

**National Marine Fisheries Service
Endangered Species Act Section 7 Consultation**

Biological and Conference Opinion

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

Activities Considered: Issuance of an Endangered Species Act section 10(a)(1) permit to Bonnie Ponwith, Southeast Fisheries Science Center [Permit No. 16253]

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

Approved by:



Date:

JAN 09 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 a permit to allow capture of green, Kemp's ridley, leatherback, loggerhead (northwestern Atlantic DPS), and olive ridley sea turtles in the Gulf of Mexico, Caribbean Sea, and Atlantic Ocean as well as Atlantic sturgeon. The consulting agency for this proposal is the NMFS' Office of Protected Resources – Endangered Species Act Interagency Cooperation Division (Endangered Species Division).

This document represents the NMFS' biological and conference 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, environmental assessment, recovery plans and status reviews for green, hawksbill, Kemp's ridley, leatherback, loggerhead (northwestern Atlantic DPS), and olive ridley sea turtles as well as smalltooth sawfish, the most current stock assessment reports, past and current research and population dynamics modeling efforts, monitoring reports from prior research, expert opinion, other information provided by the applicant, and biological

opinions involving similar research.

Consultation history

On June 27, 2011, the Permits Division published a notice in the Federal Register soliciting public comment on their intent to issue the proposed permit.

On September 23, 2011, NMFS' Endangered Species Division received a request for formal consultation from the Permits Division to authorize Permit Number 16253, Bonnie Ponwith, Southeast Fisheries Science Center.

On October 18, 2011, information was found to be sufficient to initiate consultation on this date.

Description of the proposed action

The Southeast Fisheries Science Center (SEFSC) proposes to conduct experiments to evaluate the effectiveness of modified gear types in commercial longline and trawl fisheries. This includes two projects, one that would evaluate turtle excluder devices (TEDs) in the Gulf of Mexico and Atlantic Ocean and another to evaluate modifications to pelagic and bottom longline fishing gear. Both projects seek to find techniques and equipment that will reduce the incidence and significance of sea turtle bycatch in commercial fisheries using these gear types.

The trawl project would introduce modified TEDs onto commercial vessels of several fisheries, including flynet, high opening bottom trawl, crab trawl, shrimp trawl, skimmer trawl, butterfly net, and groundfish. Experiments could be conducted at any time of year from Cape Canaveral, Florida north to the New York/Connecticut border in waters of the U.S. EEZ up to 200 m deep, as well as from the Florida Keys to Brownsville, Texas, in nearshore and offshore waters. However, effort would be focused during the October to April time frame. Activities conducted in federal waters have been addressed in consultation for these fisheries, but activities occurring in state waters (within three nautical miles of U.S. possessions) are evaluated in this consultation. Experiments would involve placing prototype TEDs, approved TEDs, and/or retaining control no-TED nets on single or double rigged trawl vessels. Captains would be instructed to fish as they normally would. Cameras and/or sonar equipment would be placed on nets to evaluate and document bycatch escapement; the applicant indicates cameras would be used on 40-70% of experiments and would be focused in high sea turtle density areas, such as off Cape Canaveral and offshore of Georgia and South Carolina, and off Duck, North Carolina, where significant Atlantic sturgeon bycatch has previously occurred. Video use would occur in waters of 50 m or less and involve a real-time video feed of the narrowing cod-end of the net where a TED would be installed, allowing for visualization of all turtles or sturgeon approaching the rear of the net and confirmation of individuals exiting from a TED. A transmitter tethered between a surface float and the trawl-mounted camera would transmit video to an observer on the trawl vessel, allowing immediate response to any sea turtles or sturgeon observed to be captured in video-monitored trawls. If a sea turtle or sturgeon is seen to be captured, hauling would cease and the individual would be removed from the net. Trawling would not be started when marine mammals other than dolphins and porpoises are seen in the vicinity. Any sea turtles that are captured alive could be handled and/or restrained, skin biopsied, PIT

and/or flipper tagged, measured, and or weighed. Research activities would follow those outlined in the SEFSC sea turtle research techniques manual (Bigg and Fisher 1974). In addition to commercial trawler testing, prototypes would also be tested aboard NOAA vessels to evaluate TED prototype effectiveness in excluding sea turtles before moving testing to commercial vessels. Trawls types would include two and four seam shrimp trawls with headrope lengths of up to 70 feet, crab trawls with head ropes of up to 50 feet, flounder trawls with headrope lengths of up to 120 feet, flynets with headrope lengths of up to 150 feet, and skimmer trawls with headrope lengths of up to 30 feet. Tow times would be limited to 30 minutes except in cases where fishery-specific regulations do not mandate TEDs in lieu of a tow time limitation; in such a case (such as skimmer net trawls), tow times would be limited to 55 minutes (skimmer nets are operated in the States of North Carolina, Louisiana, Mississippi, and Alabama). Trawls would operate at two to four knots. Most trawls would utilize a prototype TED, with lesser numbers of trawls involving no TEDs.

The longline project would also be undertaken on commercial fishing vessels, but would evaluate the effectiveness of new hook designs, methods for safely handling and releasing bycaught sea turtles and other bycatch, new baits and baiting techniques, and other fishing tactics. Sea turtle capture typically occurs either by foul hooking (leatherbacks), entanglement, or hooking in the beak, mouth, or digestive tract. Gear removal procedures would follow guidelines in NMFS' Careful Release Protocols For Sea Turtle Release With Minimal Injury document and research activities would follow those outlined in the SEFSC Sea Turtle Research Techniques Manual (Bigg and Fisher 1974; Epperly et al. 2004). If an entangled turtle is encountered, it would be brought alongside the vessel and an assessment made as to whether to bring the individual onboard. If boating is not appropriate, procedures outlined in NMFS' Careful Release Protocols for Sea Turtle Release with Minimal Injury would be followed to tether and dehook the individual. Only externally-visible hooks would be attempted to be removed; all other embedded hooks that are visible and unlikely to cause additional harm by removal attempts would be removed to the extent possible. This would include the use of bolt cutters to remove any available component where the entire hook cannot be removed. Release would be conducted from the rear of the vessel, not while the longline is deployed, and while the engine is in neutral.

Should a marine mammal become entangled or hooked, every attempt would be made to immediately disentangle or dehook it.

Handling, restraint, and release

Once captured, sea turtles would be removed from the ocean using a large dipnet or cradle. All the investigators and personnel involved would be experienced in capturing and handling sea turtles and would undertake several precautions. Antiseptic methods such as disinfecting equipment with 5-6% bleach, use of 10% providone iodine and isopropyl alcohol at tag sights would be standard protocol to prevent the transmission of disease and prevent infection. Captured sea turtles would be placed on foam pads (cleaned/disinfected between turtles), kept moist, and protected from temperature extremes (shade for heat, covered/kept out of wind for cold). Researchers would initially examine captured sea turtles for signs of injury, vigor, and behavior. Injured or abnormally-behaving sea turtles would be treated onboard to the extent possible,

including resuscitation techniques described in the SEFSC Sea Turtle Research Techniques Manual (Bigg and Fisher 1974). Otherwise, captured sea turtles would begin to be processed for activities described in subsequent sections. Total time required for directed research has been estimated by the applicant at no more than 10 minutes. Release would be accomplished by lowering sea turtles as near to the water's surface as possible followed by release and subsequent monitoring of swimming and diving ability.

Biopsy

Biopsy would be conducted in accordance with accepted best practice detailed in the SEFSC Sea Turtle Research Techniques Manual (Bigg and Fisher 1974). Biopsies would be taken from the skin along the posterior edge of a rear flipper. Alternatively, a front flipper or shoulder area may be targeted. The area would be scrubbed with 10% providone iodine. A disinfected, flat object would be placed under the flipper and a clean biopsy punch would be used to bore a plug from the flipper margin. The area would then be re-treated with 10% providone iodine.

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 flipper tags attached to the trailing edge of both right and left front flippers and/or a PIT tag inserted intramuscularly into the foreflipper, enabling future identification of the individual. Tags will be disinfected prior to implantation. The anticipated duration of flipper tag attachment is three to five years while the PIT tag is permanent barring amputation.

Morphometrics

Morphometrics may be recorded for all captured sea turtles and would be taken via measurement of straight and curved carapace length and width as well as total mass via a hanging scale. Photographs may also be taken.

Permit Conditions

I. Number and Kind(s) of Protected Species, Location(s) and Manner of Taking

1. The table in Appendix 1 (of the permit) outlines the number of protected species, by species authorized to be taken, and the locations, and manner in which they may be taken.
2. Researchers working under this permit may collect visual images (*e.g.*, still photographs, motion pictures) as needed to document the permitted activities, provided the collection of such images does not result in takes of protected species.
3. The Permit Holder may use visual images and audio recordings collected under this permit, including those authorized in Tables 1 and 2 of Appendix 1, 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 a NMFS Permit. This statement must accompany the images and recordings in all subsequent uses or sales.

4. 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 Chief, Permits Division.
 - a. Where such non-essential photography, filming, or recording activities are authorized they must not influence the conduct of permitted activities or result in takes of protected species.
 - b. Personnel authorized to accompany the Researchers during permitted activities for the purpose of non-essential photography, filming, or recording activities are not allowed to participate in the permitted activities.
 - c. The Permit Holder and Researchers cannot require compensation in return for allowing non-essential personnel to accompany Researchers to conduct non-essential photography, filming, or recording activities.
5. Researchers must comply with the following conditions related to the manner of taking:
 - a. Turtles Captured Under Another Authority Prior to Research Activities:
 - i. Trawling must not be initiated when marine mammals, except dolphins or porpoises, are observed within the vicinity of the research, and the marine mammals must be allowed to either leave or pass through the area safely before trawling is initiated.
 - ii. Researchers must make every effort to prevent interactions with marine mammals. Researchers must be aware of the presence and location of these animals at all times as they conduct trawling activities.
 - iii. If a marine mammal is captured, researchers must:
 1. Stop trawling activities and immediately free the animal,
 2. Notify the appropriate NMFS Regional Stranding Coordinator as soon as possible (see Attachment 1 or go to:

<http://www.nmfs.noaa.gov/pr/health/coordinators.htm>), and

3. Report the incident

Permitted activities will be suspended until the Permits Division has granted approval to continue research

b. General Handling, Resuscitation, and Release:

i. Researchers must:

- a. Handle turtles according to procedures specified in 50 CFR 223.206(d)(1)(i). Use care when handling live animals to minimize any possible injury;
- b. Use appropriate resuscitation techniques on any comatose turtle prior to returning it to the water; and
- c. When possible, transfer injured animals to rehabilitation facilities and allow them an appropriate period of recovery before return to the wild.
- d. Name an experienced veterinarian, veterinary technician, or rehabilitation facility 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.

For research activities occurring in conjunction with other NMFS research, if a veterinarian cannot be contacted and the animal cannot be taken to a rehabilitation center, NMFS researchers must cease any activities that will further significantly stress the animal, allow it to recuperate as conditions dictate, and return the animal to the sea.

In addition to Condition A.2, 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. Compromised or Injured Sea Turtles

- a. The Permit Holder may conduct the activities authorized by

this permit 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.

- b. 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. Turtles are to be protected from temperature extremes of heat and cold, provided adequate air flow, and kept moist (if appropriate) during sampling. Turtles must be placed on pads for cushioning and this surface must be cleaned and disinfected between turtles. The area surrounding the turtle must not contain any materials that could be accidentally ingested.
- v. During release, turtles must be lowered as close to the water's surface as possible to prevent potential injuries.
- vi. For research activities occurring in conjunction with NMFS research, NMFS researchers must carefully observe newly released turtles and record observations on the turtle's apparent ability to swim and dive in a normal manner.
- vii. Extra care must be exercised when handling, sampling and releasing leatherbacks. Field and laboratory observations indicate that leatherbacks have more friable skin and softer bones than hardshell turtles which tend to be hardier and less susceptible to trauma. Leatherbacks must:
 - a. Only be boarded if they can be safely brought on board the vessel.
 - b. Be handled by at least two people, one on either side of the turtle and supported from underneath.
 - c. Not be turned on their backs.
- c. Handling, Measuring, Weighing, PIT and Flipper Tagging:
 - 1. When handling, measuring, and/or tagging turtles, researchers must:
 - a. Clean and disinfect all equipment (tagging equipment, tape measures, etc.) that comes in contact with sea turtles between the processing of each turtle;

- b. Maintain a separate set of sampling equipment for handling animals displaying fibropapillomas tumors or lesions. All equipment that comes in contact with the turtle must be cleaned and disinfected between the processing of each turtle.
- c. Examine turtles for existing flipper and PIT tags before attaching or inserting new ones. If existing tags are found, the tag identification numbers must be recorded and included in the annual report. Researchers must have PIT tag readers capable of reading 125, 128, 134.2, and 400 kHz tags.
- d. Clean and disinfect flipper tags (e.g., to remove oil residue) before use. Applicators must be cleaned (and disinfected when appropriate, e.g., contaminated with fluids) between animals. The application site must be cleaned and then scrubbed with a disinfectant (e.g., Betadine) before the tag pierces the animal's skin.
- e. 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. If it has been exposed to fluids from another animal, the injector handle must be disinfected between animals.

2. Painting of the Carapace (Hardshells)

- a. Researchers must use non-toxic paints that do not contain xylene or toluene.
- b. For turtles \leq approximately 4 years old, paint must be applied without crossing suture lines (margins) if the paint will remain on the shell for 3 months or more.
- c. For juvenile turtles $>$ approximately 4 years old, paint must be applied without crossing suture lines (margins) if the paint will remain on the shell for 1 year or more.
- d. For adult turtles, paint must be applied without crossing suture lines (margins) if the paint will remain on the shell for 2 years or more.

3. Biopsy (tissue-skin) Sampling:

- a. A new biopsy punch must be used on each turtle.
- b. Turtles brought on-board the vessel for sampling:
 - i. Sterile techniques must be used at all times. Samples must be collected from the trailing edge of a flipper if possible and practical (preference should be given to a rear flipper if practical). 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.
 - ii. Turtles not boarded for sampling:
 - a. Turtles must be sampled (using a pole-biopsy or for leatherbacks: via shallow carapacial scrapes) in the location most safely and easily accessed by the researcher.
 - b. Samples may be collected from anywhere on the limbs or neck, avoiding the head.
 - c. If it can be easily determined (through markings, tag number, etc.) that a sea turtle has been recaptured and has been already sampled by this permit, no additional biopsy samples may be collected from the animal over the permit year.
- d. Non-Target Species
 - a. Bycatch: All incidentally captured species must be released alive as soon as possible. Bycatch data (number per species/taxa) should be provided in annual reports.
 - b. Shortnose and Atlantic Sturgeon Requirements:
 - 1. Video monitoring of the turtle excluder device must be used when trawling around Duck, North Carolina. If ESA-listed sturgeon are observed in the net, researchers must immediately haul up the net and follow the handling requirements outlined below.

2. If a sturgeon is incidentally captured, Researchers must follow NOAA sturgeon handling protocols (Kahn and Mohead 2010) and minimally be scanned for PIT tags and released.
 - i. Sturgeon must be handled carefully, kept in water as much as possible to reduce stress, and returned to the water as soon as possible.
 - ii. Sturgeon overly stressed from capture must be resuscitated and/or allowed to recover inside a live well (if possible) and released without further handling.
 - iii. Smooth rubber gloves should be worn when handling sturgeon to reduce abrasion of skin and removal of mucus.
 - iv. Existing PIT tags should be recorded by scanning the entire dorsal surface of the animal with a PIT tag reader.
3. Reports of incidentally captured Atlantic sturgeon must be provided to the following contacts in the NMFS Regional Offices:

Northeast Region: Lynn Lankshear, Atlantic Sturgeon Coordinator, at Lynn.Lankshear@noaa.gov or (978)282-8473.

Southeast Region: Kelly Shotts, Protected Resources, within 14 days of the incident (F/SER3, 263 13th Ave. S., St. Petersburg, Florida 33701); (727)570-5312 (Fax: 727-824-5309).

This report must contain: the description of the take, location, and final disposition of the sturgeon (*i.e.*, released in good health, *etc.*) (Appendix 3). If possible specimens or body parts of dead Atlantic sturgeon should be preserved (preferably on ice or refrigeration) until sampling and disposal procedures are discussed with NMFS.

- c. Submerged Aquatic Vegetation (SAV; e.g., seagrass) Coral Communities, Live or Hard and Live Bottom Habitat

1. Researchers must take all practicable steps to identify SAV, coral communities, and live/hard bottom habitats and avoid setting gear in such areas. Researchers must use strategies to identify SAV, coral, and live or hard bottom types and avoid adverse impacts to EFH, including the use of tools such as charts, GIS, sonar, fish finders, or other electronic devices to help determine characteristics and suitability of bottom habitat prior to using gear.
2. If research gear is lost, diligent efforts must be made to recover the lost gear to avoid further damage to benthic habitat and impacts related to “ghost fishing.”
3. *Johnson’s sea grass and critical habitat.* No research activities will be conducted over, on, or immediately adjacent to Johnson’s sea grass or in Johnson’s sea grass critical habitat.
4. *Other sea grass species.* Researchers must avoid conducting research over, on, or immediately adjacent to any non-listed sea grass species. If these non-listed species cannot be avoided, then the following avoidance/minimization measures must be implemented-
 - i. In order to reduce the potential for sea grass damage, anchors must be set by hand when water visibility is acceptable. Anchors must be placed in unvegetated areas within seagrass meadows or areas having relatively sparse vegetation coverage. Anchor removal must be conducted in a manner that would avoid the dragging of anchors and anchor chains.
 - ii. Researchers must take great care to avoid damaging any sea grass species and if the potential for anchor or net drag is evident researchers must suspend research activities immediately.
 - iii. Researchers must be careful not to tread or trample on seagrass and coral reef habitat.
- e. No gear may be set, anchored on, or pulled across coral or hard/live bottom habitats.

- d. North Atlantic Right Whale: The permit holder must ensure that staff conducts observations for right whales. Monitoring is required on all vessels and must be conducted by research staff with at-sea large whale identification experience. In accordance with 50 CFR 224.103(c)(1), the Permit Holder must not get within 500 yards of a right whale. If a right whale is sighted within 500 yards of the vessel, immediate avoidance measures must be taken and researchers must immediately report the sighting and location data to either the U.S. Coast Guard or the appropriate NMFS Regional Administrator.

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 – Jeff Gearhart
 - b. Co-Investigator(s) – Daniel Foster, Bret Hataway, John Mitchell, and Brian Stacy (veterinarian).
 - 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 this permit
2. Individuals conducting permitted activities must possess qualifications commensurate with their roles and responsibilities. The roles and responsibilities of personnel operating under this permit are as follows:
 - a. The Permit Holder is ultimately responsible for activities of individuals operating under the authority of this permit. Where the Permit Holder is an institution/facility, the Responsible Party is the person at the institution/facility who is responsible for the supervision of the Principal Investigator.
 - 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 this permit unless a Co-Investigator named in Condition C.1 is present to act in place of the PI.
 - 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, except with written approval pursuant to Condition B.3 or as specifically provided for in an Incidental Take Statement or Incidental Take Permit for the specific activity.

III. Reports

1. The Permit Holder must submit annual, final, and incident reports, and papers or publications resulting from the research authorized herein 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, MD 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 Chief, Permits Division 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, the Permit Holder 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. The Permits Division may grant authorization to resume permitted activities based on review of the incident report and in consideration of the Terms and Conditions of this permit.

3. An annual report must be submitted to the Chief, Permits Division at the conclusion of each year for which the permit is valid. The annual report describing activities conducted during the previous permit year must follow the format in Appendix 2 of the permit, including a tabular accounting of takes and a narrative description of activities and effects.
4. A final report must be submitted to the Chief, Permits Division 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. The Permit Holder 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 Assistant Regional Administrator(s) for Protected Resources:

Southeast Region (*Email notification preferred*)
Email: nmfs.ser.research.notification@noaa.gov;
NMFS, 263 13th Ave South, St. Petersburg, FL 33701; phone
(727)824-5312; fax (727)824-5309.

Northeast Region

Email: NER.permit.notification@noaa.gov;

NMFS, 55 Great Republic Drive, Gloucester, MA 01930; phone (978)281-9328; fax (978)281-9394.

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. The appropriate Regional Office(s) listed in F.1.b may be contacted for information about coordinating with other Permit Holders.
3. In addition to the terms and conditions of this permit, Researchers must comply with protocols provided by the Regional Administrators related to coordination of research, including additional mitigation and monitoring protocols deemed necessary to minimize unnecessary duplication, harassment, or other adverse impacts from multiple permit holders.

V. Observers and Inspections

1. NMFS may review activities conducted pursuant to this permit. At the request of NMFS, the Permit Holder must cooperate with any such review by:
 - a. Allowing an employee of NOAA or other person designated by the Director, NMFS Office of Protected Resources to observe permitted activities; and
 - b. Providing all documents or other information relating to the permitted activities.

VI. Modification, Suspension, and Revocation

1. Permits are 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 Director, NMFS Office of Protected Resources may modify, suspend, or revoke this 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 103 of the MMPA and 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 request¹ 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 this permit and information provided to NOAA personnel pursuant to Section G of this 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 this 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 Holder, including those of a continuing nature.

VII. Penalties and Permit Sanctions

1. A person who violates a provision of this 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

The NMFS approaches its 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

¹ The Permit Holder may request changes to the permit related to: the objectives or purposes of the permitted activities; the species or number of animals taken; and the location, time, or manner of taking or importing protected species. Such requests must be submitted in writing to the Permits Division in the format specified in the application instructions.

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 individuals’ “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, expert opinion, and the general scientific literature.

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 supplemented these searches with electronic searches of doctoral dissertations and master's theses, as well as additional published literature available through the Los Angeles County Museum of Natural History and the Archie Carr Sea Turtle Library. These searches specifically tried to identify data or other information that supports a particular conclusion (for example, a study that suggests sea turtles will exhibit a particular response to aircraft approach) 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).

During the course of consultation, we necessarily made several assumptions in our analyses.

1. The action would be carried out in the manner described, including the use of methods described in handling guidelines for several protected species (Bigg and Fisher 1974; Epperly et al. 2004)(NMFS 2007)(Kahn and Mohead 2010).
2. No major alteration to the action area would occur during the course of the proposed action that would alter fundamental justification for species occurring

where and to the extent they do, as well as the reasoning for their presence in the action area.

Action Area

The proposed action area includes a broad region of the Gulf of Mexico and Atlantic Ocean from the New York/Connecticut border coastally to Brownsville, Texas (excluding the region from Cape Canaveral to the Florida Keys) and includes waters essentially from shore to the U.S. EEZ extent. Some longline activities may also occur in the Caribbean Sea. Activities could occur at any time of year, but trawling activities would be concentrated between October and April.

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.*) or are anticipated to be protected within the time frame of the proposed action.

Table 1. Listed resources in the action area. Asterisks denote critical habitat in the action area.

| <i>Common Name (Distinct Population Segment, Evolutionarily Significant Unit, or Subspecies)</i> | <i>Scientific Name</i> | <i>Status</i> |
|--|-------------------------------|---------------------|
| <i>Cetaceans</i> | | |
| Blue whale | <i>Balaenoptera musculus</i> | Endangered |
| Fin whale | <i>Balaenoptera physalus</i> | Endangered |
| Humpback whale | <i>Megaptera novaeangliae</i> | Endangered |
| North Atlantic right whale* | <i>Eubalaena glacialis</i> | Endangered |
| Sei whale | <i>Balaenoptera borealis</i> | Endangered |
| Sperm whale | <i>Physeter macrocephalus</i> | Endangered |
| <i>Marine Turtles</i> | | |
| Green sea turtle (Florida & Mexico's Pacific coast colonies) | <i>Chelonia mydas</i> | Endangered |
| Green sea turtle (All other areas) | | Threatened |
| Hawksbill sea turtle | <i>Eretmochelys imbricate</i> | Endangered |
| Kemp's ridley sea turtle | <i>Lepidochelys kempii</i> | Endangered |
| Leatherback sea turtle | <i>Dermochelys coriacea</i> | Endangered |
| Loggerhead sea turtle (northwestern Atlantic DPS) | <i>Caretta caretta</i> | Endangered |
| Olive ridley sea turtle | <i>Lepidochelys olivacea</i> | Threatened |
| <i>Anadromous Fishes</i> | | |
| Smalltooth sawfish* | <i>Pristis pectinata</i> | Endangered |
| Large-tooth sawfish | <i>Pristis perotteti</i> | Endangered |
| <i>Marine Invertebrates</i> | | |
| Elkhorn coral* | <i>Acropora palmata</i> | Threatened |
| Staghorn coral* | <i>Acropora cervicornis</i> | Threatened |
| <i>Proposed for listing</i> | | |
| Atlantic sturgeon (New York Bight DPS) | <i>Acipenser oxyrinchus</i> | Proposed endangered |
| Atlantic sturgeon (Chesapeake Bay DPS) | <i>Acipenser oxyrinchus</i> | Proposed |

| <i>Common Name (Distinct Population Segment, Evolutionarily Significant Unit, or Subspecies)</i> | <i>Scientific Name</i> | <i>Status</i> |
|--|-----------------------------|---------------------|
| | | endangered |
| Atlantic sturgeon (South Atlantic DPS) | <i>Acipenser oxyrinchus</i> | Proposed endangered |

Species not considered further

Blue, fin, humpback, sei, North Atlantic right, and sperm whales may be exposed to stressors associated with the proposed action, such as fuel leakage, acoustic noise exposure, ship strike, and entanglement. The potential for fuel or oil leakages and ship strikes are extremely unlikely. The former would likely pose a significant risk to the vessel and its crew and actions to correct a leak should occur immediately to the extent possible. In the event that a leak should occur, the amount of fuel and oil onboard research vessels is incapable of causing widespread, high-dose contamination that would impact listed species or critical habitats directly or pose hazards to their food sources. Over the past decade of activities (including several hundred trawls and longline sets), we are not aware of a ship strike or harassment of a listed marine mammal. We do not expect a significant probability of ship strike due to low whale density as well as the lack of strikes in the past. We expect that research vessels will add to the local noise environment in its operating area due to the propulsion and other noise characteristics of the vessel's machinery. This contribution is likely small in the overall regional sound field. The research vessel's passage past a whale would be brief and not likely to be significant in impacting any individual's ability to feed, reproduce, or avoid predators. Brief interruptions in communication via masking are possible, but unlikely given the habits of whales to move away from vessels, either as a result of engine noise, the physical presence of the vessel, or both (Lusseau 2006). The towed trawling gear and longline sets could come in direct contact with a listed marine mammal. Entanglement of listed marine mammals is highly unlikely due to the low density of listed marine mammals in the action area and lack of entanglement history over the past decade of similar SEFSC research in the region. As we do not expect listed marine mammals to be exposed to stressors associated with the proposed action that may cause an adverse affect, we do not consider these species further in this consultation.

It is possible that largetooth sawfish may be caught by longline or trawl surveys. Historically, largetooth sawfish have occurred in the Gulf of Mexico. However, no individuals have been documented in the region for several decades, likely due to curtailment of habitat and severe population depression. Based upon the rarity of the species in the action area (or its current absence) and the lack of reported or observed bycatch in much larger commercial fisheries in the action area in the recent past, we do not consider largetooth sawfish further in this analysis.

Even though elkhorn and staghorn coral co-occur with the proposed action area, we do not expect trawling or longline activities to occur in the specific areas where these species occur due to the risk of gear loss in reef areas. Elkhorn and staghorn coral are therefore not considered further in this consultation.

Although critical habitat has been defined for smalltooth sawfish, North Atlantic right

whales, as well as elkhorn and staghorn coral in the action area, primary constituent elements were not identified in the listings. However, these areas were identified as being significant to breeding and nursing. We do not expect any stressors associated with the proposed research to influence the quality of smalltooth sawfish, North Atlantic right whale, staghorn coral, or elkhorn coral critical habitat for these aspects of the species' biology. We therefore do not consider critical habitat further in this Opinion.

The biology and ecology of species (green, hawksbill, Kemp's ridley, leatherback, northwestern Atlantic loggerhead DPS, and olive ridley sea turtles as well as smalltooth sawfish and proposed Atlantic sturgeon DPSs) 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 2003).

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. 2006a) |
| 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) |
| 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) |
| 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 | (Maison et al. 2010) |
| 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 (Bjørndal 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; Bjørndal 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 (Chaloupka et al. 2004; Chaloupka and Musick 1997; Hirth 1997; 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 1997), these reproductive longevity estimates suggest that a female may nest 3 to 11 seasons over the course of her life. Based on reasonable means of three nests per season and 100 eggs per nest (Hirth 1997), 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 Garçon 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; Tiwari et al. 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 (Bjørndal 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). 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 20° C in the coldest month, but may occur considerably north of these regions during warm-water events, such as El Niño. Stinson (1984b) found green turtles to appear most frequently in U.S. coastal waters with temperatures exceeding 18° 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 1998a). 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 (Bjørndal 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. 1995; 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 matter 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 1998a). 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).

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.

Based on the mean annual reproductive effort, 108,761-150,521 females nest each year among 46 worldwide sites whose nesting abundance is monitored. 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 2004).

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 1993a; 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).

All other areas. Nesting populations are doing relatively well in the western Atlantic and central Atlantic Ocean. In contrast, populations are doing relatively poorly in Southeast Asia, the eastern Indian Ocean, and perhaps the Mediterranean.

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; Witherington et al. 2007). 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).

In the Atlantic, green sea turtles are captured and killed in turtle fisheries in Colombia, Grenada, the Lesser Antilles, Nicaragua, St. Vincent and the Grenadines; the turtle fishery along the Caribbean coast of Nicaragua, by itself, has captured more than 11,000 green sea turtles annually over the past decade (Bräutigam and Eckert 2006b; Lagueux 1998). While these threats have been largely eliminated in Florida due to successful conservation measures, the hunting of juvenile and adult turtles continues both legally and illegally in many foraging areas where green sea turtles originating from Florida are known to occur (Chacon 2002; Fleming 2001).

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 majuscula* could promote the development of fibropapillomatosis (Arthur et al. 2008). It has also been

theorized that dinoflagellates of the genus *Prorocentrum* that produce the tumorigenic compound okadaic 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.

Hawksbill sea turtle

Distribution. The hawksbill has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical waters of the Atlantic, Indian, and Pacific oceans. Satellite tagged turtles have shown significant variation in movement and migration patterns. In the Caribbean, distance traveled between nesting and foraging locations ranges from a few kilometers to a few hundred kilometers (Byles and Swimmer 1994; Hillis-Starr et al. 2000; Horrocks et al. 2001; Lagueux et al. 2003; Miller et al. 1998; Prieto et al. 2001).

Population designation. Populations are distinguished generally by ocean basin and more specifically by nesting location. Our understanding of population structure is relatively poor. For example, genetic analysis of hawksbill sea turtles foraging off the Cape Verde Islands identified three closely-related haplotypes in a large majority of individuals sampled that did not match those of any known nesting population in the Western Atlantic, where the vast majority of nesting has been documented (McClellan et al. 2010; Monzon-Arguello et al. 2010).

Migration and movement. Upon first entering the sea, neonatal hawksbills in the Caribbean are believed to enter an oceanic phase that may involve long distance travel and eventual recruitment to nearshore foraging habitat (Boulon 1994). In the marine environment, the oceanic phase of juveniles (i.e., the "lost years") remains one of the most poorly understood aspects of hawksbill life history, both in terms of where turtles occur and how long they remain oceanic. Nesting site selection in the southwest Pacific appears to favor sites with higher wind and wave exposure, possibly as a means to aid hatchling dispersal (Garcon et al. 2010).

Habitat. Hawksbill sea turtles are highly migratory and use a wide range of broadly separated localities and habitats during their lifetimes (Musick and Limpus 1997; Plotkin 2003). Small juvenile hawksbills (5-21 cm straight carapace length) have been found in association with *Sargassum* spp. in both the Atlantic and Pacific oceans (Musick and Limpus 1997) and observations of newly hatched hawksbills attracted to floating weed have been made (Hornell 1927; Mellgren and Mann 1996; Mellgren et al. 1994). Post-oceanic hawksbills may occupy a range of habitats that include coral reefs or other hard-bottom habitats, sea grass, algal beds, mangrove bays and creeks (Bjorndal and Bolten 2010; Musick and Limpus 1997), and mud flats (R. von Brandis, unpublished data in NMFS and USFWS 2007c). Individuals of multiple breeding locations can occupy the same foraging habitat (Bass 1999; Bowen et al. 1996; Bowen et al. 2007; Diaz-Fernandez et al. 1999; Velez-Zuazo et al. 2008). As larger juveniles, some individuals may associate with the same feeding locality for more than a decade, while others apparently migrate from one site to another (Blumenthal et al. 2009a; Mortimer et al. 2003; Musick

and Limpus 1997). Larger individuals may prefer deeper habitats than their smaller counterparts (Blumenthal et al. 2009a). Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al. 2010).

Hawksbill sea turtles appear to be rare visitors to the Gulf of Mexico, with Florida being the only Gulf state with regular sightings (Forester and Machlis 1996; Hildebrand 1983; NMFS and USFWS 1993; Rabalais and Rabalais 1980; Witzell 1983). Individuals stranded in Texas are generally young (hatchlings or yearlings) originating from Mexican nesting beaches (Amos 1989; Collard and Ogren 1990; Hildebrand 1983; Landry and Costa 1999).

Feeding. Dietary data from oceanic stage hawksbills are limited, but indicate a combination of plant and animal material (Bjorndal 1997).

Diving. Hawksbill diving ability varies with age and body size. As individuals increase with age, diving ability in terms of duration and depth increases (Blumenthal et al. 2009b). Studies of hawksbills in the Caribbean have found diurnal diving behavior, with dive duration nearly twice as long during nighttime (35-47 min) compared to daytime (19-26 min Blumenthal et al. 2009b; Van Dam and Diez 1997). Daytime dives averaged 5 m, while nighttime dives averaged 43 m (Blumenthal et al. 2009b)

Hawksbills have long dive durations, although dive depths are not particularly deep. Adult females along St. Croix reportedly have average dive times of 56 min, with a maximum time of 73.5 min (Starbird et al. 1999). Average day and night dive times were 34–65 and 42–74 min, respectively. Immature individuals have much shorter dives of 8.6–14 min to a mean depth of 4.7 m while foraging (Van Dam and Diez 1997).

Status and trends. Hawksbill sea turtles received protection on June 2, 1970 (35 FR 8495) under the Endangered Species Conservation Act and since 1973 have been listed as endangered under the ESA. Although no historical records of abundance are known, hawksbill sea turtles are considered to be severely depleted due to the fragmentation and low use of current nesting beaches (NMFS and USFWS 2007c). Worldwide, an estimated 21,212-28,138 hawksbills nest each year among 83 sites. Among the 58 sites for with historic trends, all show a decline during the past 20 to 100 years. Among 42 sites for which recent trend data are available, 10 (24%) are increasing, three (7%) are stable and 29 (69%) are decreasing. Encouragingly, nesting range along Mexico and Central America appears not to have contracted and estimates continue to increase as additional dedicated study is conducted in the eastern Pacific (Gaos et al. 2010).

Atlantic Ocean. Atlantic nesting sites include: Antigua (Jumby Bay), the Turks and Caicos, Barbados, the Bahamas, Puerto Rico (Mona Island), the U.S. Virgin Islands, the Dominican Republic, Sao Tome, Guadeloupe, Trinidad and Tobago, Jamaica, Martinique, Cuba (Doce Leguas Cays), Mexico (Yucatan Peninsula), Costa Rica (Tortuguero National Park), Guatemala, Venezuela, Bijagos Archipelago, Guinea-Bissau, and Brazil.

Population increase has been greater in the Insular Caribbean than along the Western Caribbean Mainland or the eastern Atlantic (including Sao Tomé and Equatorial Guinea). Nesting populations of Puerto Rico appeared to be in decline until the early 1990s, but have universally increased during the survey periods. Mona Island now hosts 199-332

nesting females annually, and the other sites combined host 51-85 nesting females annually (R.P. van Dam and C.E. Diez, unpublished data in NMFS and USFWS 2007c) (C.E. Diez, Chelonia, Inc., in litt. to J. Mortimer 2006). The U.S. Virgin Islands have a long history of tortoiseshell trade (Schmidt 1916). At Buck Island Reef National Monument, protection has been in force since 1988, and during that time, hawksbill nesting has increased by 143% to 56 nesting females annually, with apparent spill over to beaches on adjacent St. Croix (Z. Hillis-Starr, National Park Service, in litt. to J. Mortimer 2006). However, St. John populations did not increase, perhaps due to the proximity of the legal turtle harvest in the British Virgin Islands (Z. Hillis-Starr, National Park Service, in litt. to J. Mortimer 2006). Populations have also been identified in Belize and Brazil as genetically unique (Hutchinson and Dutton 2007). An estimated 50-200 nests are laid per year in the Guinea-Bissau (Catry et al. 2009).

Pacific Ocean. American Samoa and Western Samoa host fewer than 30 females annually (Grant et al. 1997; Tuato'o-Bartley et al. 1993). In Guam, only 5-10 females are estimated to nest annually (G. Balazs, NMFS, in litt. to J. Mortimer 2007; G. Davis, NMFS, in litt. to J. Mortimer 2007) and the same is true for Hawaii, but there are indications that this population is increasing (G. Balazs, pers. comm. in NMFS and USFWS 2007c). Additional populations are known from the eastern Pacific (potentially extending from Mexico through Panama), northeastern Australia, and Malaysia (Hutchinson and Dutton 2007).

Indian Ocean. The Indian Ocean hosts several populations of hawksbill sea turtles (Hutchinson and Dutton 2007; Spotila 2004b). These include western Australian, Andaman and Nicobar islands, Maldives, Seychelles, Burma, East Africa, Egypt, Oman, Saudi Arabia, Sudan, and Yemen.

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 be lethal. The only other significant natural threat to hawksbill sea turtles is from hybridization of hawksbills with other species of sea turtles. This is especially problematic at certain sites where hawksbill numbers are particularly low (Mortimer and Donnelly in review). Predators (primarily of eggs and hatchlings) include dogs, pigs, rats, crabs, sea birds, reef fishes, groupers, feral cats, and foxes (Bell et al. 1994; Ficetola 2008). In some areas, nesting beaches can be almost completely destroyed and all nests can sustain some level of depredation (Ficetola 2008).

Anthropogenic threats. Threats to hawksbill sea turtles are largely anthropogenic, both historically and currently. Impacts to nesting beaches include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997b). Because hawksbills prefer to nest under vegetation (Horrocks and Scott 1991; Mortimer 1982), they are particularly impacted by beachfront development and clearing of dune vegetation (Mortimer and Donnelly in review). 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). One of the most detrimental human threats to hawksbill sea turtles is the intensive harvest of eggs from nesting beaches.

In addition to impacting the terrestrial zone, anthropogenic disturbances also threaten coastal marine habitats. 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). Hawksbills are typically associated with coral reefs, which are among the world's most endangered marine ecosystems (Wilkinson 2000). Although primarily spongivorous, bycatch of hawksbill sea turtles in the swordfish fishery off South Africa occurs (Petersen et al. 2009).

The killing of nesting hawksbill females continues to threaten the stability of hawksbill subpopulations in many areas. The centuries-old historic trade in tortoise shell greatly impacted hawksbill populations in the Insular Caribbean. Increases in nesting hawksbills in the region coincide with the decline of international trade in hawksbill shell (Milliken and Tokunaga 1987), and in particular with the 90% reduction in the annual take of large hawksbills from Cuban waters (Carrillo et al. 1999).

Future impacts from climate change and global warming may result in significant changes in hatchling sex ratios. The fact that hawksbill turtles exhibit temperature-dependent sex determination (Wibbels 2003) suggests that there may be a skewing of future hawksbill cohorts toward strong female bias (since warmer temperatures produce more female embryos).

Critical habitat. On September 2, 1998, the NMFS established critical habitat for hawksbill sea turtles around Mona and Monito Islands, Puerto Rico (63 FR 46693). Aspects of these areas that are important for hawksbill sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for hawksbill sea turtle prey.

Kemp's ridley sea turtle

Distribution. The Kemp's ridley was formerly known only from the Gulf of Mexico and along the Atlantic coast of the U.S. (TEWG 2000). However, recent records support Kemp's ridley sea turtles distribution extending into the Mediterranean Sea on occasion (Tomas and Raga 2008). The vast majority of individuals stem from breeding beaches at Rancho Nuevo on the Gulf of Mexico coast of Mexico.

Movement and migration. Tracking of post-nesting females from Rancho Nuevo and Texas beaches indicates that turtles move along coastal migratory corridors either to the north or south from the nesting beach (Byles 1989b; Byles and Plotkin 1994; Renaud 1995b; Renaud et al. 1996; Shaver 1999; Shaver 2002). These migratory corridors appear to extend throughout the coastal areas of the Gulf of Mexico and most turtles appear to travel in waters less than roughly 164 feet in depth. Turtles that headed north and east traveled as far as southwest Florida, whereas those that headed south and east traveled as far as the Yucatan Peninsula, Mexico (Morreale et al. 2007).

Following migration, Kemp's ridley sea turtles settle into resident feeding areas for several months (Byles and Plotkin 1994; Morreale et al. 2007). Females may begin returning along relatively shallow migratory corridors toward the nesting beach in the winter in order to arrive at the nesting beach by early spring.

Reproduction. Mating is believed to occur about three to four weeks prior to the first

nesting (Rostal 2007), or late March through early to mid April. It is presumed that most mating takes place near the nesting beach (Morreale et al. 2007; Rostal 2007). Females initially ovulate within a few days after successful mating and lay the first clutch approximately two to four weeks later; if a turtle nests more than once per season, subsequent ovulations occur within approximately 48 hours after each nesting (Rostal 2007).

Approximately 60% of Kemp's ridley nesting occurs along an approximate 25-mile stretch of beach near Rancho Nuevo, Tamaulipas, Mexico from April to July, with limited nesting to the north (100 nests along Texas in 2006) and south (several hundred nests near Tampico, Mexico in 2006 USFWS 2006). Nesting at this location may be particularly important because hatchlings can more easily migrate to foraging grounds (Putman et al. 2010). The Kemp's ridley sea turtle tends to nest in large aggregations or arribadas (Bernardo and Plotkin 2007). The period between Kemp's ridley arribadas averages approximately 25 days, but the precise timing of the arribadas is unpredictable (Bernardo and Plotkin 2007; Rostal et al. 1997). Like all sea turtles, Kemp's ridley sea turtles nest multiple times in a single nesting season. The most recent analysis suggests approximately 3.075 nests per nesting season per female (Rostal 2007). The annual average number of eggs per nest (clutch size) is 94 to 100 and eggs typically take 45 to 58 days to hatch, depending on temperatures (Marquez-M. 1994; Rostal 2007; USFWS 2000; USFWS 2001; USFWS 2002; USFWS 2003; USFWS 2004; USFWS 2005; USFWS 2006). The period between nesting seasons for each female is approximately 1.8 to 2.0 years (Marquez et al. 1989; Rostal 2007; TEWG 2000). The nesting beach at Rancho Nuevo may produce a "natural" hatchling sex ratio that is female-biased, which can potentially increase egg production as those turtles reach sexual maturity (Coyne and Landry Jr. 2007; Wibbels 2007).

Growth. Kemp's ridleys require approximately 1.5 to two years to grow from a hatchling to a size of approximately 7.9 inches long, at which size they are capable of making a transition to a benthic coastal immature stage, but can range from one to four years or more (Caillouet et al. 1995; Ogren 1989; Schmid 1998; Schmid and Witzell 1997; Snover et al. 2007; TEWG 2000; Zug et al. 1997). Based on the size of nesting females, it is assumed that turtles must attain a size of approximately 23.6 inches long prior to maturing (Marquez-M. 1994). Growth models based on mark-recapture data suggest that a time period of seven to nine years would be required for this growth from benthic immature to mature size (Schmid and Witzell 1997; Snover et al. 2007). Currently, age to sexual maturity is believed to range from approximately 10 to 17 years for Kemp's ridleys (Snover et al. 2007). However, estimates of 10 to 13 years predominate in previous studies (Caillouet et al. 1995; Schmid and Witzell 1997; TEWG 2000).

Habitat. Stranding data indicate that immature turtles in this benthic stage are found in coastal habitats of the entire Gulf of Mexico and U.S. Atlantic coast (Morreale et al. 2007; TEWG 2000). Developmental habitats for juveniles occur throughout the entire coastal Gulf of Mexico and U.S. Atlantic coast northward to New England (Morreale et al. 2007; Schmid 1998; Wibbels et al. 2005). Key foraging areas in the Gulf of Mexico include Sabine Pass, Texas; Caillou Bay and Calcasieu Pass, Louisiana; Big Gulley, Alabama; Cedar Keys, Florida; and Ten Thousand Islands, Florida (Carr and Caldwell

1956; Coyne et al. 1995; Ogren 1989; Schmid 1998; Schmid et al. 2002; Witzell et al. 2005b). Foraging areas studied along the Atlantic coast include Pamlico Sound, Chesapeake Bay, Long Island Sound, Charleston Harbor, and Delaware Bay. Near-shore waters of 120 feet or less provide the primary marine habitat for adults, although it is not uncommon for adults to venture into deeper waters (Byles 1989a; Mysing and Vanselow 1989; Renaud et al. 1996; Shaver et al. 2005; Shaver and Wibbels 2007b).

Benthic coastal waters of Louisiana and Texas seem to be preferred foraging areas for Kemp's ridley sea turtles (particularly passes and beachfronts), although individuals may travel along the entire coastal margin of the Gulf of Mexico (Landry and Costa 1999; Landry et al. 1996; Renaud 1995a). Sightings are less frequent during winter and spring, but this is likely due to lesser sighting effort during these times (Keinath et al. 1996; Shoop and Kenney 1992b).

Feeding. Kemp's ridley diet consists mainly of swimming crabs, but may also include fish, jellyfish, and an array of mollusks.

Dividing. Kemp's ridley sea turtles can dive from a few seconds in duration to well over two and a half hours, although most dives are from 16 to 34 minutes (Mendonca and Pritchard 1986; Renaud 1995b). Individuals spend the vast majority of their time underwater; over 12-hour periods, 89% to 96% of their time is spent below the surface (Byles 1989b; Gitschlag 1996).

Status and trends. The Kemp's ridley sea turtle was listed as endangered on December 2, 1970 (35 FR 18319). Internationally, the Kemp's ridley is considered the most endangered sea turtle (NRC 1990b; USFWS 1999).

During the mid 20th century, the Kemp's ridley was abundant in the Gulf of Mexico. Historic information indicates that tens of thousands of Kemp's ridleys nested near Rancho Nuevo, Mexico, during the late 1940s (Hildebrand 1963). From 1978 through the 1980s, arribadas were 200 turtles or less, and by 1985, the total number of nests at Rancho Nuevo had dropped to approximately 740 for the entire nesting season, or a projection of roughly 234 turtles (TEWG 2000; USFWS and NMFS 1992). Beginning in the 1990s, an increasing number of beaches in Mexico were being monitored for nesting, and the total number of nests on all beaches in Tamaulipas and Veracruz in 2002 was over 6,000; the rate of increase from 1985 to 1999 was 11.3% annually (TEWG 2000; USFWS 2002). In 2006, approximately 7,866 nests were laid at Rancho Nuevo with the total number of nests for all the beaches in Mexico estimated at about 12,000 nests, which amounted to about 4,000 nesting females based upon three nests per female per season (Rostal 2007; Rostal et al. 1997; USFWS 2006). Considering remigration rates, the population included approximately 7,000 to 8,000 adult female turtles at that time (Marquez et al. 1989; Rostal 2007; TEWG 2000). Most recently, the 2007 nesting season included an arribada of over 4,000 turtles over a three-day period at Rancho Nuevo (P. Burchfield, pers. comm. in NMFS and USFWS 2007a). The increased recruitment of new adults is illustrated in the proportion of first time nesters, which has increased from 6% in 1981 to 41% in 1994. Average population growth was estimated at 13% per year between 1991 and 1995 (TEWG 1998a). Nesting has also expanded geographically, with a headstart program reestablishing nesting on South Padre Island starting in 1978. Growth remained slow until 1988, when rates of return started to grow slowly (Shaver

and Wibbels 2007a). In 2006, 101 nests were laid compared to 51 the year before (NPS 2006).

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. Kemp’s ridley sea turtles are particularly prone to this phenomenon along Cape Cod (Innis et al. 2009).

Anthropogenic threats. Population decline has been curtailed due to the virtual elimination of sea turtle and egg harvesting, as well as assistance in hatching and raising hatchlings (head-start). However, habitat destruction remains a concern in the form of bottom trawling and shoreline development. Trawling destroys habitat utilized by Kemp’s ridley sea turtles for feeding and construction activities can produce hazardous runoff. Bycatch is also a source of mortality for Kemp’s ridley sea turtles (McClellan et al. 2009).

Toxin burdens in Kemp’s ridley sea turtles include DDT, DDE, PCBs, PFOA, PFOS, chlordane, and other organochlorines (Keller et al. 2005; Keller et al. 2004a; Lake et al. 1994; Rybitski et al. 1995). These contaminants have the potential to cause deficiencies in endocrine, developmental and reproductive health, and are known to depress immune function in loggerhead sea turtles (Keller et al. 2006; Storelli et al. 2007a). Along with loggerheads, Kemp’s ridley sea turtles have higher levels of PCB and DDT than leatherback and green sea turtles (Pugh and Becker 2001b). Organochlorines, including DDT, DDE, DDD, and PCBs have been identified as bioaccumulative agents and in greatest concentration in subcutaneous lipid tissue (Rybitski et al. 1995). Concentrations ranged from 7.46 $\mu\text{g/kg}$ to 607 $\mu\text{g/kg}$, with a mean of 252 $\mu\text{g/kg}$ in lipid tissue. Five PCB congeners composed most of the contaminants: 153/132, 138/158, 180, 118, and 187 in order of concentration. PCBs have also been identified in the liver, ranging in concentration from 272 ng/g to 655 ng/g of wet weight, values that are several fold higher than in other sea turtle species (Lake et al. 1994). However, concentrations are reportedly 5% of that which causes reproductive failure in snapping turtles. DDE was identified to range from 137 ng/g to 386 ng/g wet weight. Trans-nonachlor was found at levels between 129 ng/g and 275 ng/g wet weight. Blood samples may be appropriate proxies for organochlorines in other body tissues (Keller et al. 2004a).

Perfluorinated compounds in the forms of PFOA and PFOS have been identified in the blood of Kemp’s ridley turtles at concentrations of 39.4 ng/mL and 3.57 ng/mL , respectively (Keller et al. 2005). PFCAs have also been detected. It is likely that age and habitat are linked to PFC bioaccumulation.

Oil can also be hazardous to Kemp’s ridley turtles, with fresh oil causing significant mortality and morphological changes in hatchlings, but aged oil having no detectable effects (Fritts and McGehee 1981). Blood levels of metals are lower in Kemp’s ridley sea turtles than in other sea turtles species or similar to them, with copper (215 ng/g to 1,300 ng/g), lead (0 to 34.3 ng/g), mercury (0.5 ng/g to 67.3 ng/g), silver (0.042 ng/g to 2.74 ng/g), and zinc (3,280 ng/g to 18,900 ng/g) having been identified (Innis et al. 2008; Orvik 1997). It is likely that blood samples can be used as an indicator of metal concentration. Mercury has been identified in all turtle species studied, but are generally an order of magnitude lower than toothed whales. The higher level of contaminants

found in Kemp's ridley sea turtles are likely due to this species tendency to feed higher on the food chain than other sea turtles. Females from sexual maturity through reproductive life should have lower levels of contaminants than males because contaminants are shared with progeny through egg formation.

In addition to commercial bycatch, recreational hook-and-line interaction also occurs. Cannon and Flanagan (1996) reported that from 1993 to 1995, at least 170 Kemp's ridley sea turtles were hooked or tangled by recreational hook-and-line gear in the northern Gulf of Mexico. Of these, 18 were dead stranded turtles, 51 were rehabilitated turtles, five died during rehabilitation, and 96 were reported as released by fishermen.

Critical habitat. NMFS has not designated critical habitat for Kemp's ridley sea turtle.

Leatherback sea turtle

Distribution. Leatherbacks range farther than any other sea turtle species, having evolved physiological and anatomical adaptations that allow them to exploit cold waters (Frair et al. 1972; Greer et al. 1973; USFWS 1995). High-latitude leatherback range includes in the Atlantic includes the North and Barents Seas, Newfoundland and Labrador, Argentina, and South Africa (Goff and Lien 1988; Hughes et al. 1998; Luschi et al. 2003; Luschi et al. 2006; Márquez 1990; Threlfall 1978). Pacific ranges extend to Alaska, Chile, and New Zealand (Brito 1998; Gill 1997; Hodge and Wing 2000).

Leatherbacks also occur in Mediterranean and Indian Ocean waters (Casale et al. 2003; Hamann et al. 2006b). Associations exist with continental shelf and pelagic environments and sightings occur in offshore waters of 7-27° C (CETAP 1982). Juvenile leatherbacks usually stay in warmer, tropical waters >21° C (Eckert 2002). Males and females show some degree of natal homing to annual breeding sites (James et al. 2005).

Population designations. Leatherbacks break into four nesting aggregations: Pacific, Atlantic, and Indian oceans, and the Caribbean Sea. Detailed population structure is unknown, but is likely dependent upon nesting beach location.

Atlantic Ocean. Nesting aggregations occur along Gabon, Sao Tome and Principe, French Guiana, Suriname, and Florida (Bräutigam and Eckert 2006a; Márquez 1990; Spotila et al. 1996). Widely dispersed but fairly regular African nesting also occurs between Mauritania and Angola (Fretey et al. 2007). Many sizeable populations (perhaps up to 20,000 females annually) of leatherbacks are known to nest in West Africa (Fretey 2001b). The population of leatherbacks nesting on Gabon beaches has been suggested as being the world's largest, with 36,185-126,480 clutches being laid by 5,865-20,499 females annually from 2002-2007 (Witt et al. 2009). The total number of females utilizing Gabon nesting beaches is estimated to be 15,730- 41,373 (Witt et al. 2009). Genetic analyses support distinct subpopulations within the Atlantic basin, including the St. Croix (U.S.V.I.), Trinidad, and mainland Caribbean (Florida, Costa Rica, Suriname/French Guiana) nesting aggregations (Dutton et al. 1999). Recent analysis suggests seven Atlantic stocks including Florida, northern Caribbean, western Caribbean, southern Caribbean-Guyana Shield-Trinidad, West Africa, South Africa, and Brazil (TEWG 2007). North Atlantic leatherbacks likely number 34,000-94,000 individuals, with females numbering 18,800 and the eastern Atlantic segment numbering 4,700 (TEWG 2007). Trends and numbers include only nesting females and are not a complete

demographic or geographic cross-section. The largest nesting aggregation in the western North Atlantic occurs in French Guiana and Suriname, likely belongs to a metapopulation whose limits remain unknown (Rivalan et al. 2006). Heppell et al. (2003) concluded that leatherbacks generally show less genetic structuring than green and hawksbill sea turtles. The French Guiana nesting aggregation has declined ~15% annually since 1987 (NMFS 2001b). However, from 1979-1986, the number of nests increased ~15% annually, possibly indicating the current decline may be linked with the erosion cycle of Guiana beaches (NMFS 2006e). Guiana nesting may have increased again in the early 2000s (NMFS 2006e). Suriname nesting numbers have recently increased from more than 10,000 nests annually since 1999 and a peak of 30,000 nests in 2001. Overall, Suriname and French Guiana nesting trends towards an increase (Girondot et al. 2007; Hilterman and Govere 2003). Florida (March-July) and U.S. Caribbean nesting since the early 1980s has increased ~0.3% and 7.5% per year, respectively, but lags behind the French Guiana coast and elsewhere in magnitude (NMFS/SEFSC 2001).

Caribbean Sea. Nesting occurs in Puerto Rico, St. Croix, Costa Rica, Panama, Colombia, Trinidad and Tobago, Guyana, Suriname, and French Guiana (Bräutigam and Eckert 2006a; Márquez 1990; Spotila et al. 1996).

Indian Ocean. Nesting is reported in South Africa, India, Sri Lanka, and the Andaman and Nicobar islands (Hamann et al. 2006b).

Pacific Ocean. Leatherbacks are found from tropical waters north to Alaska within the North Pacific and is the most common sea turtle in the eastern Pacific north of Mexico (Eckert 1993b; Stinson 1984a; Wing and Hodge 2002). The west coast of Central America and Mexico hosts nesting from September-March, although Costa Rican nesting peaks during April-May (Chacón-Chaverri and Eckert 2007; LGL Ltd. 2007). Leatherback nesting aggregations occur widely in the Pacific, including China, Malaysia, Papua New Guinea, Indonesia, Thailand, Australia, Fiji, the Solomon Islands, and Central America (Dutton et al. 2007; Limpus 2002). Significant nesting also occurs along the Central American coast (Márquez 1990). Although not generally known to nest on Japanese shores, two nests were identified in the central Ryukyu Islands in 2002 (Kamezaki et al. 2002).

In the Pacific, nesting beaches in Mexico and Costa Rica (nesting occurs October through March) are a separate population from the western Pacific beaches (Benson et al. 2007a; summary in NMFS and USFWS 2007d; Spotila 2004b). In Costa Rica, leatherbacks nest at Playa Naranjo in Santa Rosa National Park, the second-most important nesting beach on the Pacific coast (Yañez et al. 2010), Rio Oro on the Osa Peninsula, and at various beaches in Las Baulas National Park, which includes Playa Langosta and Playa Grande and contains the largest colony of leatherbacks in the Pacific (Spotila 2004b). Females typically lay six clutches per season (average nine days between nests), which incubate for 58–65 days (Lux et al. 2003). Limited nesting also occurs along Nicaragua, Panama, El Salvador, and Guatemala.

Habitat. Leatherbacks occur throughout marine waters, from nearshore habitats to oceanic environments (Grant and Ferrell 1993; Schroeder and Thompson 1987; Shoop and Kenney 1992a; Starbird et al. 1993). Movements are largely dependent upon reproductive and feeding cycles and the oceanographic features that concentrate prey

(Collard 1990; Davenport and Balazs 1991; Frazier 2001; HDLNR 2002). Aerial surveys off the western U.S. support continental slope waters as having greater leatherback occurrence than shelf waters (Bowby et al. 1994; Carretta and Forney 1993; Green et al. 1992; Green et al. 1993). Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al. 2010).

Areas above 30° N in the Atlantic appear to be popular foraging locations (Fossette et al. 2009b). Northern foraging areas were proposed for waters between 35° and 50° N along North American, Nova Scotia, the Gulf of Saint-Laurent, in the western and northern Gulf Stream, the Northeast Atlantic, the Azores front and northeast of the Azores Islands, north of the Canary Islands. Southern foraging was proposed to occur between 5° and 15° N in the Mauritania upwelling, south of the Cape Verde islands, over the Guinea Dome area, and off Venezuela, Guyana and Suriname.

Migration and movement. Leatherback sea turtles migrate throughout open ocean convergence zones and upwelling areas, along continental margins, and in archipelagic waters (Eckert 1998; Eckert 1999; Morreale et al. 1994). In a single year, a leatherback may swim more than 9,600 km to nesting and foraging areas throughout ocean basins (Benson et al. 2007a; Benson et al. 2007b; Eckert 1998; Eckert 2006; Eckert et al. 2006; Ferraroli et al. 2004; Hays et al. 2004; Sale et al. 2006). Much of this travel may be due to movements within current and eddy features, moving individuals along (Sale and Luschi 2009). Return to nesting beaches may be accomplished by a form of geomagnetic navigation and use of local cues (Sale and Luschi 2009). Leatherback females will either remain in nearshore waters between nesting events, or range widely, presumably to feed on available prey (Byrne et al. 2009; Fossette et al. 2009a).

Fossette et al. (2009b) identified three main migratory strategies in leatherbacks in the North Atlantic (almost all of studied individuals were female). One involved 12 individuals traveling to northern latitudes during summer/fall and returning to waters during winter and spring. Another strategy used by six individuals was similar to this, but instead of a southward movement in fall, individuals overwintered in northern latitudes (30-40° N, 25-30° W) and moved into the Irish Sea or Bay of Biscay during spring before moving south to between 5 and 10° in winter, where they remained or returned to the northwest Atlantic. A third strategy, which was followed by three females remaining in tropical waters for the first year subsequent to nesting and moving to northern latitudes during summer/fall and spending winter and spring in latitudes of 40-50° N.

Satellite tracking data reveal that leatherback females leaving Mexican and Central American nesting beaches migrate towards the equator and into Southern Hemisphere waters, some passing the Galápagos Islands, and disperse south of 10°S (Dutton et al. 2006; Shillinger et al. 2010). However, observations of leatherbacks in the Galápagos Islands are rare (Zárate et al. 2010).

Nesting site selection in the southwest Pacific appears to favor sites with higher wind and wave exposure, possibly as a means to aid hatchling dispersal (Garcon et al. 2010).

Sex ratio. A significant female bias exists in all leatherback populations thus far studied. An examination of strandings and in-water sighting data from the U.S. Atlantic and Gulf of Mexico coasts indicates that 60% of individuals were female. Studies of Suriname

nesting beach temperatures suggest a female bias in hatchlings, with estimated percentages of females hatched over the course of each season at 75.4, 65.8, and 92.2% in 1985, 1986, and 1987, respectively (Plotkin 1995). Binckley et al. (1998) found a heavy female bias upon examining hatchling gonad histology on the Pacific coast of Costa Rica, and estimated male to female ratios over three seasons of 0:100, 6.5:93.5, and 25.7:74.3. James et al. (2007) also found a heavy female bias (1.86:1) as well as a primarily large sub-adult and adult size distribution. Leatherback sex determination is affected by nest temperature, with higher temperatures producing a greater proportion of females (Mrosovsky 1994; Witzell et al. 2005a).

Feeding. Leatherbacks may forage in high-invertebrate prey density areas formed by favorable features (Eckert 2006; Ferraroli et al. 2004). Although leatherbacks forage in coastal waters, they appear to remain primarily pelagic through all life stages (Heppell et al. 2003). The location and abundance of prey, including medusae, siphonophores, and salpae, in temperate and boreal latitudes likely has a strong influence on leatherback distribution in these areas (Plotkin 1995). Leatherback prey are frequently found in the deep-scattering layer in the Gulf of Alaska (Hodge and Wing 2000). North Pacific foraging grounds contain individuals from both eastern and western Pacific rookeries, although leatherbacks from the eastern Pacific generally forage in the Southern Hemisphere along Peru and Chile (Dutton 2005-2006; Dutton et al. 2000; Dutton et al. 1998). Mean primary productivity in all foraging areas of western Atlantic females is 150% greater than in eastern Pacific waters, likely resulting in twice the reproductive output of eastern Pacific females (Saba et al. 2007). Leatherbacks have been observed feeding on jellyfish in waters off Washington State and Oregon (Eisenberg and Frazier 1983; Stinson 1984a).

Diving. Leatherbacks are champion deep divers among sea turtles with a maximum-recorded dive of over 4,000 m (Eckert et al. 1989; López-Mendilaharsu et al. 2009). Dives are typically 50-84 m and 75-90% of time duration is above 80 m (Standora et al. 1984). Leatherbacks off South Africa were found to spend <1% of their dive time at depths greater than 200 m (Hays et al. 2009). Dive durations are impressive, topping 86 min, but routinely 1-14 min (Eckert et al. 1989; Eckert et al. 1996; Harvey et al. 2006; López-Mendilaharsu et al. 2009). Most of this time is spent traveling to and from maximum depths (Eckert et al. 1989). Dives are continual, with only short stays at the surface (Eckert et al. 1989; Eckert et al. 1986; Southwood et al. 1999). Off Playa Grande, Costa Rica, adult females spent 57–68% of their time underwater, diving to a mean depth of 19 m for 7.4 min (Southwood et al. 1999). Off St. Croix, adult females dove to a mean depth of 61.6 m for an average of 9.9 min, and spent an average of 4.9 min at the surface (Eckert et al. 1989). During shallow dives in the South China Sea, dives averaged 6.9–14.5 min, with a maximum of 42 min (Eckert et al. 1996). Off central California, leatherbacks dove to 20–30 m with a maximum of 92 m (Harvey et al. 2006). This corresponded to the vertical distribution of their prey (Harvey et al. 2006). Leatherback prey in the Gulf of Alaska are frequently concentrated in the deep-scattering layer (Hodge and Wing 2000). Mean dive and surface durations were 2.9 and 2.2 min, respectively (Harvey et al. 2006). In a study comparing diving patterns during foraging versus travelling, leatherbacks dove shallower (mean of 53.6 m) and moved more slowly (17.2 km/day) while in foraging areas while travelling to or from these areas (81.8 m and 51.0 km/day) (Fossette et al. 2009b).

Status and trends. Leatherback sea turtles received protection on June 2, 1970 (35 FR 8491) under the Endangered Species Conservation Act and, since 1973, have been listed as endangered under the ESA, but declines in nesting have continued worldwide. Breeding females were initially estimated at 29,000-40,000, but were later refined to ~115,000 (Pritchard 1971; Pritchard 1982). Spotila et al. (1996) estimated 34,500 females, but later issued an update of 35,860 (Spotila 2004a). The species as a whole is declining and local populations are in danger of extinction (NMFS 2001a; NMFS 2001b).

Heavy declines have occurred at all major Pacific basin rookeries, as well as Mexico, Costa Rica, Malaysia, India, Sri Lanka, Thailand, Trinidad, Tobago, and Papua New Guinea. This includes a nesting decline of 23% between 1984-1996 at Mexiquillo, Michoacán, Mexico (Sarti et al. 1996). Fewer than 1,000 females nested on the Pacific coast of Mexico from 1995-1996 and fewer than 700 females are estimated for Central America (Spotila et al. 2000). The number of leatherback turtles nesting in Las Baulas National Park declined rapidly during the 1990s, from about 1,500 females during the 1988-89 nesting season, to about 800 in 1990-91 and 1991-92 to 193 in 1993-94 (Williams et al. 1996) and 117 in 1998-99 (Spotila et al. 2000). Spotila (2004b) reported that between 59 and 435 leatherbacks nest at Las Baulas each year depending on the El Niño-La Niña cycle. Leatherbacks have rarely been observed during NSF-funded seismic surveys in the eastern tropical Pacific (Hauser et al. 2008; Holst and Smultea 2008; Holst et al. 2005; Smultea and Holst 2003).

Declines in the western Pacific is equally severe. Nesting at Terengganu, Malaysia is 1% of that in 1950s (Chan and Liew 1996). The South China Sea and East Pacific nesting colonies have undergone catastrophic collapse. Overall, Pacific populations have declined from an estimated 81,000 individuals to <3,000 total adults and subadults (Spotila et al. 2000). The number of nesting leatherbacks has declined by an estimated 95% over the past 20 years in the Pacific (Gilman 2009). Drastic overharvesting of eggs and mortality from fishing activities is likely responsible for this tremendous decline (Eckert 1997; Sarti et al. 1996).

Natural threats. Sea turtles face predation primarily by sharks and to a lesser extent by killer whales (Pitman and Dutton 2004). Hatchlings are preyed upon by herons, gulls, dogfish, and sharks. Leatherback hatching success is particularly sensitive to nesting site selection, as nests that are overwashed have significantly lower hatching success and leatherbacks nest closer to the high-tide line than other sea turtle species (Caut et al. 2009a).

Anthropogenic threats. Leatherback nesting and marine environments are facing increasing impacts through widespread development and tourism along nesting beaches (Hamann et al. 2006b; Hernandez et al. 2007; Maison 2006; Santidrián Tomillo et al. 2007). Structural impacts to beaches include building and piling construction, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997b). In some areas, timber and marine debris accumulation as well as sand mining reduce available nesting habitat (Bourgeois et al. 2009; Chacón Chaverri 1999; Formia et al. 2003; Laurance et al. 2008). Lights on or adjacent to nesting beaches alter nesting adult behavior and is often fatal to emerging hatchlings as they are drawn to light sources and away from the sea (Bourgeois et al. 2009; Cowan et al. 2002; Deem et al. 2007; Witherington 1992; Witherington and Bjorndal 1991). Plastic ingestion is very common

in leatherbacks and can block gastrointestinal tracts leading to death (Mrosovsky et al. 2009). Although global warming may expand foraging habitats into higher latitude waters, increasing temperatures may increase feminization of nests (Hawkes et al. 2007b; James et al. 2006; McMahan and Hays 2006; Mrosovsky et al. 1984). Rising sea levels may also inundate nests on some beaches. Egg collection is widespread and attributed to catastrophic declines, such as in Malaysia. Harvest of females along nesting beaches is of concern worldwide.

Bycatch, particularly by longline fisheries, is a major source of mortality for leatherback sea turtles (Crognale et al. 2008; Fossette et al. 2009a; Gless et al. 2008; Petersen et al. 2009). 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 leatherbacks. Donoso and Dutton (2010) found that 284 leatherbacks were bycaught between 2001 and 2005 as part of the Chilean longline fishery, with two individuals observed dead; leatherbacks were the most frequently bycaught sea turtle species.

We know little about the effects of contaminants on leatherback sea turtles. The metals arsenic, cadmium, copper, mercury, selenium, and zinc bioaccumulate, with cadmium in highest concentration in leatherbacks versus any other marine vertebrate (Caurant et al. 1999; Gordon et al. 1998). A diet of primarily jellyfish, which have high cadmium concentrations, is likely the cause (Caurant et al. 1999). Organochlorine pesticides have also been found (McKenzie et al. 1999). PCB concentrations are reportedly equivalent to those in some marine mammals, with liver and adipose levels of at least one congener being exceptionally high (PCB 209: 500-530 ng/g wet weight Davenport et al. 1990; Oros et al. 2009).

Critical habitat. On March 23, 1979, leatherback critical habitat was identified adjacent to Sandy Point, St. Croix, U.S.V.I. from the 183 m isobath to mean high tide level between 17° 42' 12" N and 65° 50' 00" W (44 FR 17710). This habitat is essential for nesting, which has been increasingly threatened since 1979, when tourism increased significantly, bringing nesting habitat and people into close and frequent proximity. However, studies do not currently support significant critical habitat deterioration.

On January 5, 2010, the NMFS proposed to designate critical habitat for leatherback sea turtles in waters along Washington State (Cape Flattery to the Umpqua River; 63,455 km²) and California (Point Arena to point Vincente; 119,400 km²). The primary constituent elements of these areas include (1.) the occurrence of prey species, primarily scyphomedusae of the order Semaestomeae (*Chrysaora*, *Aurelia*, *Phacellophora*, and *Cyanea*) of sufficient condition, distribution, diversity, and abundance to support individual as well as population growth, reproduction, and development and (2) migratory pathway conditions to allow for safe and timely passage and access

Loggerhead sea turtle-Northwestern Atlantic DPS

Distribution. Western Atlantic nesting locations include The Bahamas, Brazil, and numerous locations from the Yucatán Peninsula to North Carolina (Addison 1997; Addison and Morford 1996; Marcovaldi and Chaloupka 2007). This group comprises five nesting subpopulations: Northern, Southern, Dry Tortugas, Florida Panhandle, and

Yucatán. Additional nesting occurs on Cay Sal Bank (Bahamas), Cuba, the Bahamian Archipelago, Quintana Roo (Yucatan Peninsula), Colombia, Brazil, Caribbean Central America, Venezuela, and the eastern Caribbean Islands. Genetic studies indicate that, although females routinely return to natal beaches, males may breed with females from multiple populations and facilitate gene flow Bowen et al. (2005). The northwestern Atlantic DPS is considered to be bounded by the equator and 60° N latitude and extend east to 40° W in the Atlantic basin; this is based upon oceanographic features satellite telemetry, sightings, and bycatch data (Conant et al. 2009).

Reproduction and growth. Loggerhead nesting is confined to lower latitudes temperate and subtropic zones but absent from tropical areas (NMFS and USFWS 1991b; NRC 1990a; 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 1985; NMFS 2001a; Witherington et al. 2006).

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).

Loggerhead sea turtles belonging to the northwestern Atlantic DPS nest along the shoreline from Virginia to Alabama primarily from April to September (peaking in June and July), but can also include the Bahamas, the Yucatan Peninsula of Mexico, and southwestern Cuba and other locations along Central and South America (Conant et al. 2009). Once hatched, individuals disperse to convergence zones, driftlines, and areas covered by *Sargassum* weed (particularly the North Atlantic Gyre), presumably for the foraging and shelter these areas occur to hatchlings (Conant et al. 2009).

Migration and movement. 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 2001a). For individuals

of the northwestern Atlantic DPS, this includes areas along the U.S. Atlantic coast, the Bahamas, Mexico, Cuba, and the Antilles (Conant et al. 2009). Adult loggerheads make lengthy migrations from nesting beaches to foraging grounds (TEWG 1998b). In the Gulf of Mexico, larger females tend to disperse more broadly after nesting than smaller individuals, which tend to stay closer the nesting location (Girard et al. 2009). In the North Atlantic, loggerheads travel north during spring and summer as water temperatures warm and return south in fall and winter, but occur offshore year-round assuming adequate temperature. For immature individuals, this movement occurs in two patterns: a north-south movement over the continental shelf with migration south of Cape Hatteras in winter and movement north along Virginia for summer foraging, and a not-so-seasonal oceanic dispersal into the Gulf Stream as far north as the 10-15° C isotherm (Mansfield et al. 2009). Wallace et al. (2009) suggested differences in growth rate based upon these foraging strategies. There is conflicting evidence that immature loggerheads roam the oceans in currents and eddies and mix from different natal origins or distribute on a latitudinal basis that corresponds with their natal beaches (Monzon-Arguello et al. 2009; Wallace et al. 2009). McCarthy et al. (2010) found that movement patterns of loggerhead sea turtles were more convoluted when sea surface temperatures were higher, ocean depths shallower, ocean currents stronger, and chlorophyll a levels lower.

Sighting and stranding records support loggerhead sea turtles to be common, year-round residents of the Gulf of Mexico, although their abundance is much greater in the northeastern region versus the northwestern (Davis et al. 2000; Fritts et al. 1983; Landry and Costa 1999). Loggerheads may occur in both offshore habitats (particularly around oil platforms and reefs, where prey and shelter are available; (Davis et al. 2000; Fritts et al. 1983; Gitschlag and Herczeg 1994; Lohofener et al. 1990; Rosman et al. 1987), as well as shallow bays and sounds (which may be important developmental habitat for late juveniles in the eastern Gulf of Mexico; (Davis et al. 2000; Lohofener et al. 1990; USAF 1996). Offshore abundance in continental slope waters increases during the winter in the eastern Gulf of Mexico, as cooler inshore waters force individuals into warmer offshore areas (Davis et al. 2000).

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 2001a; 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. 2002). 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.

Status and trends. Loggerhead sea turtles were listed as threatened under the ESA of 1973 on July 28, 1978 (43 FR 32800). The NMFS recently determined that a petition to reclassify loggerhead turtles in the western North Atlantic Ocean as endangered may be warranted due to the substantial scientific and commercial information presented. Consequently, NMFS has initiated a review of the status of the species and is currently soliciting additional information on the species status and ecology, as well as areas that may qualify as critical habitat (73 FR 11849; March 5, 2008).

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).

Atlantic Ocean. In the eastern Atlantic, the Cape Verde Islands support the only known loggerhead nesting assemblage, which is of at least intermediate size (Fretey 2001a); 1,071 nests were observed in 2009 (Lino et al. 2010). In 2000, researchers tagged over 1,000 nesting females (Erhart et al. 2003). Annual data from monitoring projects in Cyprus, Greece, Israel, Tunisia, and Turkey reveal total annual nesting in the Mediterranean ranging of 3,375–7,085 nests per season (Margaritoulis et al. 2003). Libya and the West African coast host genetically-unique breeding populations of loggerhead sea turtles as well (Hutchinson and Dutton 2007). A recently discovered nesting site along the southern Italian shores of the Ionian Sea found particularly high genetic diversity amongst nesting females (Garofalo et al. 2009). Nesting at Dalyan Beach, Turkey does not have an apparent trend, with between 50 and 286 nests laid annually for the past 19 years (Turkoz and Yilmaz 2008).

The greatest concentration of loggerheads occurs in the Atlantic Ocean and the adjacent Caribbean Sea, primarily on the Atlantic coast of Florida, with other major nesting areas

located on the Yucatán Peninsula of Mexico, Columbia, Cuba, South Africa (EuroTurtle 2006 as cited in LGL Ltd. 2007; Márquez 1990).

Among the five subpopulations, loggerhead females lay 53,000-92,000 nests per year in the southeastern U.S. and the Gulf of Mexico, and the total number of nesting females is 32,000-56,000. All of these are currently in decline or data are insufficient to access trends (NMFS 2001a; TEWG 1998a). Loggerheads from western North Atlantic nesting aggregations may or may not feed in the same regions from which they hatch. Loggerhead sea turtles from the northern nesting aggregation, which represents about 9% of the loggerhead nests in the western North Atlantic, comprise 25-59% of individuals foraging from Georgia up to the northeast U.S. (Bass et al. 1998; Norrgard 1995; Rankin-Baransky 1997; Sears 1994; Sears et al. 1995). Loggerheads associated with the South Florida nesting aggregation occur in higher frequencies in the Gulf of Mexico (where they represent ~10% of the loggerhead captures) and the Mediterranean Sea (where they represent ~45% of loggerhead sea turtles captured). About 4,000 nests per year are laid along the Brazilian coast (Ehrhart et al. 2003).

Because of its size, the south Florida subpopulation of loggerheads may be critical to the survival of the species in the Atlantic, and in the past it was considered second in size only to the Oman nesting aggregation (NMFS 2006e; NMFS and USFWS 1991b). The South Florida population increased at ~5.3% per year from 1978-1990, and was initially increasing at 3.9-4.2% after 1990. An analysis of nesting data from 1989-2005, a period of more consistent and accurate surveys than in previous years, showed a detectable trend and, more recently (1998-2005), has shown evidence of a declining trend of approximately 22.3% (FFWCC 2007a; FFWCC 2007b; Witherington et al. 2009). This is likely due to a decline in the number of nesting females within the population (Witherington et al. 2009). Nesting data from the Archie Carr Refuge (one of the most important nesting locations in southeast Florida) over the last 6 years shows nests declined from approximately 17,629 in 1998 to 7,599 in 2004, also suggesting a decrease in population size². Loggerhead nesting is thought to consist of just 60 nesting females in the Caribbean and Gulf of Mexico (NMFS 2006f). Based upon the small sizes of almost all nesting aggregations in the Atlantic, the large numbers of individuals killed in fisheries, and the decline of the only large nesting aggregation, we suspect that the extinction probabilities of loggerhead sea turtle populations in the Atlantic are only slightly lower than those of populations in the Pacific.

The northwestern Atlantic DPS is considered to have a high risk of quasi-extinction in the foreseeable future and has one of the highest potentials for future decline of all loggerhead DPSs (Conant et al. 2009). All “subpopulations” showed some degree of decline.

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

² While this is a long period of decline relative to the past observed nesting pattern at this location, aberrant ocean surface temperatures complicate the analysis and interpretation of these data. Although caution is warranted in interpreting the decreasing nesting trend given inherent annual fluctuations in nesting and the short time period over which the decline has been noted, the recent nesting decline at this nesting beach is reason for concern.

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 disproportionately 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. Along the Atlantic coast of the U.S., the NMFS estimated that shrimp trawls capture almost 163,000 loggerhead sea turtles each year in the Gulf of Mexico, of which 3,948 die. Each year, various fisheries capture about 2,000 loggerhead sea turtles in Pamlico Sound, of which almost 700 die. 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).

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. NMFS (2002) estimated that 62,000 loggerhead sea turtles have been killed as a result of incidental capture and drowning in shrimp trawl gear. Although turtle excluder devices and other bycatch reduction devices have significantly reduced the level of bycatch to sea turtles and other marine species in U.S. waters, mortality still occurs in Gulf of Mexico waters.

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

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 1°-2° C can potentially change

hatchling sex ratios to all or nearly all female in tropical and subtropical areas (Hawkes et al. 2007a). 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. 2008). 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. 2007b). 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. 2007b). 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. 2006b; 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 2001a). 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).

The loggerhead BRT identified bycatch as the primary threat to northwestern DPS loggerheads; boat strikes and marine debris are considered additional significant threats (Conant et al. 2009). Other threats summarized above are also issues for the survival and recovery of the northwestern Atlantic DPS.

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 (>20° 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 1994a; 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 (Cliffon 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 (Cliffon 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 1998b). 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 1993a; NMFS and USFWS 1998b; 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; Pitman 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). McMahan et al. (2007) reported a maximum dive duration of 200 min (\pm 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).

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 is estimated at two million (Spotila 2004a).

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 preparation). 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 (Cliffon et al. 1982; NMFS and USFWS 2007b). By 1969, after years of adult harvest, the estimate was just over one million (Cliffon 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 1998b). 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 1998b). 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; NMFS 2004b). 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 1994b). 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 (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. 2007b), 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. 2006a). 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.

Smalltooth sawfish

Description of the species. The smalltooth sawfish is a tropical marine and estuarine elasmobranch fish (sharks and rays) that has been reported to have a circumtropical distribution. Although they are rays, sawfish physically more resemble sharks, with only the trunk and especially the head ventrally flattened. Smalltooth sawfish are characterized by their “saw,” a long, narrow, flattened rostral blade with a series of transverse teeth along either edge.

Distribution. In the western Atlantic, the smalltooth sawfish has been reported from Brazil through the Caribbean and Central America, the Gulf of Mexico, and the Atlantic coast of the U.S. The smalltooth sawfish has also been recorded from Bermuda (Bigelow

and Schroeder 1953). Forms of smalltooth sawfish have been reported from the eastern Atlantic in Europe and West Africa; the Mediterranean; South Africa; and the Indo-West Pacific, including the Red Sea, India, Burma, and the Philippines (Bigelow and Schroeder 1953; Compagno and Cook 1995; Van der Elst 1981). Whether populations outside of the Atlantic are truly smalltooth sawfish or closely related species is unknown (Adams and Wilson 1995). Pacific coast records of smalltooth sawfish off Central America need confirmation (Bigelow and Schroeder 1953; Compagno and Cook 1995).

The range of the smalltooth sawfish in the Atlantic has contracted markedly over the past century. The northwestern terminus of their Atlantic range is located in the waters of the eastern U.S. Historic capture records within the U.S. range from Texas to New York. Water temperatures no lower than 61°F to 64.4°F and the availability of appropriate coastal habitat serve as the major environmental constraints limiting the northern movements of smalltooth sawfish in the western North Atlantic (Simpfendorfer 2001). As a result, most records of this species from areas north of Florida occur during spring and summer periods (May to August) when inshore waters reach appropriately high temperatures. The data also suggest that smalltooth sawfish may utilize warm water outflows of power stations as thermal refuges during colder months to enhance their survival or become trapped by surrounding cold water from which they would normally migrate. Almost all occurrences of smalltooth sawfish in warm-water outflows were during the coldest part of the year, when water temperatures in these outfalls are typically well above ambient temperatures.

Movement. Historic records of smalltooth sawfish indicate that some large mature individuals migrated north along the U.S. Atlantic coast as temperatures warmed in the summer and then south as temperatures cooled (Bigelow and Schroeder 1953). Recent Florida encounter data, however, do not suggest such migration. Only two smalltooth sawfish have been recorded north of Florida since 1963 (the first was captured off of North Carolina in 1999 and the other off Georgia 2002) but it is unknown whether these individuals resided in Georgia and North Carolina waters annually or if they had migrated north from Florida (Schwartz 2003, Burgess unpublished data). Given the very limited number of encounter reports from the east coast of Florida, Simpfendorfer and Wiley (2004) hypothesize the population previously undertaking the summer migration has declined to a point where the migration is undetectable or does not occur.

Most specimens captured along the Atlantic coast north of Florida have also been large (>9 feet) adults and likely represent seasonal migrators, wanderers, or colonizers from a core population(s) to the south rather than being members of a continuous, even-density population (Bigelow and Schroeder 1953). It is likely that these individuals migrated southward toward Florida as water temperatures declined in the fall, as there is only one winter record from the Atlantic coast north of Florida. Based on smalltooth sawfish encounter data, the current core range for the smalltooth sawfish is from the Caloosahatchee River, Florida, to Florida Bay (NMFS 2000; Simpfendorfer and Wiley 2004).³

³ See the 2006 Draft Recovery Plan for more detailed information on the historic and current distribution of smalltooth sawfish in four regions of the eastern U.S. This information is based on the Status Review

Habitat. Smalltooth sawfish are euryhaline, occurring in waters with a broad range of salinities from freshwater to full seawater (Simpfendorfer 2001). Younger, smaller individuals tend to inhabit very shallow mud banks and tides are a major factor in their movement (Simpfendorfer et al. 2010). As they grow, juveniles tend to occupy deeper habitat, but shallow areas (<1 m depth) remain preferred habitat; juveniles also expand their ranges, whereas small individuals have very restricted ranges (Simpfendorfer et al. 2010). Their occurrence in freshwater is suspected to be only in estuarine areas temporarily freshwater from receiving high levels of freshwater input. Many encounters are reported at the mouths of rivers or other sources of freshwater inflows, suggesting estuarine areas may be an important factor in the species distribution (Simpfendorfer and Wiley 2004).

Smalltooth sawfish are most common in shallow coastal waters less than 82 feet (Adams and Wilson 1995; Bigelow and Schroeder 1953). Indeed, the distribution of the smallest size classes of smalltooth sawfish indicate that nursery areas occur throughout Florida in areas of shallow water, close to shore and typically associated with mangroves (Simpfendorfer and Wiley 2004). However, encounter data indicate there is a tendency for smalltooth sawfish to move offshore and into deeper water as they grow. Larger animals are more likely to be found in deeper waters. Since large animals are also observed in very shallow waters, it is believed that smaller (younger) animals are restricted to shallow waters, while large animals roam over a much larger depth range (Simpfendorfer 2001). Recent data from sawfish encounter reports and from satellite tagging indicate mature animals occur regularly in waters in excess of 164 feet (Poulakis and Seitz 2004; Simpfendorfer and Wiley 2004).

Growth and reproduction. As in all elasmobranchs, fertilization is internal. Bigelow and Schroeder (1953) report the litter size as 15 to 20. Simpfendorfer and Wiley (2004), however, caution this may be an overestimate, with recent anecdotal information suggesting smaller litter sizes (about ten). Smalltooth sawfish mating and pupping seasons, gestation, and reproductive periodicity are all unknown. Gestation and reproductive periodicity, however, may be inferred based on that of the largetooth sawfish, sharing the same genus and having similarities in size and habitat. Thorson (1976) reported the gestation period for largetooth sawfish was approximately five months and concluded that females probably produce litters every second year.

Bigelow and Schroeder (1953) describe smalltooth sawfish as generally about 2 feet long at birth and growing to a length of 18 feet or greater. Recent data from smalltooth sawfish caught off Florida, however, demonstrate young are born at 2.5 to 2.8 feet (Simpfendorfer and Wiley 2004), with males reaching maturity at approximately 8.9 feet and females at approximately 11.8 feet (Simpfendorfer 2002). The maximum reported size of a smalltooth sawfish is 24.9 feet (Last and Stevens 1994), but the maximum size normally observed is 19.7 feet (Adams and Wilson 1995). No formal studies on the age and growth of the smalltooth sawfish have been conducted to date, but growth studies of largetooth sawfish suggest slow growth, late maturity (10 years) and long lifespan (25 to 30 years Simpfendorfer 2000; Thorson 1982). These characteristics suggest a very low

Team's analysis and the more recent encounter database research {Poulakis, 2004 #1266;Seitz, 2002 #1426;Simpfendorfer, 2004 #1465;Simpfendorfer, 2004 #1465}.

intrinsic rate of increase (Simpfendorfer 2000).

Feeding. Smalltooth sawfish feed primarily on fish, with mullet, jacks, and ladyfish believed to be their primary food resources (Simpfendorfer 2001). In addition to fish, smalltooth sawfish also prey on crustaceans (mostly shrimp and crabs), which are located by disturbing bottom sediment with their saw (Bigelow and Schroeder 1953; Norman and Fraser 1937).

Status and trends. The U.S. smalltooth sawfish distinct population segment (DPS) was listed as endangered under the ESA on April 1, 2003 (68 FR 15674). The smalltooth sawfish is the first marine fish to be listed in the U.S. Despite being widely recognized as common throughout their historic range up until the middle of the 20th century, the smalltooth sawfish population declined dramatically during the middle and later parts of the century. The decline in the population of smalltooth sawfish is attributed to fishing (both commercial and recreational), habitat modification, and sawfish life history. Large numbers of smalltooth sawfish were caught as bycatch in the early part of this century. Smalltooth sawfish were historically caught as bycatch in various fishing gears throughout their historic range, including gillnet, otter trawl, trammel net, seine, and to a lesser degree, hand line. Frequent accounts in earlier literature document smalltooth sawfish being entangled in fishing nets from areas where smalltooth sawfish were once common but are now rare (Evermann and Bean 1898). Loss and/or degradation of habitat contributed to the decline of many marine species and continue to impact the distribution and abundance of smalltooth sawfish. Simpfendorfer (2001) estimated that the U.S. population size is currently less than 5% of its size at the time of European settlement.

Seitz and Poulakis (2002) and Poulakis and Seitz (2004) documented recent (1990 to 2002) occurrences of sawfish along the southwest coast of Florida, and in Florida Bay and the Florida Keys, respectively and includes a total of 2,969 smalltooth sawfish encounters. Mote Marine Laboratory also maintains a smalltooth sawfish public encounter database, established in 2000 to compile information on the distribution and abundance of sawfish. A total of 434 sawfish encounters have been validated since 1998, most from recreational fishers (Simpfendorfer and Wiley 2004). Dr. Simpfendorfer reluctantly gives an estimate of 2,000 individuals based on his four years of field experience and data collected from the public, but cautions that actual numbers may be plus or minus at least 50%.

The majority of smalltooth sawfish encounters today are from the southwest coast of Florida between the Caloosahatchee River and Florida Bay. Outside of this core area, the smalltooth sawfish appears more common on the west coast of Florida and in the Florida Keys than on the east coast, and occurrences decrease the greater the distance from the core area (Simpfendorfer and Wiley 2004). The capture of a smalltooth sawfish off Georgia in 2002 is the first record north of Florida since 1963. New reports during 2004 extend the current range of the species to Panama City, offshore Louisiana (south of Timbalier Island in 100 feet of water), southern Texas (unconfirmed), and the northern coast of Cuba.

The abundance of juveniles encountered, including very small individuals, suggests that the population remains reproductively active and viable (Seitz and Poulakis 2002;

Simpfendorfer 2003; Simpfendorfer and Wiley 2004). The declining numbers of individuals with increasing size is consistent with the historic size composition data (G. Burgess, pers. comm. in Simpfendorfer and Wiley 2004). This information and recent encounters in new areas beyond the core abundance area suggest that the population may be increasing. However, recovery of the species expected to be slow on the basis of the species' life history and other threats to the species remaining (see below), the population's future remains tenuous.

Natural threats. The primary natural threat to smalltooth sawfish survival is the species low reproductive rate. In the face of reduced population sizes, this biological parameter means that recovery, at best, will be slow, and that catastrophic perturbations can have severe consequences to recovery.

Anthropogenic threats. Smalltooth sawfish decline has been largely due to fisheries interaction (see NMFS 2006 for a review). The distinctive "saw" can easily become entangled in a variety of commercial and recreational fishing gear, resulting in drowning or injury. Even when individuals that have been entangled are retrieved alive, individuals may be killed for curio collection of the saw, fear of injury from fisherman, or injured from the gear or handling during gear removal. However, additional anthropogenic impacts result from habitat loss. Destruction of mangrove habitat, dredging, trawling and filling, and loss of reef habitat have negative impacts on all life stages of smalltooth sawfish. Although a concern, pollution impacts on particularly reproductive biology are unknown. However, habitat degradation due to runoff containing pesticides, eutrophying agents, and other contaminants can also have a negative impact on smalltooth sawfish habitat.

Critical habitat. On September 2, 2009, critical habitat was designated for smalltooth sawfish along the central and southwest coast of Florida (74 FR 45353). Although PCEs were not identified, the mangrove and adjacent shallow euryhaline habitat are important nursery habitat for smalltooth sawfish.

Proposed New York Bight, Chesapeake Bay, and South Atlantic Atlantic sturgeon DPSs

Habitat and movement. Atlantic sturgeon spawn in freshwater, but spend most of their sub-adult and adult life in the marine environment. While few specific spawning locations have been identified in the United States, many rivers are known to support reproducing populations. Early life stage Atlantic sturgeon coupled with upstream movements of adults suggest spawning adults generally migrate upriver in the spring/early summer; February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems (Bain 1997; Kahnle et al. 1998; Smith 1985; Smith and Clugston 1997). Some rivers may also support a fall spawning migration.

Sub-adult and adult Atlantic sturgeon undertake long marine migrations and utilize habitat up and down the East Coast for rearing, feeding, and migrating (Bain 1997; Dovel and Berggren 1983; Harrison and Thurley 1974). These migratory sub-adults, as well as adults, are normally located in shallow (10-50m) near shore areas dominated by gravel and sand substrate (Stein et al. 2004). Despite extensive mixing in coastal waters, Atlantic sturgeon display high site fidelity to their natal streams. Straying between rivers within a proposed DPS would sometimes exceed 5 migrants per generation, but between

DPSs was usually less than one migrant per generation, with the exception of fish from the Delaware River straying more frequently to southern rivers (Grunwald et al. 2008).

Reproduction. Spawning intervals range from 1-5 years for male Atlantic sturgeon (Collins et al. 2000; Schueller and Peterson 2010; Smith 1985) and 3-5 for females (Bain 1997; Gales et al. 2010; Schueller and Peterson 2010; Stevenson and Secor 1999). Fecundity of Atlantic sturgeon has been correlated with age and body size (ranging from 400,000 – 8 million eggs) (Dadswell 2006; Smith et al. 1982; Van Eenennaam and Doroshov 1998).

Distribution. The Atlantic sturgeons' historic range included major estuarine and riverine systems that spanned from Hamilton Inlet on the coast of Labrador to the Saint Johns River in Florida (ASSRT 2007; Smith and Clugston 1997). Atlantic sturgeon have been documented as far south as Bermuda and Venezuela (Lee et al. 1980). Historically, Atlantic sturgeon were present in approximately 38 rivers in the United States from St. Croix, ME to the Saint Johns River, FL, of which 35 rivers have been confirmed to have had historic spawning populations. Atlantic sturgeon are currently present in 36 rivers, and spawning occurs in at least 20 of these. Other estuaries along the coast formed by rivers that do not support Atlantic sturgeon spawning populations may still be important rearing habitats.

Status and trends. Five DPSs of Atlantic sturgeon have been proposed for listing under the ESA. The Gulf of Maine DPS was proposed as threatened while the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs were proposed as endangered (75 FR 61872 and 75 FR 904).

Prior to 1890, Atlantic sturgeon populations were at or near carrying capacity. Between 1890 and 1905, Atlantic sturgeon (and shortnose sturgeon) populations were drastically reduced for sale of meat and caviar. Between 1920 and 1998, the harvest level remained very low due to small remnant populations. Prompted by research on juvenile production between 1985 and 1995 (Peterson et al. 2000), the Atlantic sturgeon fishery was closed by the Atlantic States Marine Fisheries Commission in 1998, when a coastwide fishing moratorium was imposed for 20-40 years, or at least until 20 year classes of mature female Atlantic sturgeon were present (ASMFC 1998).

Since the closure of the Atlantic sturgeon fishery, the only assessments of adult spawning populations have been made in the Hudson and Altamaha Rivers. While Atlantic sturgeon have been captured, tagged, and tracked through estuaries and rivers along the East Coast, no other estimates of spawning run size or juvenile population sizes have been made. Making estimates of spawning adults relies on the assumptions that 1) all adults that migrate into the freshwater portion of a river are native to that river and 2) are making that upstream migration with the intention of spawning. Kahnle et al. (2007) reported that approximately 870 adults per year returned to the Hudson River between 1985 and 1995. Peterson et al. (2008) reported that approximately 324 and 386 adults per year returned to the Altamaha River in 2004 and 2005, respectively.

Juvenile Atlantic sturgeon abundance may be a more precise way to measure the status of Atlantic sturgeon populations because it is believed that all age-1 and age-2 juveniles are restricted to their natal rivers (Bain et al. 1999; Dovel and Berggren 1983), avoiding the assumptions noted above. Peterson et al. (2000) reported that there were approximately

4,300 age-1 and -2 Atlantic sturgeon in the Hudson River between 1985 and 1995. Schueller and Peterson (2010) reported that age-1 and -2 Atlantic sturgeon population densities ranged from 1,000 to 2,000 individuals over a 4 year period from 2004 to 2007.

Critical habitat. Critical habitat has not been proposed for Atlantic sturgeon.

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, sawfish, and sturgeon 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; IPCC 2001a; IPCC 2001b; IPCC 2002). From 1906 to 2006, global surface temperatures have risen 0.74° C and continue at an accelerating pace; 11 or the 12 warmest years on record since 1850 have occurred since 1995 and the past decade has been the warmest in instrumental history (Arndt et al. 2010; 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 effects on species whose populations are already in tenuous positions (Isaac 2008). These changes would produce changes in habitats, including their suitability as breeding, foraging, or resting sites. As such, we expect the risk of extinction to listed species to rise with the degree of climate shift associated with global warming.

The indirect effects of climate change would result from changes in the distribution of

temperatures suitable for reproduction, the distribution and abundance of prey and abundance of competitors or predators. For species that undergo long migrations, individual movements are usually associated with prey availability or habitat suitability. If either is disrupted by changing ocean temperature regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Elliott. 2009). For sea turtles, warming ocean temperatures may extend poleward the habitat which they can utilize (Poloczanska et al. 2009). Seagrass habitats have declined by 29% in the last 130 years and 19% of coral reefs have been lost due to human degradation, reducing lower latitude habitat for some sea turtle species (Poloczanska et al. 2009). Primary production is estimated to have declined by 6% between the early 1980s and 2010, making foraging more difficult for marine species (Hoegh-Guldberg and Bruno 2010).

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 yet appear to have affected population viabilities through reduced reproductive success, although average nesting and emergence dates have changed over the past several decades by days to weeks in some locations (Poloczanska et al. 2009). However, such a fundamental shift in population demographics causes a fundamental instability in population viability. Altered ranges can also result in the spread of novel diseases to new areas via shifts in host ranges (Simmonds and Elliott. 2009). It has also been suggested that increases in harmful algal blooms could be a result from increases in sea surface temperature (Simmonds and Elliott. 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 to 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 and 3.3 mm/year between 1993 and 2006 due to glacial melting and thermal expansion of ocean water; this rate will likely increase, which is supported by the latest data from 2009 (Arndt et al. 2010; Hoegh-Guldberg and Bruno 2010; Wilkinson and Souter 2008). 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), although other areas might experience less frequent tropical activity and a subsequent reduction in tropical cyclone impacts to sea turtle nests (Fuentes and Abbs 2010). 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, temperatures regimes, and 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. 2009b). 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 hatchlings), 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). Taken together, the body of literature on climate change supports widespread and significant negative consequences to sea turtle species.

Coastal development

A large number of coastal development activities can have adverse impacts on sea turtles. Most of these, such as construction of breakwaters and seawalls, lighting, building construction, and vehicular beach traffic are significant mostly or only for nesting sea turtles and their hatchlings. The action area does generally not host sea turtle nesting (or where it does, the establishment of state and national refuges limit or prevent human development), we focused on impacts to sea turtles in the marine environment, namely dredging activity. Dredging has been documented to capture or kill 168 sea turtles from 1995 to 2009 in the Gulf of Mexico, including 97 loggerheads, 35 Kemp's ridleys, 32 greens, and three unidentified sea turtles (USACOE 2010).

Oil and gas development

The northern Gulf of Mexico is the location of massive industrial activity associated with oil and gas extraction and processing. Over 4,000 oil and gas structures are located outside of state waters in the northern Gulf of Mexico; 90% of these occur off Louisiana and Texas (USN 2009). This is both detrimental and beneficial for sea turtles. These structures appreciably increase the amount of hard substrate in the marine environment, providing shelter and foraging opportunities for species like loggerhead sea turtles (Parker et al. 1983; Stanley and Wilson 2003). However, the Bureau of Ocean Energy Management requires that structures must be removed within one year of lease termination. Many of these structures are removed by explosively severing the underwater supportive elements, which produces a shock wave that kills, injures, or disrupts marine life in the blast radius (Gitschlag et al. 1997). For sea turtles, this means death or serious injury for individuals within a few hundred meters of the structure and overt behavioral (potentially physiological) impacts for individuals further out (Duronslet et al. 1986; Klima et al. 1988). Although observers and procedures are in place to mitigate impacts to sea turtles (i.e., not blasting when sea turtles are present), not all sea turtles are observed all the time and low-level sea turtle injury and mortality still occurs (Gitschlag and Herczeg 1994; Gitschlag et al. 1997); two loggerheads were killed in August 2010 (G. Gitschlag, NOAA, pers. comm.). Current annual authorized takes due to Bureau of Ocean Energy Management OCS oil and gas exploration, development, production, and abandonment activities are 30 sea turtles, including no more than one each of Kemp's ridley, green, hawksbill, or leatherback turtles and no more than ten loggerhead turtles (NMFS 1988). These levels were far surpassed by the *Deepwater Horizon* incident (see oil spills and releases below). Overall, these activities provide both positive and negative effects at the individual level and have no clear impact at the population and species levels.

Pollution

The Gulf of Mexico is a sink for massive levels of pollution from a variety of marine and terrestrial sources, which ultimately can interfere with ecosystem health and particularly that of sea turtles (see *Status of listed resources* section). Sources include the petrochemical industry in and along the Gulf of Mexico, wastewater treatment plants, septic systems, industrial facilities, agriculture, animal feeding operations, and improper refuse disposal. The Mississippi River drains 80% of United States cropland (including the fertilizers, pesticides, herbicides, and other contaminants that are applied to it) and discharges into the Gulf of Mexico near the action area (MMS 1998). Agricultural discharges, as well as discharges from large urban centers (ex.: Houston and New Orleans) contribute contaminants as well as coliform bacteria to Gulf of Mexico habitats (Garbarino et al. 1995). These contaminants can be carried long distances from terrestrial or nearshore sources and ultimately accumulate in offshore pelagic environments (USCOP 2004). The ultimate impacts of this pollution are poorly understood.

Significant attention has been paid to nutrient enrichment of Gulf of Mexico waters, which leads to algal blooms (including harmful algal blooms), oxygen depletion, loss of seagrass and coral reef habitat, and the formation of a hypoxic “dead zone” (USCOP 2004). This hypoxic event occurs annually from as early as February to as late as October, spanning roughly 12,700 km² (although in 2005 the “dead zone” grew to a record size of 22,000 km²) from the Mississippi River Delta to Galveston, Texas (LUMCON 2005; MMS 1998; Rabalais et al. 2002; USGS 2010). Although sea turtles do not extract oxygen from sea water, numerous staple prey items of sea turtles, such as fish, shrimp, and crabs, do and are killed by the hypoxic conditions (Craig et al. 2001). More generally, the “dead zone” decreases biodiversity, alters marine food webs, and destroys habitat (Craig et al. 2001; Rabalais et al. 2002). High nitrogen loads entering the Gulf of Mexico from the Mississippi River is the likely culprit; nitrogen concentrations entering the Gulf of Mexico have increased three fold over the past 60 years (Rabalais et al. 2002). Through these indirect effects, sea turtles are unable to utilize this region during this time for foraging and can only utilize it to a limited extent when the “dead zone” does not occur while the underlying food web recovers.

Marine debris is also a significant problem for the health of Gulf of Mexico ecosystems. For sea turtles, marine debris is a problem due primarily to individuals ingesting debris and blocking the digestive tract, causing death or serious injury (Laist et al. 1999; Lutcavage et al. 1997a). Gulko and Eckert (2003) estimated that between one-third and one-half of all sea turtles ingest plastic at some point in their lives; this figure is supported by data from Lazar and Gračan (Lazar and Gračan 2010), who found 35% of loggerheads had plastic in their gut. A Brazilian study found that 60% of stranded green sea turtles had ingested marine debris (primarily plastic and oil; (Bugoni et al. 2001)). Loggerhead sea turtles had a lesser frequency of marine debris ingestion. Plastic is possibly ingested out of curiosity or due to confusion with prey items; for example, plastic bags can resemble jellyfish (Milton and Lutz 2003). Marine debris consumption has been shown to depress growth rates in post-hatchling loggerhead sea turtles, elongating the time required to reach sexual maturity and increasing predation risk (McCauley and Bjørndal 1999). Studies of shore cleanups have found that marine debris washing up along the northern Gulf of Mexico shoreline amounts to about 100 kg/km

(ACC 2010; LADEQ 2010; MASGC 2010; TGLO 2010). Sea turtles can also become entangled and die in marine debris, such as discarded nets and monofilament line (Laist et al. 1999; Lutcavage et al. 1997a; NRC 1990c; O'Hara et al. 1988). This fundamentally reduces the reproductive potential of affected populations, many of which are already declining (such as loggerhead and leatherback sea turtle populations in the action area).

Oil spills and releases

Oil pollution has been a significant concern in the Gulf of Mexico for several decades due to the large amount of extraction and refining activity in the region. Routine discharges into the northern Gulf of Mexico (not including oil spills) include roughly 88,200 barrels of petroleum per year from municipal and industrial wastewater treatment plants and roughly 19,250 barrels from produced water discharged overboard during oil and gas operations (MMS 2007b; USN 2008). These sources amount to over 100,000 barrels of petroleum discharged into the northern Gulf of Mexico annually. Although this is only 10% of the amount discharged in a major oil spill, such as the Exxon *Valdez* spill (roughly 1 million barrels), this represents a significant, continual, and “unseen” threat to Gulf of Mexico wildlife and habitats. Generally, accidental oil spills may amount to less than 24,000 barrels of oil discharged annually in the northern Gulf of Mexico, making non-spilled oil normally one of the leading sources of oil discharge into the Gulf of Mexico, although incidents such as the 2010 *Deepwater Horizon* incident are exceptional (MMS 2007a). The other major source from year to year is oil naturally seeping into the northern Gulf of Mexico. Although exact figures are unknown, natural seepage is estimated at between 120,000 and 980,000 barrels of oil annually (MacDonald et al. 1993; MMS 2007b).

Although non-spilled oil is the primary contributor to oil introduced into the Gulf of Mexico, concern over accidental oil spills is well-founded. Over five million barrels of oil and one million barrels of refined petroleum products are transported in the northern Gulf of Mexico daily (MMS 2007b); worldwide, it is estimated that 900,000 barrels of oil are released into the environment as a result of oil and gas activities (Epstein and (Eds.). 2002). Even if a small fraction of the annual oil and gas extraction is released into the marine environment, major, concentrated releases can result in significant environmental impacts. Due to the density of oil extraction, transport, and refining facilities in the Houston/Galveston and Mississippi Delta areas (and the extensive activities taking place at these facilities), these locations have the greatest probability of experiencing oil spills. Oil released into the marine environment contains aromatic organic chemicals known to be toxic to a variety of marine life; these chemicals tend to dissolve into the air to a greater or lesser extent, depending upon oil type and composition (Yender et al. 2002). Solubility of toxic components is generally low, but does vary and can be relatively high (0.5-167 parts per billion; (Yender et al. 2002)). Use of dispersants can increase oil dispersion, raising the levels of toxic constituents in the water column, but speeding chemical degradation overall (Yender et al. 2002). The remaining oil becomes tar, which forms floating balls that can be transported thousands of kilometers into the North Atlantic. The most toxic chemicals associated with oil can enter marine food chains and bioaccumulate in invertebrates such as crabs and shrimp to a small degree (prey of some sea turtles (Law and Hellou 1999; Marsh et al. 1992)), but generally do not bioaccumulate or biomagnify in finfish (Baussant et al. 2001; Meador et al. 1995;

Varanasi et al. 1989; Yender et al. 2002). Sea turtles are known to ingest and attempt to ingest tar balls, which can block their digestive systems, impairing foraging or digestion and potentially causing death (NOAA 2003). Dispersants reduce the formation of tar balls. Although the effects of dispersant chemicals on sea turtles is unknown, testing on other organisms have found currently used dispersants to be less toxic than those used in the past (NOAA 2003). It is possible that dispersants can interfere with surfactants in the lungs (surfactants prevent the small spaces in the lungs from adhering together due to surface tension, facilitating large surface areas for gas exchange), as well as interfere with digestion, excretion, and salt gland function (NOAA 2003). Oil exposure can also cause acute damage upon direct exposure to oil, including skin, eye, and respiratory irritation, reduced respiration, burns to mucous membranes such as the mouth and eyes, diarrhea, gastrointestinal ulcers and bleeding, poor digestion, anemia, reduced immune response, damage to kidneys or liver, cessation of salt gland function, reproductive failure, and death (NOAA 2003; NOAA 2010b; Vargo et al. 1986a; Vargo et al. 1986b; Vargo et al. 1986c). Nearshore spills or large offshore spills can oil beaches on which sea turtles lay their eggs, causing birth defects or mortality in the nests (NOAA 2003; NOAA 2010b).

Several oil spills have impacted the northern Gulf of Mexico over the past few years, largely due to hurricanes. The impacts of Hurricane Ivan in 2004 on the Gulf Coast included pipeline damage causing 16,000 barrels of oil to be released and roughly 4,500 barrels of petroleum products from other sources (BOEMRE 2010; USN 2008). The next year, Hurricane Katrina caused widespread damage to onshore oil storage facilities, releasing 191,000 barrels of oil (LHR 2010). Another 4,530 barrels of oil were released from 70 other smaller spills associated with hurricane damage. Shortly thereafter, Hurricane Rita damaged offshore facilities resulting in 8,429 barrels of oil to be released (USN 2008).

Major oil spills have impacted the Gulf of Mexico for decades (NMFS 2010a). Until 2010, the largest oil spill in North America occurred in the Bay of Campeche (1979), when a well “blew out”, allowing oil to flow into the marine environment for nine months, releasing 2.8-7.5 million barrels of oil. Oil from this release eventually reached the Texas coast, including the Kemp’s ridley sea turtle nesting beach at Rancho Nuevo, from where 9,000 hatchlings were airlifted and released offshore (NOAA 2003). Over 7,600 m³ of oiled sand was eventually removed from Texas beaches and 200 gallons of oil were removed from the area around Rancho Nuevo (NOAA 2003). Eight dead and five live sea turtles were recovered during the oil spill event; although cause of deaths were not determined, oiling was suspected to play a part (NOAA 2003). Also in 1979, the oil tanker *Burmah Agate* collided with another vessel near Galveston, Texas, causing an oil spill and fire that ultimately released 65,000 barrels of oil into estuaries, beachfronts, and marshland along the northern and central Texas coastline (NMFS 2010a). Clean-up of these areas was not attempted due to the environmental damage such efforts would have caused. Another 195,000 barrels of oil are estimated to have been burned in a multi-month-long fire aboard the *Burmah Agate* (NMFS 2010a). The tanker *Alvenus* grounded in 1984 near Cameron, Louisiana, spilling 65,500 barrels of oil which spread west along the shoreline to Galveston (NMFS 2010a). One oiled sea turtle was recovered and released (NOAA 2003). In 1990, the oil tanker *Megaborg* experienced an accident near Galveston during the lightering process and released 127,500 barrels of oil, most of which burned off in the ensuing fire (NMFS 2010a).

On April 20, 2010, a fire and explosion occurred aboard the semisubmersible drilling platform *Deepwater Horizon* roughly 80 km southeast of the Mississippi Delta (NOAA 2010a). The platform had 17,500 barrels of fuel aboard, which likely burned, escaped, or sank with the platform (NOAA 2010a). However, once the platform sank, the riser pipe connecting the platform to the wellhead on the seafloor broke in multiple locations, initiating an uncontrolled release of oil from the exploratory well. Over the next three months, oil was released into the Gulf of Mexico, resulting in oiled regions of Texas, Louisiana, Mississippi, Alabama, and Florida and widespread oil slicks throughout the northern Gulf of Mexico that closed more than one-third of the Gulf of Mexico Exclusive Economic Zone to fishing due to contamination concerns. Apart from the widespread surface slick, massive undersea oil plumes formed, possibly through the widespread use of dispersants, and reports of tarballs washing ashore throughout the region were common. Although estimates vary, NOAA has estimated that 4.9 million barrels of oil were released (Lubchenco et al. 2010). A total of 720 sea turtles have been verified in the spill zone of which 172 were verified as having been exposed to oil (NOAA 2010c). However, specific causes of injury or death have not yet been established for many individuals as investigations into the role of oil in these animals' health status continue.

Oil can also cause indirect effects to sea turtles through impacts to habitat and prey organisms. Seagrass beds may be particularly susceptible to oiling as oil contacts grass blades and sticks to them, hampering photosynthesis and gas exchange (Wolfe et al. 1988). If spill cleanup is attempted, mechanical damage to seagrass can result in further injury and long-term scarring. Loss of seagrass due to oiling would be important to green sea turtles, as this is a significant component of their diets (NOAA 2003). The loss of invertebrate communities due to oiling or oil toxicity would also decrease prey availability for hawksbill, Kemp's ridley, and loggerhead sea turtles (NOAA 2003). Furthermore, Kemp's ridley and loggerhead sea turtles, which commonly forage on crustaceans and mollusks, may ingest large amounts of oil due oil adhering to the shells of these prey and the tendency for these organisms to bioaccumulate toxins found in oil (NOAA 2003). It is suspected that oil adversely impacted the symbiotic bacteria in the gut of herbivorous marine iguanas when the Galapagos Islands experienced an oil spill, contributing to a >60% decline in local populations the following year. The potential exists for green sea turtles to experience similar impacts, as they also harbor symbiotic bacteria to aid in their digestion of plant material (NOAA 2003). Dispersants are believed to be as toxic to marine organisms as oil itself.

Hurricanes

The Gulf of Mexico, Caribbean Sea, and southern U.S. Atlantic seaboard is prone to major tropical weather systems, including tropical storms and hurricanes. The impacts of these storms on sea turtles in the marine environment is not known, but storms can cause major impacts to sea turtle eggs on land, as nesting frequently overlaps with hurricane season, particularly Kemp's ridley sea turtles (NRC 1990c). Mortality can result both from drowning of individuals while still in the egg or emerging from the nest as well as causing major topographic alteration to beaches, preventing hatchling entry to marine waters. Kemp's ridley sea turtles are likely highly sensitive to hurricane impacts, as their only nesting locations are in a limited geographic area along southern Texas and northern Mexico (Milton et al. 1994). In 2010, Hurricane Alex made landfall in this area;

surprisingly, few nests were lost (Jaime Pena, Gladys Porter Zoo, pers. comm.). Tropical storm Hermine arrived too late in 2010 to impact eggs or hatchlings at Rancho Nuevo (Donna Shaver, NPS, pers. comm.).

Ship strike

Sea turtle ship strikes are a poorly-studied threat to sea turtles, but has the potential to be highly-significant (Work et al. 2010). All sea turtles must surface to breath and several species are known to bask at the surface for long periods, including loggerhead sea turtles. Although sea turtles can move rapidly, sea turtles apparently are not well able to move out of the way of vessels moving at more than 4 km/hr; most vessels move far faster than this in open water (Hazel and Gyuris 2006; Hazel et al. 2007; Work et al. 2010). This, combined with the massive level of vessel traffic in the Gulf of Mexico, has the potential to result in frequent injury and mortality to sea turtles in the region (MMS 2007b). Hazel et al. (2007) suggested that green sea turtles may use auditory cues to react to approaching vessels rather than visual cues, making them more susceptible to strike as vessel speed increases. Each state along the Gulf of Mexico has several hundred thousand recreational vessels registered, including Florida with nearly one million-the highest number of registered boats in the United States-and Texas with over 600,000-ranked sixth nationally (NMMA 2007; USCG 2003; USCG 2005). Commercial vessel operations are also extensive. Vessels servicing the offshore oil and gas industry are estimated to make 115,675-147,175 trips annually, apart from commercial vessels travelling to and from some of the largest ports in the United States (such as New Orleans and Houston)(MMS 2007a; USN 2008). Extensive shrimping and other fishery effort is also expended in the area. Overall, ship strike is likely highly underestimated as a source of injury or mortality to sea turtles in the action area.

Sea turtles may also be harassed by the high level of helicopter activity over Gulf of Mexico waters. It is estimated that between roughly 900,000 and 1.5 million helicopter take-offs and landings are undertaken in association with oil and gas activities in the Gulf of Mexico annually (NRC 1990c; USN 2008). This likely includes numerous overflights of sea turtles, an activity which has been observed to startle and at least temporarily displace sea turtles (USN 2009).

Scientific and research activities

Scientific research permits issued by the NMFS currently authorize studies of listed species in the Atlantic 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, captive experiments, laparoscopy, and imaging. Research activities involve “takes” by harassment, with some resulting 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 number of “takes” rarely approach the number authorized. Therefore, it is unlikely that the 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 Atlantic Ocean, mostly from

Florida to Maine, and in the eastern Gulf of Mexico. 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 5-11 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 Atlantic Ocean.

| Year | Capture/handling /restraint | Satellite,sonic, or pit tagging | Blood/tissue collection | Lavage | Ultrasound | Captive experiment | Laparoscopy | Imaging | Mortality |
|-------|--------------------------------|------------------------------------|----------------------------|--------|------------|-----------------------|-------------|---------|-----------|
| 2009 | 3,093 | 3,093 | 3,009 | 1,860 | 555 | 66 | 74 | 72 | 6 |
| 2010 | 3,753 | 3,753 | 3,669 | 2,480 | 555 | 66 | 74 | 72 | 6 |
| 2011 | 4,255 | 4,255 | 3,505 | 2,990 | 564 | 66 | 74 | 72 | 20 |
| 2012 | 2,428 | 2,428 | 1,696 | 1,890 | 504 | 66 | 74 | 72 | 16 |
| 2013 | 2,273 | 2,273 | 1,541 | 1,920 | 504 | 66 | 74 | 72 | 16 |
| Total | 15,802 | 15,802 | 13,420 | 11,140 | 2,682 | 330 | 370 | 360 | 64 |

Permit numbers: 10014, 10022, 13306, 13543, 13544, 1462, 1501, 1506, 1507, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 13307, 14508, 14655, 14726, 14506, 13573, 1450, 1518, 15135, 15556, 15606, and 1522.

Table 6. Hawksbill sea turtle takes in the Atlantic Ocean.

| Year | Capture/handling /restraint | Satellite,sonic, or pit tagging | Blood/tissue collection | Lavage | Ultrasound | Captive experiment | Laparoscopy | Imaging | Mortality |
|-------|--------------------------------|------------------------------------|----------------------------|--------|------------|-----------------------|-------------|---------|-----------|
| 2009 | 1,073 | 1,073 | 1,066 | 464 | 254 | 0 | 0 | 0 | 3 |
| 2010 | 1,079 | 1,079 | 1,072 | 464 | 254 | 0 | 0 | 0 | 3 |
| 2011 | 1,057 | 1,057 | 1,048 | 464 | 255 | 0 | 0 | 0 | 4 |
| 2012 | 525 | 525 | 518 | 394 | 255 | 0 | 0 | 0 | 1 |
| 2013 | 445 | 445 | 438 | 344 | 255 | 0 | 0 | 0 | 1 |
| Total | 4,179 | 4,179 | 4,142 | 2,130 | 1,268 | 0 | 0 | 0 | 12 |

Permit numbers: 10014, 13306, 13543, 13544, 1462, 1501, 1506, 1507, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 13307, 14272, 1518, 14508, 14726, 14506, 15606, 15135, 15566, and 14655.

Table 7. Kemp's ridley sea turtle takes in the Atlantic Ocean.

| Year | Capture/handling /restraint | Satellite,sonic, or pit tagging | Blood/tissue collection | Lavage | Ultrasound | Captive experiment | Laparoscopy | Imaging | Mortality |
|-------|--------------------------------|------------------------------------|----------------------------|--------|------------|-----------------------|-------------|---------|-----------|
| 2009 | 1,394 | 1,394 | 1,195 | 425 | 371 | 56 | 53 | 53 | 5 |
| 2010 | 1,402 | 1,402 | 1,203 | 426 | 371 | 56 | 53 | 53 | 5 |
| 2011 | 2,210 | 2,210 | 1,368 | 976 | 400 | 56 | 53 | 53 | 9 |
| 2012 | 1,604 | 1,604 | 816 | 972 | 400 | 56 | 53 | 53 | 6 |
| 2013 | 1,557 | 1,557 | 769 | 972 | 400 | 56 | 53 | 53 | 6 |
| Total | 8,167 | 8,167 | 5,351 | 3,771 | 1,942 | 280 | 265 | 265 | 31 |

Permit numbers: 10014, 10022, 13306, 13543, 13544, 15135, 15606, 1462, 1501, 1506, 1507, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 14508, 14726, 14506, and 14655.

Table 8. Leatherback sea turtle takes in the Atlantic Ocean.

| Year | Capture/handling /restraint | Satellite,sonic, or pit tagging | Blood/tissue collection | Lavage | Ultrasound | Captive experiment | Laparoscopy | Imaging | Mortality |
|-------|--------------------------------|------------------------------------|----------------------------|--------|------------|-----------------------|-------------|---------|-----------|
| 2009 | 1,357 | 1,357 | 1,331 | 197 | 188 | 0 | 0 | 0 | 2 |
| 2010 | 1,361 | 1,361 | 1,334 | 197 | 188 | 0 | 0 | 0 | 1 |
| 2011 | 1,353 | 1,353 | 1,326 | 197 | 188 | 0 | 0 | 0 | 1 |
| 2012 | 208 | 208 | 191 | 187 | 188 | 0 | 0 | 0 | 0 |
| 2013 | 208 | 208 | 191 | 187 | 188 | 0 | 0 | 0 | 0 |
| Total | 4,487 | 4,487 | 4,373 | 965 | 940 | 0 | 0 | 0 | 4 |

Permit numbers: 10014, 10022, 13306, 13307, 13543, 13544, 1462, 1501, 1506, 1507, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 13307, 14249, 1450, 1522, 14506, 14726, 14508, and 14655.

Table 9. Loggerhead sea turtle takes in the Atlantic Ocean.

| Year | Capture/handling /restraint | Satellite,sonic, or pit tagging | Blood/tissue collection | Lavage | Ultrasound | Captive experiment | Laparoscopy | Imaging | Mortality |
|-------|--------------------------------|------------------------------------|----------------------------|--------|------------|-----------------------|-------------|---------|-----------|
| 2009 | 5,327 | 5,327 | 4,909 | 1,165 | 1,322 | 200 | 109 | 123 | 111 |
| 2010 | 5,199 | 5,199 | 4,781 | 1,205 | 1,322 | 200 | 109 | 116 | 111 |
| 2011 | 5,794 | 5,794 | 4,676 | 1,405 | 1,667 | 200 | 109 | 114 | 121 |
| 2012 | 2,886 | 2,886 | 1,786 | 1,355 | 1,429 | 200 | 109 | 114 | 22 |
| 2013 | 2,752 | 2,752 | 1,652 | 1,355 | 1,429 | 200 | 109 | 114 | 22 |
| Total | 21,958 | 21,958 | 17804 | 7,690 | 7,169 | 1,000 | 545 | 581 | 387 |

Permit numbers: 10014, 10022, 13306, 13307, 13543, 13544, 1462, 1501, 1506, 1507, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 13307, 14249, 1450, 1522, 14506, 14726, 14508, 15566, 15135, and 14655.

Table 10. Olive ridley sea turtle takes in the Atlantic Ocean.

| Year | Capture/handling /restraint | Satellite,sonic, or pit tagging | Blood/tissue collection | Lavage | Ultrasound | Captive experiment | Laparoscopy | Imaging | Mortality |
|-------|--------------------------------|------------------------------------|----------------------------|--------|------------|-----------------------|-------------|---------|-----------|
| 2009 | 187 | 187 | 187 | 34 | 34 | 0 | 0 | 0 | 1 |
| 2010 | 187 | 187 | 187 | 34 | 34 | 0 | 0 | 0 | 1 |
| 2011 | 187 | 187 | 187 | 34 | 34 | 0 | 0 | 0 | 1 |
| 2012 | 34 | 34 | 34 | 34 | 34 | 0 | 0 | 0 | 0 |
| 2013 | 34 | 34 | 34 | 34 | 34 | 0 | 0 | 0 | 0 |
| Total | 629 | 629 | 629 | 170 | 170 | 0 | 0 | 0 | 3 |

Permit numbers: 1551, 1570, and 1576.

Table 11. Smalltooth sawfish takes.

| Year | Rod and reel capture | Longline capture | Gill, seine, longline, or rod and reel capture | Tagging | Tissue sample | Morphometrics | Ultrasound |
|-------|----------------------|------------------|--|---------|---------------|---------------|------------|
| 2009 | 45 | 5 | 200 | 250 | 250 | 10 | 200 |
| 2010 | 45 | 5 | 200 | 250 | 250 | 10 | 200 |
| 2011 | 45 | 0 | 200 | 245 | 245 | 5 | 200 |
| 2012 | 45 | 0 | 200 | 245 | 245 | 5 | 200 |
| 2013 | 45 | 0 | 0 | 45 | 45 | 5 | 0 |
| Total | 225 | 10 | 800 | 1,035 | 1,035 | 35 | 800 |

Permit numbers: 13330, 1475, and 1538.

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 amendment 16253 would authorize “takes” by harassment of green, Kemp’s ridley, hawksbill, leatherback, loggerhead (northwestern Atlantic DPS), and olive ridley sea turtles during the proposed research by the SEFSC. In this section, we describe the potential physical, chemical, or biotic stressors associated with the proposed actions, the probability of individuals of listed or proposed 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 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 or proposed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

For this consultation, we are particularly concerned about behavioral, mortality, 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 evading a trawl net), 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. ship strike by the research vessel
2. acoustic interference produced by the research vessel or its deployed equipment
3. capture/entanglement by longline hook/line
4. capture by trawl net
5. handling and restraint following capture
6. application of flipper and/or PIT tags

Based on a review of available information, this Opinion determined which possible stressors would be likely to occur and which would be discountable or insignificant. We are not aware of the applicant striking a sea turtle, sturgeon, or sawfish during permitted activities from data collected over the past decade. Sea turtles would likely hear or see the approach of research vessels and be able to avoid a collision with vessels (applicant vessels would normally be moving slowly, except when transiting to or from study sites). Sturgeon tend to be benthic in nature and not in the water column where a vessel would contact an individual. Although sturgeon may leap from the water in some areas and at certain times, these areas are not expected to co-occur with the action area. Based upon this, we discount the possibility of ship strike to listed species.

The hearing range of sea turtles (and probably sturgeon and sawfish) overlaps that of the low-frequency sounds produced by vessel propulsion and machinery, as well as noise produced from trawls moving over the seafloor. However, it is unknown what these species use hearing for in the marine environment and how much individuals would be impacted by masking of natural sound by anthropogenic sources. We expect any such masking to be brief and not result in the loss of feeding or breeding opportunities, or increase exposure to predation. Therefore, we expect exposure to the noise produced by the research vessel to be insignificant.

We do expect capture by longline and trawl activities as well as handling, restraint, and tagging activities to adversely affect listed sea turtles, smalltooth sawfish, and proposed New York Bight, Chesapeake Bay, and South Atlantic DPSs of Atlantic sturgeon and focus the *Effects analysis* on these stressors.

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.

Sea turtles

Our *Exposure analysis* began with identifying the stressors that listed resources are likely to be exposed to, which we did in the preceding section. We continue by identifying the amount or extent of exposure that we believe is reasonably likely to occur. The Permit's Division provided estimated take numbers (Table 12) in their initiation package, representing the amount of exposure it believes will occur. However, no rationale was

provided for these levels of exposure. We therefore adopted an independent methodology that relied upon past performance to assess likely exposure.

Table 12. Number of individuals proposed to be taken by species by the Permit’s Division, life stage, and action under Permit 16253.

| Sea turtle species | Life stage | Proposed number of individuals taken annually | Action |
|---------------------------|----------------------|--|--|
| Green | All except hatchling | 10 | Trawl capture |
| | | 4 | Longline capture |
| | | 49 | Handle, restrain, PIT/flipper tag, weigh, biopsy |
| | | 2 | Incidental mortality |
| Hawksbill | All except hatchling | 10 | Trawl capture |
| | | 4 | Longline capture |
| | | 37 | Handle, restrain, PIT/flipper tag, weigh, biopsy |
| | | 1 | Incidental mortality |
| Kemp’s ridley | All except hatchling | 20 | Trawl capture |
| | | 3 | Longline capture |
| | | 101 | Handle, restrain, PIT/flipper tag, weigh, biopsy |
| | | 2 | Incidental mortality |
| Leatherback | All except hatchling | 18 | Trawl capture |
| | | 30 | Longline capture |
| | | 112 | Handle, restrain, PIT/flipper tag, weigh, biopsy |
| | | 1 | Incidental mortality |
| Loggerhead | All except hatchling | 70 | Trawl capture |
| | | 28 | Longline capture |
| | | 253 | Handle, restrain, PIT/flipper tag, weigh, biopsy |
| | | 3 | Incidental mortality |
| Olive ridley | All except hatchling | 10 | Trawl capture |
| | | 3 | Longline capture |
| | | 36 | Handle, restrain, PIT/flipper tag, weigh, biopsy |

| Sea turtle species | Life stage | Proposed number of individuals taken annually | Action |
|--------------------|----------------------|---|--|
| | | 1 | Incidental mortality |
| Unidentified | All except hatchling | 28 | Trawl capture |
| | | 3 | Longline capture |
| | | 88 | Handle, restrain, PIT/flipper tag, weigh, biopsy |
| | | 0 | Incidental mortality |

We expect the level of all actions to be different than the levels of “take” requested (Table 13). This is based upon annual monitoring reports and supplemental information of the applicant’s activities from 2001-present that include activities similar or identical to those proposed. Expected exposure levels for each species and activity were determined by calculating means and standard deviations for each action on each species. Four standard deviations were added to the mean to encompass a reasonably likely maximum exposure to similar activities for each species in the future. In addition, we identified which populations that would likely be exposed were stable, increasing, or decreasing. For those that were increasing (green-Costa Rica population, Kemp’s ridley-Rancho Nuevo population, and leatherback) we incorporated the best available estimate of annual population growth to the number of individuals we expect to be exposed at the end of the permit’s life (five years). Expected exposure numbers were rounded to the next highest multiple of five to reflect analytical uncertainty for species and activity combinations which the applicant has experienced in the past (loggerhead and Kemp’s ridley sea turtles). Although no exposure to capture or other action stressors have occurred over the past decade under previous applicant permits for the same actions, a single annual exposure to trawl or longline activities was qualitatively added for green, hawksbill, and olive ridley sea turtles. A single annual exposure of leatherbacks to trawl capture and Kemp’s ridley and leatherbacks to longline capture was also qualitatively added. This was based upon species abundance and life history that would make future exposure reasonably likely to occur. No mortality has occurred in the applicant’s prior performance. However, a single mortality over the life of the permit is also qualitatively expected for loggerhead sea turtles due to the frequency of trawl capture and incidence of mortality in commercial trawling in the action area as well as research trawling under more restrictive conditions. This is particularly true for testing in the flynet fishery, where time limitations on timing (usually 30 minutes) are less restrictive (55 minutes).

The applicant’s past performance data includes most years (7 of 10) not attempting longline modification research, even though it had been authorized. If the amount of effort increases significantly under the proposed permit, past performance would not be a good indicator of the actions exposure that is reasonably likely to occur under the proposed permit. However, the applicant indicates that effort under the proposed permit is likely to be roughly equivalent as what has been undertaken in the recent past and, thus, we do not expect effort to be significantly greater or lesser than that which has previously occurred.

Applicant data always reported individuals to species (no difficulty in identification was documented), but the Permit’s Division proposes to issue unidentified sea turtle take based upon the possibility of identification difficulties (such as through video monitoring). Our analysis does not include an unidentified sea turtle category, but assumes that if an individual cannot be identified, its’ species and the cumulative amount of exposure that species would experience falls within the bounds of the exposure analysis presented (i.e., true exposure would not be underestimated).

Sea turtle species are prone to eruptive local occurrences, such as within ephemeral oceanographic front or boundary systems, upwelling features, and other areas where temporary foraging opportunities exist. We cannot anticipate these rare and unpredictable events and, even when they do occur, we can only hypothesize on the underlying causality when spikes in sea turtle occurrence are encountered. This leads to the possibility that low, reasonably expected exposure may be suddenly surpassed if such an ephemeral foraging situation co-occurs with proposed actions. Because of the rarity of such events, we cannot treat them as reasonably likely to occur, but can better position future analyses to anticipate and incorporate them by obtaining at minimum brief details on the circumstances surrounding applicant encounters with listed or proposed species, the exposure to applicant actions individuals receive, and the response(s) individuals present.

Table 13. Expected annual exposure of listed species to the proposed actions.

| Sea turtle species | Life stage | Proposed number of individuals taken annually | Action |
|---------------------------|----------------------|--|--|
| Green | All except hatchling | 1 | Trawl capture |
| | | 0 | Longline capture |
| | | 1 | Handle, restrain, PIT/flipper tag, weigh, biopsy |
| | | 0 | Incidental mortality |
| Hawksbill | All except hatchling | 1 | Trawl capture |
| | | 0 | Longline capture |
| | | 1 | Handle, restrain, PIT/flipper tag, weigh, biopsy |
| | | 0 | Incidental mortality |
| Kemp’s ridley | All except hatchling | 10 | Trawl capture |
| | | 1 | Longline capture |
| | | 11 | Handle, restrain, PIT/flipper tag, weigh, biopsy |
| | | 0 | Incidental mortality |
| Leatherback | All except | 1 | Trawl capture |

| Sea turtle species | Life stage | Proposed number of individuals taken annually | Action |
|---------------------------|----------------------|--|--|
| | hatchling | 1 | Longline capture |
| | | 2 | Handle, restrain, PIT/flipper tag, weigh, biopsy |
| | | 0 | Incidental mortality |
| Loggerhead | All except hatchling | 50 | Trawl capture |
| | | 10 | Longline capture |
| | | 60 | Handle, restrain, PIT/flipper tag, weigh, biopsy |
| | | 0.2 | Incidental mortality |
| Olive ridley | All except hatchling | 1 | Trawl capture |
| | | 0 | Longline capture |
| | | 1 | Handle, restrain, PIT/flipper tag, weigh, biopsy |
| | | 0 | Incidental mortality |
| Unidentified | All except hatchling | 0 | Trawl capture |
| | | 0 | Longline capture |
| | | 0 | Handle, restrain, PIT/flipper tag, weigh, biopsy |
| | | 0 | Incidental mortality |

We expect that an individual would be exposed to these stressors no more than once in a given year. This is due to the low number of expected captures anticipated to occur, the continuous movement of the research activities to new locations (the same can also be said for most the movements of individual sea turtles), and the hundreds to thousands of individuals that occur within each population. An individual of any life stage except hatchling could be exposed to the proposed activities; nesting beaches generally do not co-occur with the action area and the catch history over the past decade does not support hatchlings as interacting with the proposed longline or trawl activities (hatchlings appear to stay in relatively shallow areas of the water column; trawl and longline activities deploy in relatively deep water depths). We expect both sexes would be exposed to the proposed stressors, but female green, leatherback, loggerhead sea turtles exhibit a female-biased sex ratio in free ranging populations and would likely be exposed at a higher rate than their male counterparts (Binckley et al. 1998; Dodd 1988; James et al. 2007; NMFS 2001a; Plotkin 1995; Rees and Margaritoulis 2004; Wibbels 2003).

Smalltooth sawfish

The applicant's bycatch data for the past ten years shows that no interactions have occurred with smalltooth sawfish. However, smalltooth sawfish were a significant bycatch component in trawl fisheries in the southeastern U.S. prior to their listing and were probably the leading factor in the species' decline (NMFS 2010b). Additional captures occurred in pelagic longlines (particularly the bottom shark longline fishery, which the applicant proposes to experiment in abundantly under the proposed permit). Large individuals were frequently capable of breaking free of nets, but smaller individuals remained entangled and, if they survived until gear retrieval, were killed so as to avoid injury to fisherman and be more easily removed from nets. The incidence of bycatch declined precipitously by the mid 1970's, presumably due to the drastic reduction in population size(s). Lethal interactions with trawling still occur in the Florida Keys and southwestern Florida (the latest a 2006 event in a U.S. Army Corps of Engineers turtle relocation trawl)(Shelley Norton, NMFS, pers. comm.). Most of these individuals were adults or subadults, as neonate through juvenile life stages remain in shallow mangrove habitat where the proposed actions would not occur. Richards (2007) indicated three smalltooth captures in 219 observed shark bottom longline sets from 2003-2005 in the Gulf of Mexico. All individuals were released alive. These captures occurred in habitat consistent with adult or subadult distribution (Florida Keys or offshore). Based upon this information, we expect there is a reasonable possibility that smalltooth sawfish may be captured during the course of the proposed trawling and longline research.

To quantify the expected level of exposure, we extracted data from observer data of the shrimp trawling fishery in the Gulf of Mexico (NMFS 2011a; NMFS 2011b). These data indicated that five smalltooth sawfish captures occurred over 5,559 trawls (averaging 7.75 hours each). Of the five captures indicated from shrimp trawling data, at least two and possibly three of the individuals died as a result of capture (NMFS 2011b). Shrimp trawling mortalities likely resulted from individuals being intentionally killed so that removal from nets would be made easier and safer. Because of the rarity of smalltooth sawfish capture, we used a Poisson distribution to calculate the probability of smalltooth sawfish capture given the expected level of effort provided by the applicant. Based upon this, we expect one smalltooth sawfish is reasonably likely to be captured during trawling operations over the life of the proposed permit. However, we do not expect mortality as a result of capture under the proposed permit. This is because we expect that NOAA personnel onboard research vessels will remove entangled sawfish using procedures outlined in NMFS (2011a) and NMFS (2007).

We cannot calculate how many smalltooth sawfish would likely be captured as a result of longline activities. This is because we do not know how much effort, either in sets or hooks per set, applicants are likely to undertake and how much effort was associated with bycatch in the smalltooth encounter database. Records from the sawfish encounter database indicate that longline captures are much more common than trawl captures (35 captures in 438 observed bottom shark longline sets; (Richards 2007)), but mortality rarely occurs (NMFS 2011b). The applicants have never caught a sawfish despite years of research effort. Thus, although it is certainly possible to capture sawfish under the proposed research, it is not likely to occur with even moderate frequency or intensity.

We therefore expect researchers may capture one or two sawfish during the course of the permit's lifespan via longline activities. Captured individuals would be disentangled according to NMFS approved guidelines (NMFS 2007) and, as a result, we do not expect mortality to result from incidental sawfish capture on longlines.

We expect that males and females would be equally likely to be exposed, but that subadult and adult age classes would be most likely to be exposed.

Atlantic sturgeon

Although the proposed permit would authorize sea turtle bycatch during TED testing, there also exists the possibility of interactions with Atlantic sturgeon. To evaluate the potential for Atlantic sturgeon bycatch, we analyzed bycatch data from the applicant from 2001 to present. To date, we know of three instances of Atlantic sturgeon bycatch under the applicant's current or previous permits for similar actions, all of which were in the vicinity of Duck Pier, Duck, North Carolina using flynets. The applicant has expended significant effort throughout a broad geographic range and, with the exception of this location, has not bycaught any sturgeon elsewhere. From 2001-2007, no sturgeon were caught, nor were any caught in 2010. However, in 2008, 80 Atlantic sturgeon were captured, of which 25% died. An additional 15 individuals were bycaught in 2009 in two trawls on a single day, with an unknown level of mortality. Bycatch and mortality data from 2001-present were analyzed and the mean and standard deviation calculated. As with the sea turtle exposure analysis, four standard deviations were added to the mean, resulting in 106 reasonably likely annual captures and 28 mortalities. Our calculations processed data on an annual basis instead of over the life of the permit because effort and bycatch data were reported annually and clumping data for longer periods would have reduced the accuracy of our calculations. According to unpublished genetic data, roughly 52% of Atlantic sturgeon in the area where bycatch occurred are from the York River (proposed endangered Chesapeake Bay DPS), 14% from the Hudson River (proposed endangered New York Bight DPS), 12% from the Savannah River (proposed endangered South Atlantic DPS), and 17% from the Ogeechee River (proposed endangered South Atlantic DPS) (Isaac Wurgin, pers. comm. 2011). All individuals were of subadult size (a life stage with very low mortality and in which a large majority of individuals recruit in sexually mature adult age classes). With no further effective mitigation measures in place, we would expect the Chesapeake Bay DPS would likely experience up to 56 captures and 15 mortalities annually, the South Atlantic DPS up to 31 captures and 9 mortalities annually, and the New York Bight DPS up to 15 captures and four mortalities annually. However, the applicant will be including mitigation measures (particularly 100% video monitoring of trawls and cessation of trawling upon sturgeon detection off Duck, North Carolina) that we expect will bring these numbers down dramatically.

The proposed permit contains conditions, limitations, and new methodology that were not present in prior permits that significantly reduce this level of capture. The applicant expects effort under the proposed permit would be equivalent overall to that which has occurred in the past, although trawls would be shorter (30-55 minutes versus trawl times of 75-167 minutes when Atlantic sturgeon were bycaught under the applicant's current permit), there would be more of them. Therefore, the opportunity to capture sturgeon would likely remain the same without additional limitations (although mortality would likely decrease slightly from this measure; see Response analysis).

Much more significant to reducing the likelihood of Atlantic sturgeon bycatch would result from the use of video monitoring systems on trawl nets. The applicant has and still does use video monitoring to observe sea turtles moving out through TEDs and to account for this “take,” although the applicant indicates that sturgeon have been observed exiting through TEDs as well. Under the proposed permit, the applicant has agreed that a trawl will be stopped if Atlantic sturgeon are observed entering the trawl net. Video monitoring would be used on 40-70% of trawls overall and would be employed on all trawls in the vicinity of Duck, North Carolina (where all Atlantic sturgeon bycatch has occurred). We expect that, based upon the applicant’s ability to identify sturgeon entering trawl nets in previous years, the applicant would have a high likelihood of observing Atlantic sturgeon entering the net via video monitoring. Although it is possible that a single individual might not be observed entering the net, data support trawls capturing not one but multiple individuals when the species is encountered. Therefore, even though one might be missed, we expect any subsequent individual(s) would be observed. If detected, the proposed permit requires that trawls be immediately hauled back and Atlantic sturgeon released using NMFS-recommended safe handling protocols. This would mean that the trawl would pass through only a small part of an Atlantic sturgeon refuge and that most individuals that would otherwise be captured without this measure would not be (i.e., the opening of the trawl net would pass over the refuge not through it). As it is not standard practice for commercial trawls to repeat fishing effort over areas they have just fished, we do not expect the trawl would be redeployed over the same location and capture remaining individuals (a fishing vessel’s inertia would carry the vessel over and past a refuge before the vessel could redeploy trawl nets).

In determining the total number of Atlantic sturgeon captures, we assume that up to two individuals may be captured during a single trawl (one individual may be missed during video monitoring, but not a second) and that up to two trawling events per year may capture Atlantic sturgeon (the maximum number of trawls per year that have captured Atlantic sturgeon according to data over the past decade). Therefore, we expect up to four individual Atlantic sturgeon of the Chesapeake Bay, South Atlantic, or New York Bight DPSs would be captured annually during proposed trawling. We assume that females and males would be equally likely to be exposed (as we are unaware of gender bias in exposed populations), but bycatch data indicate that the subadult age class would be the most likely, if not only, age class to be exposed.

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), or behavioral responses that might result in reducing the fitness of listed individuals. Ideally, response analyses would 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; Mancina 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; Cowan and Curry 2002; Cowan and Curry 2008; Herraiez 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).

Trawl and longline capture

Sea turtles would be captured during the course of proposed research in one of two ways: trawl or longline. 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 by either method 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). Lutz and Dunbar (1987) found that blood lactate concentrations (an indicator of stress) increased 10-80 fold following trawl capture compared to resting levels and required 20 hours to return to baseline (Henwood and Stuntz 1987). This may partly result from significant swimming efforts to avoid trawl capture (Ogren et al. 1977). Within 30 minutes of trawl capture and retention in trawl nets, heart rate declined sharply, lactate increased, and blood oxygen levels became very low (Sasso and Epperly 2006). Berkson (1966) did not find lactate to increase

within 30 minutes of forced submersion in green sea turtles, but Lutz and Bentley (1985) did see this effect 30 minutes after starting forced submersion in loggerhead sea turtles. Stabineau et al. (1991) observed lactate concentration increase after roughly 7 minutes. Warm water conditions result in higher oxygen demands in sea turtles than in colder temperatures (Sasso and Epperly 2006). We also expect behavioral responses (attempts to outswim the trawls, breaking free of longlines, etc.) 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)).

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). Some 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, mortality has been observed in summer trawl tows as short as 15 minutes (Sasso and Epperly 2006). 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). To minimize the effects of this type of capture, trawls would be limited to 30 minutes and longlines to between 10 and 60 minutes.

Smalltooth sawfish entangled in trawls or longlines would likely experience stress in association with the event and some lacerations associated with line or netting. However, they should be capable of continued respiration (in the case of longlines, entanglement should not be so bad as to immobilize individuals and for trawls, the rostrum tangling in the net should keep individuals away from being crushed or immobilized by bycatch). If disentangled according to NOAA-approved protocols, no further injury should occur. Bycatch in the past does not appear to be fatal due to distress and we do not expect distress that would impede fitness for any interactions with trawls or longlines under the proposed permit.

Longline capture presents the additional hazard of hook retention. Hooks that become embedded in the mouth can frequently be removed before release, but swallowed hooks are not removed. In these cases, individuals are released with the hook generally embedded, with the potential for serious injury and mortality in the future (Read 2007). Most hooks ingested by loggerheads become lodged in the throat (Read 2007). The only study we are aware of directly assessing mortality and behavior after longline hooking found lightly-hooked olive ridley sea turtles returned to baseline behaviors similar to their control counterparts (Swimmer et al. 2006). All but one turtle in the experimental group had the hook removed; this single individual survived for the duration of the satellite tags' life (roughly two months). We have no information to inform us on what the consequences of hook imbedding in smalltooth sawfish may be, but similar impacts as sea turtles are expected.

As a result primarily of video monitoring of trawls off Duck, North Carolina, we do not expect Atlantic sturgeon to die as a result of proposed trawling activities. Under the applicant's current permit, bycatch of 80 Atlantic sturgeon were bycaught of which 25% died. These are the only data in which mortality are reported and the mortality likely resulted from the large amount of catch in the nets during the trawl, causing death either

by physical crushing, or by rendering sturgeon immobile and unable to respire. Extended distress may have also contributed to death. To mitigate the potential for sea turtle mortality, the applicant proposes to limit trawl tow times to 30 minutes in most cases, but fishery-specific standards in others (55 minutes). Regardless, these times far exceed the NMFS-recommended tow time limits for sturgeon to avoid mortality (10 minutes) (Kahn and Mohead 2010). As proposed trawl time durations would be several fold longer than those recommended to avoid sturgeon mortality, we do not expect reduced trawl durations in place to mitigate the potential for sea turtle mortality to be effective in significantly reducing Atlantic sturgeon mortality, although the potential for mortality would likely decline to some extent as individuals would not be restricted, stressed, or crushed for as long as they previously would have. However, the causes of Atlantic sturgeon mortality would be mitigated by another measure, video monitoring for Atlantic sturgeon entering the trawl net. It is very likely that any given Atlantic sturgeon entering the trawl net would be observed via video monitoring, at which time a haulback would immediately be initiated and Atlantic sturgeon removed from the trawl net quickly and according to NMFS-recommended safe handling protocols. Under this measure, Atlantic sturgeon would not be exposed to the stressors we expect can lead to mortality, namely crushing, respiratory distress, or severe stress associated with prolonged restraint under the biomass captured in the trawl net under this condition. Therefore, we do not expect mortality of Atlantic sturgeon to result from the proposed action.

We expect capture, handling, and restraint of Atlantic sturgeon during trawling to cause short-term stress (Kahn and Mohead 2010). This can be exacerbated by less than ideal environmental conditions, such as relatively high water temperature (higher than 28° C), high salinity, or low dissolved oxygen, potentially resulting in mortality or failure to breed (Hastings et al. 1987; Jenkins et al. 1993; Kynard et al. 2007; Moser and Ross 1995; Niklitschek 2001; Niklitschek and Secor 2009; Niklitscheka and Secor 2009; Secor and Niklitschek 2002; Secor and Gunderson 1998; Secor and Niklitschek 2001). Although sturgeon may be captured during warm water periods, the action area generally encompasses areas where water movement is good (generally providing good oxygenation and moderating salinity) and would not occur in breeding areas. The applicant's effort would be concentrated from October to April, which does not include particularly warm water periods in the action area. We do not expect the additional stress associated with brief capture, handling, and restraint to result in more than short-term stress if the SEFSC follows guidelines outlined in Kahn and Mohead (2010), as provided for in the proposed permit's terms and conditions and the Provisional Incidental Harassment Authorization of this Opinion.

Morphometrics, biopsy, flipper tagging, and PIT tagging

Once sea turtles have been captured, individuals will be handled and exposed to various activities of greater or lesser degrees of invasiveness. Stabenau et al. (1991) found that blood gases measured on handled versus baseline individuals were similar, suggesting little stress effects from the handling process. Each sea turtle will be exposed to morphometric measurement, including 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 these activities. All sea turtles will also be scanned or visually inspected for PIT and flipper tags,

respectively. If either of these is absent, then individuals may 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 1999). Based upon several hundred tagging events, behavioral responses may or may not be evident during tag implantation; when evident, behavioral responses are fleeting (Eastman and Coalson 1974). We expect disinfection methods proposed by the applicant should mitigate risks from infection from both tagging and biopsy. Wounds are expected to heal without infection. 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 1999).

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, bycatch, hurricane impacts, oil and gas extraction and development to continue. Movement towards bycatch reduction and greater foreign protections of sea turtles are generally occurring through the Atlantic Ocean, which may aid in recovery of sea turtle populations. Risk of ship strike will likely increase in the future as more vessels are used in commercial and recreational marine activities. In addition, impacts from oil development and pollution will likely increase, as this industry is anticipated to grow in the northern Gulf of Mexico over the next few decades (MMS 2007a; MMS 2007b). Additional seismic survey operations will commence, likely rising from roughly 100 to about 130 annually. A windfarm is proposed for construction three to eight miles offshore of Padre Island near Baffin Bay (TGLO 2006). This 100-turbine farm would involve extensive construction, including vessel traffic and noise-generating pile driving that could adversely impact sea turtles (TGLO 2006; Washington Post 2006).

Many of the major industrial activities along the northern Gulf of Mexico, such as oil and gas extraction and fishing, are forecasted to experience significant decreases in output between 2008 and 2018 (USBLS 2010b). Stressors associated with these activities include net entanglements, ship-strike potential, and underwater noise (USBLS 2010a; USBLS 2010b). Agriculture as a whole has been declining in output between 1998 and 2008, but this rate of decline is predicted to slow between 2008 and 2018, likely meaning more herbicides, fungicides, pesticides, and fertilizer will be applied and ultimately run-off into streams which can drain into the Gulf of Mexico.

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, smalltooth sawfish, and proposed Atlantic sturgeon affected by the actions outside the action area have been adversely affected by human-induced factors such as commercial fisheries, direct harvest, and modification or degradation of the terrestrial and aquatic habitat. Effects occurring in terrestrial habitats have generally resulted in the loss of sea turtle 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 resulting in stress or possible mortality.

The *Description of the proposed action* describes the actions proposed to be undertaken to green, hawksbill, Kemp's ridley, leatherback, loggerhead (northwestern Atlantic DPS), and olive ridley sea turtles: capture by trawl and longline, handling, biopsy, and tagging of any age/sex except hatchlings.

Species with delayed maturity such as sea turtles, smalltooth sawfish, and Atlantic sturgeon 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 sea turtles species is 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 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 to 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 *Exposure analysis* identified the number of individuals that we reasonably expect may be exposed to the proposed action's stressors. These include green (one trawl capture plus tagging, handling, and biopsy annually), Kemp's ridley (10 trawl and 1 longline captures plus tagging, handling, and biopsy from each, annually), hawksbill (one trawl capture plus tagging, handling, and biopsy annually), leatherback (one trawl and one longline capture plus tagging, handling, and biopsy from each, annually), northwestern Atlantic DPS loggerhead (50 trawl and 10 longline captures plus tagging, handling, and biopsy for each, annually plus one mortality over the life of the permit), and olive ridley sea turtles (one trawl capture plus tagging, handling, and biopsy

annually). Also included were two longline and one trawl capture events of smalltooth sawfish that would require handling and release during the life of the permit. Four Atlantic sturgeon from the New York Bight, Chesapeake Bay, or South Atlantic DPSs may also be captured, handled, and restrained annually. The *Response analysis* considered that stressors to which targeted individuals would be exposed will likely cause behavioral, physiological, and/or pathological responses. Most activities will result in temporary stress to the animal, which is not expected to have more than short-term effects on individuals. These non-lethal interactions will not affect the individual's ability to reproduce and contribute to the maintenance or recovery of the species. This research will affect individuals by harassing sea turtles, smalltooth sawfish, and Atlantic sturgeon, thus raising levels of stress hormones. The exceptions to this are individuals that are captured on longlines or in trawls that are likely individually more susceptible or liable to extreme physiological responses and die relatively soon after capture.

The research activities that would take place under the permit are expected to result in a single mortality to a loggerhead sea turtle. Loggerhead sea turtles in the northwestern Atlantic are declining precipitously in number such that there is a significant threat of quasi-extinction in the foreseeable future. However, several tens of thousands of nesting females nest annually within the population. Consequently, the loss of one individual is not expected to discernibly diminish the population's reproductive potential. NMFS does not expect the proposed research activities to appreciably reduce the green, hawksbill, Kemp's ridley, leatherback, northwestern Atlantic loggerhead DPS, or olive ridley sea turtles' likelihood of survival and recovery in the wild by adversely affecting their birth rates, death rates, growth rates, or recruitment rates. We expect the same for individual smalltooth sawfish and Atlantic sturgeon. For the vast majority of individuals, the proposed action is not expected to have more than short-term effects. The information collected as a direct result of permit issuance will be used to implement the goals identified in the recovery plans for listed species.

Conclusion

After reviewing the current status of green, hawksbill, Kemp's ridley, leatherback, loggerhead (northwestern Atlantic DPS), and olive ridley sea turtles as well as smalltooth sawfish in the *Status of Listed Resources*, the *Environmental Baseline* for the action area, the effects of the proposed research, and the *Cumulative Effects*, it is the NMFS' opinion that issuing permit 16253 (Bonnie Ponwith, SEFSC) is not likely to jeopardize the continued existence of green, hawksbill, Kemp's ridley, leatherback, loggerhead (northwestern Atlantic DPS), or olive ridley sea turtles or smalltooth sawfish.

After reviewing the *Status of Listed Resources*, the *Environmental Baseline* for the action area, the effects of the proposed permit and the *Cumulative Effects*, it is the NMFS's conference opinion that the permit, as proposed, is not likely to jeopardize the continued existence of proposed New York Bight, Chesapeake Bay, or South Atlantic DPSs of Atlantic sturgeon.

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.

The measures described below are nondiscretionary, and must be undertaken by the SEFSC and the Permits Division so that they become binding conditions for SEFSC for the exemption in section 7(o)(2) to apply. Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of listed species, the NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures and term and conditions to implement the measures, must be provided. Only incidental take resulting from the agency actions and any specified reasonable and prudent measures and terms and conditions identified in the incidental take statement are exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA.

Amount or extent of take

The NMFS anticipates the issuance of the proposed permit 16253 might result in the incidental take of listed species. The proposed action is expected to take by harassment three smalltooth sawfish via capture by longline over the life of the permit. This estimate is based on the best available information of past performance in the commercial trawling industry in the region. This incidental take would result from hooking on longlines and disentanglement from the line. Death or injury of any individuals is not expected.

Reasonable and prudent measures

The NMFS believes the reasonable and prudent measures described below are necessary and appropriate to minimize the impact of incidental take of listed smalltooth sawfish resulting from the proposed action and are the best practical means of ensuring the total taking as well as its intensity is within the limits allowable under the IHA. These measures are non-discretionary and must be binding conditions of the SEFSC conducting activities under proposed permit 16253 and the NMFS' authorization for the exemption in section 7(o)(2) to apply. If the SEFSC or the NMFS Permit's Division fail to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

1. Guidelines for the safe disentanglement of smalltooth sawfish (NMFS 2007) must be followed whenever bycaught smalltooth sawfish are encountered.
2. The implementation and effectiveness of mitigation measures incorporated as part of the Reasonable and Prudent Measure mentioned above and the associated Terms and Conditions must be monitored.

Provisional 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.

The prohibitions against taking the species found in Section 9 of the ESA do not apply until the species is listed. However, the Endangered Species Act Interagency Cooperation Division advises the Permits Division to consider implementing the following reasonable and prudent measures. If this conference opinion is adopted as a biological opinion following a listing, these measures, with their implementing terms and conditions, will be non-discretionary.

Provisional amount or extent of take

The NMFS anticipates the issuance of the proposed permit 16253 might result in the incidental take of proposed New York Bight, Chesapeake Bay, and/or South Atlantic DPSs of Atlantic sturgeon. The proposed action is expected to take by harassment up to four individuals via trawl capture in each year of the permit (up to 20 over the permit's life). This estimate is based on the best available information of past performance of the applicant. Death or injury of any individuals is not expected.

Provisional reasonable and prudent measures

The NMFS believes the provisional reasonable and prudent measures described below are necessary and appropriate to minimize the impact of incidental take of proposed New York Bight, Chesapeake Bay, and/or South Atlantic DPSs of Atlantic sturgeon resulting from the proposed action and are the best practical means of ensuring the total taking as well as its intensity is within the limits allowable under the provisional IHA. Once the species is listed, these measures are non-discretionary and must be binding conditions of the SEFSC conducting activities under proposed permit 16253 and the NMFS' authorization for the exemption in section 7(o)(2) to apply. If the SEFSC or the NMFS Permit's Division fail to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

1. Guidelines for the safe handling of Atlantic sturgeon (Kahn and Mohead 2010) must be followed whenever bycaught sturgeon are encountered.
2. All trawls in the vicinity of Duck, North Carolina must be equipped with function video surveillance of trawl nets and, when sturgeon are detected entering the trawl net, haul back must begin immediately and sturgeon removed from the net.

3. The implementation and effectiveness of mitigation measures incorporated as part of the Reasonable and Prudent Measure mentioned above and the associated Terms and Conditions must be monitored.

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 recommends that annual reports submitted to the Permits Division require detail on the response of listed individuals to activities they are exposed to. Although expansive, individual-by-individual detail is not recommended, a minimum of general comments on response can be informative regarding methodological, population, researcher-based responses in future consultations.

In order for NMFS Endangered Species Division to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Permits Division should notify the Endangered Species Division of any conservation recommendations they implement in their final action.

Reinitiation Notice

Pursuant to the provisions of section 10 of the ESA, this concludes formal consultation and conferencing on NMFS' proposal to issue permit 16253 to the SEFSC. 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, NMFS Permits and Conservation Division must immediately request reinitiation of section 7 consultation.

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