proposed for use here. To date, no indication of these adverse effects have been found by the applicant and we do not expect any to occur under the proposed permit.

Cumulative effects

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered by this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

We expect that those aspects described in the *Environmental baseline* will continue to impact listed resources into the foreseeable future. We expect climate change, ship-strikes, and bycatch to continue into the future. Movement towards bycatch reduction and greater foreign protections of sea turtles are generally occurring through the Pacific Ocean, which may aid in recovery of

sea turtle populations. Risk of shipstrike will likely increase in the future as more vessels are used in commercial and recreational marine activities.

Integration and synthesis of effects

As explained in the *Approach to the assessment* section, risks to listed individuals are measured using changes to an individual's "fitness" – *i.e.*, the individual's growth, survival, annual reproductive success, and lifetime reproductive success. When listed plants or animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the population(s) those individuals represent or the species those populations comprise (Anderson, 2000; Brandon, 1978; Mills and Beatty, 1979; Stearns, 1992). As a result, if the assessment indicates that listed plants or animals are not likely to experience reductions in their fitness, we conclude our assessment. If possible, reductions in individuals' fitness are likely to occur, the assessment considers the risk posed to population(s) to which those individuals belong, and then to the species those population(s) represent.

The *Status of listed resources* discussion describes how listed sea turtles affected by the actions outside the action area have been adversely affected by human-induced factors such as commercial fisheries, direct harvest of sea turtles, and modification or degradation of the sea turtle's terrestrial and aquatic habitat. Effects occurring in terrestrial habitats have generally resulted in the loss of eggs or hatchling sea turtles, or nesting females, while those 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. Similarly, the actions discussed in the baseline, as well as those considered under *Cumulative effects* all pose the potential to result in take of sea turtle species resulting in stress or possible mortality.

Species with delayed maturity such as sea turtles are demographically vulnerable to increases in mortality, particularly of juveniles and subadults, those stages with higher reproductive value. As discussed in the *Status of listed resources*, the age of sexual maturity of most species of sea turtles is currently unknown, although the sexual maturity of loggerhead turtles may be as high as 35 years, and green turtles may not reach maturity until as late as 50 years. The potential for an egg to develop into a hatchling, into a juvenile, and finally into a sexually mature adult sea turtle varies among species, populations, and the degree of threats faced during each life stage. Each juvenile that does not survive to produce will be unable to contribute to the maintenance or improvement of the species' status. Reproducing females that are prematurely killed due the threats mentioned in the above sections or as a result of the proposed actions, while possibly having contributing something before being removed from the population, will not be allowed to realize their reproductive potential. Similarly, reproductive males prematurely removed from the population will be unable to make their reproductive contribution to the species' population.

The research activities will result in temporary stress to target animals, which is not expected to have more than short-term effects on individual threatened or endangered sea turtles. These non-lethal interactions will not affect the individual's ability to reproduce and contribute to the maintenance or recovery of the species. These effects are expected to be short-term because previous experience with the proposed research activities has demonstrated that it is reasonable to expect that effects will be minimal. This research will affect the individuals by harassing sea turtles during the research thus raising levels of stressor hormones, and individuals may experience some discomfort during capture, weighing, measuring, tagging, and other procedures.

Based on past observations of similar research, these effects are expected to dissipate within approximately a day. Some individuals will also incur a metabolic coast due to loss of prey during lavage. However, this loss is expected to be spall and easily replaceable. As such, a measureable fitness consequence is not expected. We do not expect delayed mortality of any sea turtles following their release as a result of the research based on similar activities conducted by other researchers and adherence to certain protocols identified in the proposed action.

We do not expect individual sea turtles will die, as a result of the proposed action. At the population level, we do not expect the proposed research activities to appreciably reduce the green, loggerhead, or olive ridley sea turtle's likelihood of survival and recovery in the wild by adversely affecting their birth rates, death rates, growth rates, or recruitment rates. For the vast majority of sea turtles, the proposed action is not expected to have more than short-term effects. The data generated by the applicant regarding these populations over the duration of this study will provide beneficial information that will be important to the management and recovery of endangered species. The information collected as a direct result of permit issuance will be used to implement the goals identified in the recovery plans for U.S. Pacific sea turtle populations (NMFS and USFWS, 1998a, c, d). As discussed above, we believe it is reasonable to assume that issuance of the proposed permit will have beneficial effects for the Pacific coast of Mexico/Pacific populations of green, loggerhead, and olive ridley sea turtles.

Conclusion

After reviewing the current status of green, loggerhead, and olive ridley sea turtles; the *Environmental baseline* for the action area; the anticipated effects of the proposed activities; and the *Cumulative effects*, it is NMFS' Opinion that the action (the Permits Division's issuance of a permit for research activities on sea turtles in San Diego Bay) is not likely to jeopardize the continued existence of these species. No critical habitat occurs within the action area therefore will not be affected.

Incidental take statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibits the take of endangered and threatened species, respectively, without 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 NMFS 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. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

As discussed in the accompanying Opinion, only the target species will be harassed as part of the proposed actions and take is exempted through section 10 of the ESA. We do not expect incidental take of threatened or endangered species as a result of the proposed actions.

Conservation recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and

threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Endangered Species Division has no conservation recommendations at this time.

Reinitiation notice

This concludes formal consultation on the Permit's Division's proposal to issue Permit 16803 to Lisa Ballance of NMFS Southwest Fisheries Science Center, pursuant to the provisions of section 10 of the ESA and MMPA. As provided in 50 CFR '402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of authorized take is exceeded, the Permits Division must immediately request reinitiation of section 7 consultation.

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