National Marine Fisheries Service
Endangered Species Act Section 7 Consultation

Biological Opinion

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

Activities Considered: Issuance of permit to Bonnie Ponwith, Southeast Fisheries Science Center [Permit No. 16194]

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

Approved by: Wandall

Date: 22 December 2011

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 bycatch of green, Kemp's ridley, leatherback, loggerhead, and olive ridley sea turtles in the Gulf of Mexico, Atlantic Ocean, and Caribbean Sea. The consulting agency for this proposal is the NMFS' Office of Protected Resources – Endangered Species Act Interagency Cooperation Division.

This document represents the NMFS' biological and conference opinion (Opinion) of the effects of the proposed actions on endangered and threatened species, as well as species proposed for listing, 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 for green, hawksbill, Kemp's ridley, leatherback, loggerhead, and olive ridley sea turtles, 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 August 9, 2011, the Permits Division published a notice in the Federal Register soliciting public comment on their intent to issue the proposed permit.

On September 29, 2011, NMFS' Endangered Species Act Interagency Cooperation Division received a request for formal consultation from the Permits Division to authorize Permit Number 16194, Bonnie Ponwith, Southeast Fisheries Science Center (SEFSC). Consultation was initiated on this date.

Description of the proposed action

The SEFSC proposes to conduct multifaceted research in the Gulf of Mexico, Atlantic Ocean, and Caribbean Sea that may involve sea turtle interactions. As such, the Permits Division is proposing to issue a permit under ESA Section 10(A)(1)(a). The applicant's activities would be conducted during resource assessments cruises and include groundfish and shrimp trawls, reef fish surveys, plankton surveys, and bottom longline sets. All activities would be conducted from the NOAA vessels *Oregon II*, *Gordon Gunter*, *Pisces*, *Caretta*, *Gandy*, *HST*, or charter trawl vessels.

Two trawl projects are proposed; the first would occur in relatively nearshore waters of depths 9-110 m using a 12 m wide shrimp trawl in June-July and in October-November. Pelagic trawls would also be conducted each year in October and November in more offshore regions of the Gulf of Mexico in roughly 55-366 m water depths using a 27.5 m wide trawl net. Both trawls would be deployed for 30 minutes and not be equipped with turtle excluder devices (TEDs).

The SEFSC also proposes to conduct three reef fish survey projects from February to July each year: one on offshore banks of the Gulf of Mexico, another in the Madison-Swanson and Steamboat Lumps Marine Protected Areas, and a third in the Caribbean Sea around Puerto Rico, St. Thomas, and St. Croix. These projects would involve the deployment of underwater video cameras and fish traps at locations within the study areas. The Caribbean survey would also involve the deployment of a vertical longline (see below).

Plankton surveys are proposed from April-May and in September every year as well as February-March every other year. These surveys would be conducted in the Gulf of Mexico and involve towing small plankton nets (61 cm opening).

The final components of the proposed action are two longline projects. An annual bottom longline project targeting snapper and sharks would be conducted from July to November and extend from Cape Hatteras, North Carolina into the Gulf of Mexico. The line would be one mile in length, have 100 hooks baited with Atlantic mackerel, and have a soak time of one hour. A second longline survey project would involve vertical longlines deployed in the Caribbean Sea in April and May coincident with the reef fish survey in the same area. A 300 m longline would be deployed with 10 baited hooks and have a soak time of 10 minutes. For both projects, gangions would not be long enough to reach the surface. Circle hooks would be employed, which have been shown to drastically reduce the incidence of bycatch in some sea turtle species, including loggerheads.

Any sea turtles that are captured alive could be handled and/or restrained, skin biopsied, PIT and/or flipper tagged, measured, and or weighed. 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 (Epperly et al. 2004; NMFS 2008).

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, use of Betadine© at tag sights, and surgical scrub 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 immediately transferred to a rehabilitation facility for veterinary care. 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.

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 baring 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, manner, and age/sex 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 1-4 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 Permit No. 16194. 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. <u>Turtles Captured Under Another Authority Prior to Research Activities</u>*:*

        i. Researchers must only use turtles if they appear in good health and are active, and if there is no chance that further stress from the research may compromise the animal.

    b. <u>General Handling, Resuscitation, and Release</u>:

        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.

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. <u>Compromised or Injured Sea Turtles</u>

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.

d. <u>Handling, Measuring, Weighing, PIT and Flipper Tagging</u>:

i. 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. <u>Biopsy (tissue-skin) Sampling</u>:

   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.

3. <u>Painting of Carapace</u>

   a. Researchers must use non-toxic paints that do not contain xylene or toluene.

b. For turtles ≤ 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.

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 – Karen Mitchell

   b. 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.

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.

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.

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.

1. 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 contacted be for information about coordinating with other Permit Holders.

2. 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.

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 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.

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

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

We supplemented these searches with electronic searches of doctoral dissertations and master's theses. 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).

Action Area

The proposed action area includes a broad region of the Gulf of Mexico, Atlantic Ocean, and Caribbean Sea. Only the bottom longline component would occur in the broader Atlantic Ocean, including areas from Cape Hatteras south to Florida out to roughly the 366 m isobath. Only the vertical longline project and one study area of the reef fish survey would occur in the Caribbean Sea in areas along Puerto Rico, St. Thomas, and St. Croix. All other activities would occur in the Gulf of Mexico from the Florida Keys to Brownsville, Texas in waters from roughly 9 to 366 m deep. Projects would occur during specific months of a given year, the timing of which is outlined in the *Description of the proposed action*.

Status of Listed Resources

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

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

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

Species not considered further

Blue, fin, humpback, sei, and 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 unlikely to cause widespread, high-dose contamination (excluding the remote possibility of severe damage to the vessel) that would impact listed species directly or pose hazards to their food sources. We are not aware of a ship strike by a SEFSC research vessel, although 1,000s of hours of vessel travel occur annually. We do not expect a significant probability of ship strike due to low whale density in the action area 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, the short duration of soak times, and lack of entanglement history over the past decade of 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, be do not consider these species further in this consultation.

It is possible that smalltooth or largetooth sawfish may be caught by longline or trawl surveys. However, this is highly unlikely considering the generally nearshore nature of the species versus proposed trawl and longline locations, the short duration of tows and longline sets, as well as the absence of these species in catch data. As we do not expect these species to be exposed to stressors associated with the proposed action, we do not consider them further in this consultation.

It is also possible that elkhorn and/or staghorn coral may be exposed to the proposed actions, including fish traps being lowered onto corals. However, this is not expected to occur because the applicants would use GIS, sonar, and charts to avoid areas of coral and live bottom habitat. We expect that this removes any meaningful possibility of adverse affect to listed corals. 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 listing. 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, loggerhead, and olive ridley sea turtles) 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) (Maison et al. 2010)
Coringa-Herald National Nature Reserve, Australia	1,445 AF	(Maison et al. 2010)
Guam	45 AF	(Cummings 2002)
Phoenix Islands, Kiribati	100-300 AF	(Maison et al. 2010)
Ogasawara Islands, Japan	500 AF	(Chaloupka et al. 2007)
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 (Bjorndal 1982). Growth rates of juveniles vary substantially among populations, ranging from <1 cm/year (Green 1993) to >5 cm/year (McDonald Dutton and Dutton 1998), likely due to differences in diet quality, duration of foraging season (Chaloupka et al. 2004), and density of turtles in foraging areas (Balazs and Chaloupka 2004; Bjorndal et al. 2000; Seminoff et al. 2002b). If individuals do not feed sufficiently, growth is stunted and apparently does not compensate even when greater-than-needed resources are available (Roark et al. 2009). In general, there is a tendency for green sea turtles to exhibit monotonic growth (declining growth rate with size) in the Atlantic and non-monotonic growth (growth spurt in mid size classes) in the Pacific, although this is not always the case (Balazs and Chaloupka 2004; Chaloupka and Musick 1997; Seminoff et al. 2002b).

It is estimated that green sea turtles reach a maximum size just under 100 cm in carapace length (Tanaka 2009). A female-bias has been identified from studies of green sea turtles (Wibbels 2003).

Consistent with slow growth, age-to-maturity for green sea turtles appears to be the longest of any sea turtle species and ranges from ~20-40 years or more (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 Garcon et al. 2010).

Once hatched, sea turtles emerge and orient towards a light source, such as light shining off the ocean. They enter the sea in a “frenzy” of swimming activity, which decreases rapidly in the first few hours and gradually over the first several weeks (Ischer et al. 2009; Okuyama et al. 2009). Factors in the ocean environment have a major influence on reproduction (Chaloupka 2001; Limpus and Nicholls 1988; Solow et al. 2002). It is also apparent that during years of heavy nesting activity, density dependent factors (beach crowding and digging up of eggs by nesting females) may impact hatchling production (Tiwari et al. 2005; 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 (Bjorndal et al. 2003; Campbell and Lagueux 2005).

Migration and movement. Green sea turtles are highly mobile and undertake complex movements through geographically disparate habitats during their lifetimes (Musick and Limpus 1997; Plotkin 2003). The periodic migration between nesting sites and foraging areas by adults is a prominent feature of their life history. After departing as hatchlings and residing in a variety of marine habitats for 40 or more years (Limpus and Chaloupka 1997), green sea turtles make their way back to the same beach from which they hatched (Carr et al. 1978; Meylan et al. 1990). Green sea turtles spend the majority of their lives in coastal foraging grounds. These areas include both open coastline and protected bays and lagoons. While in these areas, green sea turtles rely on marine algae and seagrass as their primary dietary constituents, although some populations also forage heavily on invertebrates. There is some evidence that individuals move from shallow seagrass beds during the day to deeper areas at night (Hazel 2009). However, avoidance of areas of greater than 10 m when moderate depths of 5-10 m with sea grass beds has been found, with speed and displacement from capture locations being similar at night as during the daytime (Senko et al. 2010a).

Habitat. Green turtles appear to prefer waters that usually remain around 20º C in the coldest month, but may occur considerably north of these regions during warm-water events, such as El Niño. Stinson (1984a) found green turtles to appear most frequently in U.S. coastal waters with temperatures exceeding 18º C. Further, green sea turtles seem to occur preferentially in drift lines or surface current convergences, probably because of the prevalence of cover and higher prey densities that associate with flotsam. For example, in the western Atlantic Ocean, drift lines commonly containing floating *Sargassum* spp. are capable of providing juveniles with shelter (NMFS and USFWS 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 (Bjorndal and Bolten 2000). Strong site fidelity appears to be a characteristic of juveniles green sea turtles along the Pacific Baja coast (Senko et al. 2010b).

Green sea turtles in the Gulf of Mexico tend to remain along the coast (lagoons, channels, inlets, and bays), with nesting primarily occurring in Florida and Mexico and infrequent nesting in all other areas (Landry and Costa 1999; Meylan et al. 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 mater replaces an omnivorous diet at around 59 cm in carapace length off Mauritania (Cardona et al. 2009). This transition may occur rapidly starting at 30 cm carapace length, but animal prey continue to constitute an important nutritional component until individuals reach about 62 cm (Cardona et al. 2010). Foraging within seagrass ecosystems by green sea turtles can be significant enough to alter habitat and ecological parameters, such as species composition (Lal et al. 2010).

Diving. Based on the behavior of post-hatchlings and juvenile green turtles raised in captivity, we presume that those in pelagic habitats live and feed at or near the ocean surface, and that their dives do not normally exceed several meters in depth (Hazel et al. 2009; NMFS and USFWS 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).

Vocalization and hearing. Although very limited information is available regarding green turtle hearing, it is one of the few sea turtle species that have been studied. Based upon auditory brainstem responses green sea turtles have been measured to hear in the 50-1600 Hz range (Dow et al. 2008) and 100-800 Hz (Bartol and Ketten 2006) , although cochlear potential suggest a range between 60 and 1000 Hz (Ridgway et al. 1969). Maximum sensitivity has been found to be 200-400 Hz for subadults and 600-700 for juveniles (Bartol and Ketten 2006; Ketten and Bartol 2006). This is supported bycochlear potential estimates of 300-500 Hz from Ridgway et al. (1969). However, Dow et al. (2008) found best sensitivity between 50 and 400 Hz. Outside of this limited range, green turtles are much less sensitive to sound (Ridgway et al. 1969). This is similar to estimates for loggerhead sea turtles, which have most sensitive hearing between 250-1,000 Hz, with rapid decline above 1,000 Hz (Moein Bartol et al. 1999).

Status and trends. Federal listing of the green sea turtle occurred on July 28, 1978, with all populations listed as threatened except for the Florida and Pacific coast of Mexico breeding populations, which are endangered (43 FR 32800). The International Union for Conservation of Nature (IUCN) has classified the green turtle as “endangered.”

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

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 2006a; 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 majuscule* could promote the development of fibropapillomatosis (Arthur et al. 2008). It has also been theorized that dinoflagellates of the genus *Prorocentrum* that produce the tumorogenic compound okadoic acid may influence the development of fibropapillomatosis (Landsberg et al. 1999).

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

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 (Hildebrand 1983; NMFS and USFWS 1993; Rabalais and Rabalais 1980; Rester and Condrey 1996; 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).

Vocalization and hearing. Although information is not available regarding hawksbill sea turtle vocalizations or auditory capabilities, green and loggerhead sea turtles have been studied and are likely similar in capacity to their close relative, the hawksbill. The frequency range at which these species hear best is 50-700 Hz, with rapid diminishment of sensitivity outside of this range (Bartol and Ketten 2006; Dow et al. 2008; Ketten and Bartol 2006; Ridgway et al. 1969). Green and loggerhead sea turtles are likely incapable of hearing frequencies >1,600 Hz (Dow et al. 2008; Moein Bartol et al. 1999; Ridgway et al. 1969).

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 1995a; 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. 2005a). 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 Vanselous 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 1995b). 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.

Diving. 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 1995a). 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 1998b). 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). Finkbeiner et al. (2011) estimated that annual bycatch interactions total at least 98,300 individuals annually for U.S. Atlantic fisheries (resulting in 2,700 mortalities or more). The vast majority of fisheries interactions with sea turtles in the U.S. are either Kemp’s ridley’s or loggerhead sea turtles (Finkbeiner et al. 2011).

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. 2007b). 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 g/kg to 607 mu g/kg, with a mean of 252 mu 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.

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 2006b; 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 2006). Guiana nesting may have increased again in the early 2000s (NMFS 2006). 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 Goverse 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 2006b; 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 1984b; 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 (Bowlby 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 30º N in the Atlantic appear to be popular foraging locations (Fossette et al.

2009b). Northern foraging areas were proposed for waters between 35º and 50º 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 5º and 15º 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 (30-40º N, 25-30º W) and moved into the Irish Sea or Bay of Biscay during spring before moving south to between 5 and 10º 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 40-50º 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 10ºS (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. 2005b).

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 1984b).

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 if 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).

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

Status and trends. 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. 2009b).

Anthropogenic threats. Leatherback nesting and marine environments are facing increasing impacts through widespread development and tourism along nesting beaches (Hamann et al. 2006b; Hernández 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; McMahon 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 km^2) and California (Point Arena to point Vincente; 119,400 km^2). The primary constituent elements of these areas include (1.) the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (*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

Distribution. Loggerheads are circumglobal occurring throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian oceans. Loggerheads are the most abundant species of sea turtle found in U.S. coastal waters.

Population designations. Five groupings represent loggerhead sea turtles by major sea or ocean basin: Atlantic, Pacific, and Indian oceans, as well as Caribbean and Mediterranean seas. As with other sea turtles, populations are frequently divided by nesting aggregation (Hutchinson and Dutton 2007). On March 16, 2010, the NMFS proposed to designate nine distinct population segments (DPSs) of loggerhead sea turtles: South Atlantic Ocean and southwest Indian Ocean as threatened as well as Mediterranean Sea, North Indian Ocean, North Pacific Ocean, northeast Atlantic Ocean, northwest Atlantic Ocean, South Pacific Ocean, and southeast Indo-Pacific Ocean as endangered (75 FR 12598).

Atlantic Ocean. 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). In the eastern Atlantic, we know of five rookeries from Cape Verde, Greece, Libya, Turkey, and the western Africa coast. The northwestern Atlantic DPS is considered to be bounded by the equator and 60º N latitude and extend east to 40º W in the Atlantic basin; this is based upon oceanographic features satellite telemetry, sightings, and bycatch data (Conant et al. 2009).

Indian Ocean. Loggerhead sea turtles nest along the Indian Ocean in Oman, Yemen, Sri Lanka, Madagascar, South Africa, and possibly Mozambique.

Pacific Ocean. Pacific Ocean rookeries are limited to the western portion of the basin. These sites include Australia, New Caledonia, New Zealand, Indonesia, Japan, and the Solomon Islands. Loggerheads north of the Equator are genetically distinct from their Southern Hemisphere counterparts (Dutton 2007; Hatase et al. 2002a)

Population structure in the Pacific is comprised of a northwestern Pacific nesting aggregation in Japan and a smaller southwestern nesting aggregation in Australia and New Caledonia (NMFS 2006e). Genetics of Japanese nesters suggest that this subpopulation is comprised of genetically distinct nesting colonies (Hatase et al. 2002a). Almost all loggerheads in the North Pacific seem to stem from Japanese nesting beaches (Bowen et al. 1995; Resendiz et al. 1998). The fidelity of nesting females to their nesting beach allowed differentiation of these subpopulations and the loss of nesting at a beach means a significant loss of diversity and the beach is unlikely to be recolonized (NMFS 2006e).

Mediterranean Sea. The Mediterranean Sea population originated from individuals of the northwestern Atlantic DPS, but have been genetically isolated for at least 10,000 years (Encalada et al. 1998; Schroth et al. 1996).

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).

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

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 1998a). 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.

Individuals in the western Pacific also show wide-ranging movements. Loggerheads hatched on beaches in the southwest Pacific travel have been found to range widely in the southern portion of the basin, with individuals from populations nesting in Australia found as far east as Peruvian coast foraging areas still in the juvenile stage (Boyle et al. 2009). Individuals hatched along Japanese coasts have been found to migrate to waters off Baja California via the North Pacific Subtropical Gyre (and the Kuroshio Extension) to feed for several years before migrating back to western Pacific waters to breed (Bowen et al. 1995; Nichols 2005; Polovina et al. 2006; Polovina et al. 2000; Resendiz et al. 1998). Adult loggerheads also reside in oceanic waters off Japan (Hatase et al. 2002b). Habitat use off Japan may further be partitioned by sex and size (Hatase et al. 2002b; Hatase and Sakamoto 2004; Hatase et al. 2002c). Loggerheads returning to Japanese waters seem to migrate along nutrient-rich oceanic fronts (Kobayashi et al. 2008; Nichols et al. 2000; Polovina et al. 2000). Individuals bycaught and satellite tracked in Hawaii longline fisheries show individual movement north and south within a thermal range of 15-25º C, or 28-40º N, with juveniles following the 17-20º C isotherm (Kobayashi et al. 2008; Nichols et al. 2000; Polovina et al. 2004). The Transition Zone Chlorophyll Front and Kuroshio Extension Current are likely important foraging areas for juvenile loggerheads (Polovina et al. 2004). The Kuroshio Current off Japan may be significant for juvenile and adult loggerheads as a wintering areas for those individuals not migrating south (Hatase et al. 2002c).

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; Lohoefener 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; Lohoefener 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. 2002b). Sub-adult and adult loggerheads prey on benthic invertebrates such as gastropods, mollusks, and decapod crustaceans in hard-bottom habitats, although fish and plants are also occasionally eaten (NMFS and USFWS 1998d). Stable isotope analysis and study of organisms on turtle shells has recently shown that although a loggerhead population may feed on a variety of prey, individuals composing the population have specialized diets (Reich et al. 2010; Vander Zanden et al. 2010).

Diving. Loggerhead diving behavior varies based upon habitat, with longer surface stays in deeper habitats than in coastal ones. Off Japan, dives were shallower than 30 m (Sakamoto et al. 1993). Routine dives can last 4–172 min (Byles 1988; Renaud and Carpenter 1994; Sakamoto et al. 1990). The maximum-recorded dive depth for a post-nesting female was over 230 m, although most dives are far shallower (9-21 m(Sakamoto et al. 1990). Loggerheads tagged in the Pacific over the course of 5 months showed that about 70% of dives are very shallow (<5 m) and 40% of their time was spent within 1 m of the surface (Polovina et al. 2003; Spotila 2004b). During these dives, there were also several strong surface temperature fronts that individuals were associated with, one of 20° C at 28° N latitude and another of 17° C at 32° N latitude.

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

Status and trends. Loggerhead sea turtles were listed as threatened under the ESA of 1973 on July 28, 1978 (43 FR 32800). 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 (Turkozan 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 1998b). 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 size[1]. 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.

Pacific Ocean. Abundance has declined dramatically over the past 10-20 years, although loggerheads range widely from Alaska to Chile (NMFS and USFWS 1998d). Pacific nesting is limited to two major locations, Australia and Japan. Eastern Australia supported one of the major global loggerhead nesting assemblages until recently (Limpus 1985). Now, less than 500 females nest annually, an 86% reduction in the size of the annual nesting population in 23 years (Limpus and Limpus 2003). The status of loggerhead nesting colonies in southern Japan and the surrounding region is uncertain, but approximately 1,000 female loggerhead turtles may nest there; a 50-90% decline compared to historical estimates (Bolten et al. 1996; Dodd Jr. 1988; Kamezaki et al. 2003; STAJ 2002). In addition, loggerheads uncommonly occur in U.S. Pacific waters, and there have been no documented strandings of loggerheads on the Hawaiian Islands in nearly 20 years (1982-1999 stranding data). There are very few records of loggerheads nesting on any of the many islands of the central Pacific, and the species is considered rare or vagrant in this region (USFWS 1998). Overall, Gilman (2009) estimated that the number of loggerheads nesting the Pacific has declined by 80% in the past 20 years.

Indian Ocean. The largest known nesting aggregation occurs on Masirah and Kuria Muria Islands in Oman (Ross and Barwani 1982). Extrapolations resulting from partial surveys and tagging in 1977-1978 provided broad estimates of 19,000-60,000 females nesting annually at Masirah Island, while a more recent partial survey in 1991 provided an estimate of 23,000 nesting females (Baldwin 1992; Ross 1979; Ross 1998; Ross and Barwani 1982). Over 3,000 nests per year have been recorded on the Al-

---

[1] 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.

Halaniyat Islands, while along the Oman mainland of the Arabian Sea, about 2,000 nests are deposited per year (Salm 1991; Salm et al. 1993). Based upon genetic analyses, additional populations nest in Yemen, Sri Lanka, and Madagascar (Hutchinson and Dutton 2007). In the southwestern Indian Ocean, the highest concentration of nesting occurs on the coast of Tongaland, South Africa (Baldwin et al. 2003). The total number of females nesting annually in South Africa is estimated to be between 500-2,000 (Baldwin et al. 2003). An estimated 800-1,500 loggerheads nest annually on Dirk Hartog Island beaches along Western Australia (Baldwin et al. 2003).

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

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

The major factors inhibiting their recovery include mortalities caused by fishery interactions and degradation of the beaches on which they nest. Shrimp trawl fisheries account for the highest number of captured and killed loggerhead sea turtles. 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. Along Baja California, it is estimated that 1,500-2,950 loggerheads are killed annually by local fishing fleets (Peckham et al. 2008). Offshore longline tuna and swordfish longline fisheries are also a serious concern for the survival and recovery of loggerhead sea turtles and appear to affect the largest individuals more than younger age classes (Aguilar et al. 1995; Bolten et al. 1994; Carruthers et al. 2009; Howell et al. 2008; Marshall et al. 2009; Petersen et al. 2009; Tomás et al. 2008). Deliberate hunting of loggerheads for their meat, shells, and eggs has declined from previous exploitation levels, but still exists and hampers recovery efforts (Lino et al. 2010). In the Pacific, loggerhead turtles are captured, injured, or killed in numerous Pacific fisheries including

- Japanese longline fisheries in the western Pacific Ocean and South China Seas

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

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

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

Climate change may also have significant implications on loggerhead populations worldwide. In addition to potential loss of nesting habitat due to sea level rise, loggerhead sea turtles are very sensitive to temperature as a determinant of sex while incubating. Ambient temperature increase by just 1º-2º C can potentially change hatchling sex ratios to all or nearly all female in tropical and subtropical areas (Hawkes et al. 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. 2007a). 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. 2007a). 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 (>20º C) of the Pacific (southern California to Peru, and rarely in the Gulf of Alaska Hodge and Wing 2000), Indian (eastern Africa and the Bay of Bengal), and Atlantic oceans (Grand Banks to Uruguay and Mauritania to South Africa Foley et al. 2003; Fretey 1999; Fretey et al. 2005; Stokes and Epperly 2006). Olive ridleys are uncommon in the western Pacific and western Indian Oceans, and most of the North Atlantic (Spotila 2004a).

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

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.

Table 3. Recent estimates of olive ridley arribada size.

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

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

** These data represent total nests for season.

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

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

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

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

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). McMahon et al. (2007) reported a maximum dive duration of 200 min (± 20 min) in northern Australia. In the eastern tropical Pacific, diving rate is greater during daytime than at night (Beavers and Cassano 1996; Parker et al. 2003). During nighttime however, dives are longer (up to 95 min). In the eastern tropical Pacific, at least 25% of olive ridley total dive time is spent in the permanent thermocline, located at 20–100 m (Parker et al. 2003).

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

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

Status and trends. Except for the Mexico breeding stock, olive ridley sea turtles were listed as threatened under the ESA on July 28, 1978 (43 FR 32800). The olive ridley is the most abundant sea turtle in the world (Pritchard 1997). Worldwide, abundance of nesting female olive ridleys 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 preperation). Abundance estimates in recent years indicate that the Mismaloya and Moro Ayuta nesting populations appear to be stable and the nesting population at La Escobilla is increasing, although less than historical levels, which was roughly 10 million adults prior to 1950 (Cliffton et al. 1982; NMFS and USFWS 2007b). By 1969, after years of adult harvest, the estimate was just over one million (Cliffton et al. 1982). Olive ridley nesting at La Escobilla rebounded from approximately 50,000 nests in 1988 to over 700,000 nests in 1994, and more than a million nests by 2000 (Márquez et al. 2005; Márquez et al. 1996). The largest known arribadas in the eastern Pacific are on the coast of Costa Rica (~475,000-650,000 females estimated nesting annually) and in southern Mexico (~800,000 nests per year at La Escobilla, in Oaxaca, Mexico). Along Costa Rica, 25,000-50,000 olive ridleys nest at Playa Nancite and 450,000-600,000 turtles nest at Playa Ostional annually (NMFS and USFWS 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. 2007a), 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.

Environmental baseline

By regulation, environmental baselines for Opinions include the past and present impacts of all state, federal, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR §402.02). The *Environmental baseline* for this Opinion includes the effects of several activities affecting the survival and recovery of ESA-listed sea turtle species in the action area.

Climate change

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

In general, based on forecasts made by the Intergovernmental Panel on Climate Change, climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the near future (IPCC 2000; IPCC 2001a; IPCC 2001b; IPCC 2002). From 1906 to 2006, global surface temperatures have risen 0.74º 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 affects on species whose populations are already in tenuous positions (Isaac 2008). As such, we expect the risk of extinction to listed species to rise with the degree of climate shift associated with global warming.

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 Eliott. 2009). For sea turtles, warming ocean temperatures may extend poleward the habitat which they can utilize (Poloczanska et al. 2009). However, 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 appear to have yet 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). Altered ranges can also result in the spread of novel diseases to new areas via shifts in host ranges (Simmonds and Eliott. 2009). It has also been suggested that increases in harmful algal blooms could be a result from increases in sea surface temperature (Simmonds and Eliott. 2009).

Changes in global climatic patterns will likely have profound effects on the coastlines of every continent by increasing sea levels and the intensity, if not the frequency, of hurricanes and tropical storms (Wilkinson and Souter 2008). A half degree Celsius increase in temperatures during hurricane season from 1965 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. 2009a). 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.

Entrapment and entanglement in fishing gear

Fishery interaction remains a major factor in sea turtle recovery and, frequently, the lack there of. 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.

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.

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, Regulation, and Enforcement 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, Regulation, and Enforcement' 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).

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 km^2 (although in 2005 the “dead zone” grew to a record size of 22,000 km^2) 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).

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 Gracan (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 Bjorndal 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).

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 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 seapage 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. 1986c; Vargo et al. 1986b; Vargo et al. 1986a). 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 2010). 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 m^3 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 2010). 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 2010). The tanker *Alvenus* grounded in 1984 near Cameron, Louisiana, spilling 65,500 barrels of oil which spread west along the shoreline to Galveston (NMFS 2010). 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 2010).

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).

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. 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. Tables 5-10 describe the cumulative number of takes for each listed species in the action area currently authorized in scientific research permits. 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 currently-authorized takes summarized below have or will occur in the near term to their maximum extent. However, we assume that these “takes” will occur since they have been authorized, the Permits Division has recently shifted to an interpretation of “take” that more closely reflects exposure rather than response, and we do not know how many “takes” are likely to occur. 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.

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.

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 16194 would authorize "takes" by harassment of green, Kemp's ridley, hawksbill, leatherback, loggerhead, 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 species being exposed to these stressors based on the best scientific and commercial evidence available, and the probable responses of those individuals (given probable exposures) based on the available evidence. As described in the *Approach to the Assessment* section, for any responses that would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, or lifetime reproductive success), the assessment would consider the risk posed to the viability of the population(s) those individuals comprise and to the listed species those populations represent. The purpose of this assessment and, ultimately, of this Opinion is to determine if it is reasonable to expect the proposed action to have effects on listed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

For this consultation, we are particularly concerned about behavioral, 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 of sea turtles 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 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. During most operations, the research vessel would operate at low speeds, further reducing the potential for a collision. Based upon this, we discount the possibility of ship strike to listed sea turtles.

The hearing range of sea turtles 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 sea turtles 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 sea turtle exposure to predation. Therefore, we expect sea turtle 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 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.

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 11) 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 11. Number of individuals proposed to be taken by species, life stage, and action under Permit 16194.

Sea turtle species	Life stage	Proposed number of individuals taken annually	Action
Green	All except hatchling	10	Trawl capture, PIT/flipper tag, weigh, biopsy
		10	Capture other than trawl, PIT/flipper tag, weigh, biopsy
		0.8	Incidental mortality
Hawksbill	All except hatchling	10	Trawl capture, PIT/flipper tag, weigh, biopsy
		10	Capture other than trawl, PIT/flipper tag, weigh, biopsy
		0.4	Incidental mortality
Kemp's ridley	All except hatchling	15	Trawl capture, PIT/flipper tag, weigh, biopsy
		15	Capture other than trawl, PIT/flipper tag, weigh, biopsy
		0.8	Incidental mortality
Leatherback	All except hatchling	20	Trawl capture, PIT/flipper tag, weigh, biopsy
		20	Capture other than trawl, PIT/flipper tag, weigh, biopsy
		0.4	Incidental mortality
Loggerhead	All except hatchling	30	Trawl capture, PIT/flipper tag, weigh, biopsy
		30	Capture other than trawl, PIT/flipper tag, weigh, biopsy
		1.2	Incidental mortality
Olive ridley	All except hatchling	5	Trawl capture, PIT/flipper tag, weigh, biopsy
		5	Capture other than trawl, PIT/flipper tag, weigh, biopsy
		0.4	Incidental mortality
Unidentified	All except hatchling	3	Trawl capture, PIT/flipper tag, weigh, biopsy
		3	Capture other than trawl, PIT/flipper tag, weigh, biopsy
		2	Incidental mortality

We expect the level of all actions to be different than the levels of "take" requested (Table 12). 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 Kemp's ridley and loggerhead trawl and longline captures as well as green trawl captures and leatherback longline captures. 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 exposure to trawl and longline activities was qualitatively added for hawksbill and olive ridley sea turtles, as well as a single exposure of leatherbacks to trawl capture based upon species abundance and life history that would make future exposure reasonably likely to occur. Kemp's ridley mortality has not been documented in the applicant's prior performance. However, a single mortality over the life of the permit is also qualitatively expected. This is because of the propensity of this species to interact with trawls (including under the applicant's prior actions) leading to an eventual mortality as seen with loggerhead sea turtles (which have a somewhat greater capture rate than Kemp's ridley sea turtles and a single individual has been killed during trawling).

Table 12. 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	5	Trawl capture, PIT/flipper tag, weigh, biopsy
		0	Capture other than trawl, PIT/flipper tag, weigh, biopsy
		0	Incidental mortality
Hawksbill	All except hatchling	1	Trawl capture, PIT/flipper tag, weigh, biopsy
		1	Capture other than trawl, PIT/flipper tag, weigh, biopsy
		0	Incidental mortality
Kemp's ridley	All except hatchling	20	Trawl capture, PIT/flipper tag, weigh, biopsy
		10	Capture other than trawl, PIT/flipper tag, weigh, biopsy

Sea turtle species	Life stage	Proposed number of individuals taken annually	Action
		0.2	Incidental mortality
Leatherback	All except hatchling	1	Trawl capture, PIT/flipper tag, weigh, biopsy
		5	Capture other than trawl, PIT/flipper tag, weigh, biopsy
		0	Incidental mortality
Loggerhead	All except hatchling	15	Trawl capture, PIT/flipper tag, weigh, biopsy
		10	Capture other than trawl, PIT/flipper tag, weigh, biopsy
		2	Incidental mortality
Olive ridley	All except hatchling	1	Trawl capture, PIT/flipper tag, weigh, biopsy
		1	Capture other than trawl, PIT/flipper tag, weigh, biopsy
		0	Incidental mortality
Unidentified	All except hatchling	0	Trawl capture, PIT/flipper tag, weigh, biopsy
		0	Capture other than trawl, 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 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 where as 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).

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; Mancia et al. 2008; Moe and Bakken 1997; Noda et al. 2007; Thomson and Geraci 1986)(Dierauf and Gulland 2001; Omsjoe et al. 2009). In some species, stress can also increase an individual's susceptibility to gastrointestinal parasitism (Greer et al. 2008). In highly-stressful circumstances, or in species prone to strong "fight-or-flight" responses, more extreme consequences can result, including muscle damage and death (Cowan and Curry 1998; Cowan and Curry 2002; Cowan and Curry 2008; Herraez et al. 2007). The most widely-recognized indicator of vertebrate stress, cortisol, normally takes hours to days to return to baseline levels following a significantly stressful event, but other hormones of the HPA axis may persist for weeks (Dierauf and Gulland 2001). Repeated exposure to stressors can negatively impact the health and viability of populations (Gregory and Schmid 2001b).

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 would require 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 declines sharply, lactate increased, and blood oxygen levels become 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 seven 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)).

Additional risk to sea turtles is involved with capturing sea turtles in trawl nets or longlines due to forced submersion. Sea turtles forcibly submerged in any type of restrictive gear eventually suffer fatal consequences from prolonged anoxia and/or seawater infiltration of the lungs (Lutcavage et al. 1997a). 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.

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).

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 (NMFS 2011). 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. Sources queried for the information herein include the United States Census Bureau, Department of Labor, and Lexis-Nexis information system. With the latter (which was our source for state legislation), we reviewed bills passed in 2010 and pending bills under consideration were included as further evidence that actions “are reasonably certain to occur”. Bills that died in process or were vetoed are not included in our review.

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 into the future. 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).

Louisiana’s legislature is proposing to further restrict gear use in fisheries.

Based upon 2000 United States census data, numerous micropolitan and metropolitan areas along the northern Gulf of Mexico and within the drainage basin of the Mississippi River have shown significant increases in population (USCB 2008a; USCB 2008b). The southeast U.S. was predicted to contain 55.7 million people in 2010, with population growth predicted to remain above 10% through 2030 and greatest in Florida and North Carolina (USCB 2005a; USCB 2005b; USCB 2005c). Growth of metropolitan centers will increase discharge of wastewater from water treatment systems into rivers and streams, which will increase the loads of contaminants carried by these waterways to the marine environment, and would have concomitant effects on such parameters as biological oxygen demand, chemical oxygen demand, dissolved oxygen, and water temperature. It is likely that development will continue along the coast and waterways, which will add sediment to river systems. Oil and other roadway pollutants may increase as a result of additional vehicular traffic. Additional recreational use of lakes, waterways, and coastal areas will increase fish takes and add additional discharges from vessels.

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 affected by the actions outside the action area have been adversely affected by human-induced factors such as commercial fisheries, direct harvest of sea turtles, and modification or degradation of the sea turtle’s terrestrial and aquatic habitat. Effects occurring in terrestrial habitats have generally resulted in the loss of eggs or hatchling sea turtles, or nesting females, while those occurring in aquatic habitat have caused the mortality of juvenile, subadult and adult sea turtles through entanglement or capture in fishing gear, ingestion of debris or pollution. Similarly, the actions discussed in the baseline, as well as those considered under *Cumulative effects* all pose the potential to result in take of sea turtle species resulting in stress or possible mortality.

The *Description of the proposed action* describes the actions proposed to be undertaken to green, hawksbill, Kemp's ridley, leatherback, loggerhead, 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 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 sea turtle varies among species, populations, and the degree of threats faced during each life stage. Each juvenile that does not survive to produce will be unable to contribute to the maintenance or improvement of the species' status. Reproducing females that are prematurely killed due 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 (five trawl captures plus tagging, handling, and biopsy), Kemp's ridley (20 trawl and 10 longline captures plus tagging, handling, and biopsy and one possible mortality over the permit's life), hawksbill (one trawl and one longline capture plus tagging, handling, and biopsy), leatherback (one trawl and five longline captures plus tagging, handling, and biopsy), loggerhead (15 trawl and 10 longline captures plus tagging, handling, and biopsy and two mortalities annually), and olive ridley sea turtles (one trawl and one longline capture plus tagging, handling, and biopsy). The *Response analysis* considered that stressors to which targeted individuals would be exposed will likely cause behavioral, physiological, and pathological responses. Most research activity will result in temporary stress to the animal, which is not expected to have more than short-term effects on individual threatened or endangered sea turtles. These non-lethal interactions will not affect the individual's ability to reproduce and contribute to the maintenance or recovery of the species. This research will affect the individuals by harassing sea turtles during the research 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 sea turtle mortality. We expect up to two loggerhead sea turtles annually and one Kemp's ridley sea turtle to die over the life of the permit. 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 two individuals, or ten over the life of the proposed permit, is not expected to discernibly diminish the population's reproductive potential. Kemp's ridley sea turtle population recovery over the past two decades has been robust, with greater than 10%

annual increases in nesting from year-to-year in many cases, with several thousand females nesting annually and range expansions onto Texas beaches becoming more common. Although the 2010 nesting season was very poor compared to recent years (warranting caution in recovery, but not as yet indicating a downward trend in recovery), the general trend has been very encouraging for the recovery of the species. The loss of one Kemp's ridley sea turtles as a result of the proposed research is not expected to alter the survival or recovery trajectory of the Kemp's ridley population.

NMFS does expect some individual sea turtles will die, appreciably reducing the survival, growth, and reproductive potential of these individuals, as a result of the proposed actions. However, at the population level, NMFS does not expect the proposed research activities to appreciably reduce the green, hawksbill, Kemp's ridley, leatherback, loggerhead, 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. For the vast majority of sea turtles, 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 sea turtles.

Conclusion

After reviewing the current status of green, hawksbill, Kemp's ridley, leatherback, loggerhead, and olive ridley sea turtles 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 16194 (Bonnie Ponwith, SEFSC) is not likely to jeopardize the continued existence of green, hawksbill, Kemp's ridley, leatherback, loggerhead, and olive ridley sea turtles.

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.

We do not expect incidental take of threatened or endangered species as a result of the proposed actions.

Conservation Recommendations

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

The Endangered Species Act Interagency Cooperation 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 Act Interagency Cooperation 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 Act Interagency Cooperation Division of any conservation recommendations they implement in their final action.

Reinitiation Notice

Pursuant to the provisions of section 10 of the ESA and MMPA, this concludes formal consultation on NMFS' proposal to issue permit amendment 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.

Literature Cited

ACC. 2010. Alabama's debris history. Alabama Coastal Cleanup.

Acevedo-Whitehouse, K., and A. L. J. Duffus. 2009. Effects of environmental change on wildlife health. Philosophical Transactions of the Royal Society of London B Biological Sciences 364(1534):3429-3438.

Ackerman, R. A. 1997. The nest environment, and the embryonic development of sea turtles. Pages 83-106 *in* P. L. Lutz, and J. A. Musick, editors. The Biology of Sea Turtles. CRC Press, Boca Raton, Florida.

Addison, D. S. 1997. Sea turtle nesting on Cay Sal, Bahamas, recorded June 2-4, 1996. Bahamas Journal of Science 5:34-35.

Addison, D. S., and B. Morford. 1996. Sea turtle nesting activity on the Cay Sal Bank, Bahamas. Bahamas Journal of Science 3:31-36.

Aguilar, R., J. Mas, and X. Pastor. 1995. Impact of Spanish swordfish longline fisheries on the loggerhead sea turtle *Caretta caretta* population in the western Mediterranean. J. I. Richardson, and T. H. Richardson, editors. Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation. U.S. Department of Commerce, Jekyll Island, Georgia.

Aguirre, A. A., G. H. Balazs, B. Zimmerman, and F. D. Galey. 1994. Organic contaminants and trace metals in the tissues of green turtles (*Chelonia mydas*) afflicted with fibropapillomas in the Hawaiian Islands. Marine Pollution Bulletin

28(2):109-114.

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

Al-Bahry, S., and coauthors. 2009. Bacterial flora and antibiotic resistance from eggs of green turtles Chelonia mydas: An indication of polluted effluents. Marine Pollution Bulletin 58(5):720-725.

Alava, J. J., and coauthors. 2006. Loggerhead sea turtle (*Caretta caretta*) egg yolk concentrations of persistent organic pollutants and lipid increase during the last stage of embryonic development. Science of the Total Environment 367(1):170-181.

Amos, A. F. 1989. Recent strandings of sea turtles, cetaceans and birds in the vicinity of Mustang Island, Texas. Pages 51 *in* C. W. C. Jr., and A. M. Landry, editors. Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management.

Anan, Y., T. Kunito, I. Watanabe, H. Sakai, and S. Tanabe. 2001. Trace element accumulation in hawksbill turtles (Eretmochelys imbricata) and green turtles (Chelonia mydas) from Yaeyama Islands, Japan. Environmental Toxicology and Chemistry 20(12):2802-2814.

Anderson, J. J. 2000. A vitality-based model relating stressors and environmental properties to organism survival. Ecological Monographs 70(3):445-470.

Aprill, M. L. 1994a. Visitation and predation of the olive ridley sea turtle, *Lepidochelys olivacea*, at nest sites in Ostional, Costa Rica. Pages 3-6 *in* K. A. Bjorndal, A. B. Bolten, D. A. Johnson, and P. J. Eliazer, editors. Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. Department of Commerce.

Aprill, M. L. 1994b. Visitation and predation of the olive ridley sea turtle, *Lepidochelys olivacea*, at nest sites in Ostional, Costa Rica. Pp.3-6 *In*: K.A. Bjorndal, A.B. Bolten, D.A. Johnson, and P.J. Eliazer (Compilers), Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. Department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-351 323p.

Arauz, R. 2001. Impact of high seas longline fishery operations on sea turtle populations in the Exclusive Economic Zone (EEZ) of Costa Rica - a second look. 21st Annual Symposium on Sea Turtle Biology and Conservation, Philadelphia, PA.

Arenas, P., and M. Hall. 1991a. The association of sea turtles and other pelagic fauna with floating objects in teh eastern tropical Pacific Ocean. Pp.7-10 *In*: M. Salmon and J. Wyneken (Compilers), Proceedings of the Eleventh Annual Symposium on Sea Turtle Biology and Conservation. Department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-302. 195p.

Arenas, P., and M. Hall. 1991b. The association of sea turtles, and other pelagic fauna with floating objects in the eastern tropical Pacific Ocean. Pages 7-10 *in* M. Salmon, and J. Wyneken, editors. The Eleventh Annual Workshop on Sea Turtle Biology and Conservation.

Arndt, D. S., and coauthors. 2010. State of the climate in 2009. Bulletin of the American Meteorological Society 91(7):S1-S224.

Arthur, K., and coauthors. 2008. The exposure of green turtles (Chelonia mydas) to tumour promoting compounds produced by the cyanobacterium Lyngbya majuscula and their potential role in the aetiology of fibropapillomatosis. Harmful Algae 7(1):114-125.

Asrar, F. F. 1999. Decline of marine turtle nesting populations in Pakistan. Marine Turtle Newsletter 83:13-14.

Baker, J. D., C. L. Littnan, and D. W. Johnston. 2006. Potential effects of sea level rise on the terrestrial habitats of endangered and endemic megafauna in the Northwestern Hawaiian Islands. Endangered Species Research 4:1-10.

Balazs, G. H. 1999. Factors to consider in the tagging of sea turtles in research and management techniques for the conservation of sea turtles. K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois, and M. Donnelly, editors. IUCN/SSC Marine Turtle Specialist Group Publication No 4.

Balazs, G. H., and M. Chaloupka. 2004. Thirty-year recovery trend in the once depleted Hawaiian green sea turtle stock. Biological Conservation 117(5):491-498.

Balazs, G. H., and M. Chaloupka. 2006. Recovery trend over 32 years at the Hawaiian green turtle rookery of French Frigate Shoals. Atoll Research Bulletin 543:147-158.

Baldwin, R., G. R. Hughes, and R. I. T. Prince. 2003. Loggerhead turtles in the Indian Ocean. Pages 218-232 *in* A. B. Bolten, and B. E. Witherington, editors. Loggerhead Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Baldwin, R. M. 1992. Nesting turtles on Masirah Island: Management issues, options, and research requirements. Ministry of Regional Municipalities and Environment, Oman.

Barbieri, E. 2009. CONCENTRATION OF HEAVY METALS IN TISSUES OF GREEN TURTLES (CHELONIA MYDAS) SAMPLED IN THE CANANEIA ESTUARY, BRAZIL. Brazilian Journal of Oceanography 57(3):243-248.

Bartol, S. M., and D. R. Ketten. 2006. Turtle and tuna hearing. Y. Swimmer, and R. Brill, editors. Sea turtle and pelagic fish sensory biology: Developing techniques to reduce sea turtle bycatch in longline fisheries, volume NOAA Tech. Memo. NMFS-PIFSC-7. National Marine Fisheries Service, Honolulu, HI.

Barton, B. T., and J. D. Roth. 2008. Implications of intraguild predation for sea turtle nest protection. Biological Conservation 181(8):2139-2145.

Bass, A. L. 1999. Genetic analysis to elucidate the natural history and behavior of hawksbill turtles (Eretmochelys imbricata) in the wider Caribbean: a review and re-analysis. Chelonian Conservation and Biology 3:195-199.

Bass, A. L., S. P. Epperly, J. Braun, D. W. Owens, and R. M. Patterson. 1998. Natal origin and sex ratios of foraging sea turtles in the Pamlico-Albemarle Estuarine Complex. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, NMFS-SEFSC-415, Miami, Florida.

Baussant, T., S. Sanni, G. Jonsson, A. Skadsheim, and J. F. Borseth. 2001. Bioaccumulation of polycyclic aromatic compounds: 1. bioconcentration in two marine species and in semipermeable membrane devices during chronic exposure to dispersed crude oil. Environmental Toxicology and Chemistry 20(6):1175-1184.

Beale, C. M., and P. Monaghan. 2004. Human disturbance: people as predation-free predators? Journal of Applied Ecology 41:335-343.

Bearzi, G. 2000. First report of a common dolphin (Delphinus delphis) death following penetration of a biopsy dart. Journal of Cetacean Research and Management 2(3):217-221.

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

Bell, L. A. J., U. Fa'Anunu, and T. Koloa. 1994. Fisheries resources profiles: Kingdom of Tonga, Honiara, Solomon Islands.

Bellido, J. J., and coauthors. 2010. Loggerhead strandings and captures along the southern Spanish Coast: Body size–based differences in natural versus anthropogenic injury. Chelonian Conservation and Biology 9(2):276-282.

Benson, S. R., and coauthors. 2007a. Post-nesting migrations of leatherback turtles (*Dermochelys coriacea*) from Jamursba-Medi, Bird's Head Peninsula, Indonesia. Chelonian Conservation and Biology 6(1):150-154.

Benson, S. R., and coauthors. 2007b. Beach use, internesting movement, and migration of leatherback turtles, *Dermochelys coriacea*, nesting on the north coast of Papua New Guinea. Chelonian Conservation and Biology 6(1):7-14.

Berkson, H. 1966. Physiological adjustments to prolonged diving in the Pacific green turtle (Chelonia mydas agassizii). Comparative Biochemistry and Physiology 18(1):101-119.

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

Bernardo, J., and P. T. Plotkin. 2007. An evolutionary perspective on the arribada phenomenon, and reproductive behavioral polymorphism of olive ridley sea turtles (*Lepidochelys olivacea*). Pages 59-87 *in* P. T. Plotkin, editor. Biology and conservation of Ridley sea turtles. Johns Hopkins University Press, Baltimore, Maryland.

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

Bjorndal, K. A. 1982. The consequences of herbivory for the life history pattern of the Caribbean green turtle, Chelonia mydas. Pages 111-116 *in* K. A. Bjorndal, editor. Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C.

Bjorndal, K. A. 1997. Foraging ecology, and nutrition of sea turtles. Pages 199-232 *in* P. L. Lutz, and J. A. Musick, editors. The biology of sea turtles. CRC Press, Boca Raton, Florida.

Bjorndal, K. A., and A. B. Bolten. 2000. Proceedings on a workshop on accessing abundance and trends for in-water sea turtle populations. NOAA.

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

Bjorndal, K. A., A. B. Bolten, and M. Y. Chaloupka. 2000. Green turtle somatic growth model: evidence for density dependence. Ecological Applications 10(1):269-282.

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

Bjorndal, K. A., A. B. Bolten, and M. Y. Chaloupka. 2005. Evaluating trends in abundance of immature green turtles, *Chelonia mydas*, in the greater Caribbean. Ecological Applications 15(1):304-314.

Blumenthal, J. M., and coauthors. 2009a. Ecology of Hawksbill Turtles, Eretmochelys imbricata, on a Western Caribbean Foraging Ground. Chelonian Conservation and Biology 8(1):1-10.

Blumenthal, J. M., and coauthors. 2009b. Diving behavior and movements of juvenile hawksbill turtles Eretmochelys imbricata on a Caribbean coral reef. Coral Reefs 28(1):55-65.

BOEMRE. 2010. Gulf of Mexico region-spills = 50 barrels (2,100 gallons) - 2004 - Hurricane Ivan. Bureau of Ocean Energy Management, Regulation and Enforcement Offshore Energy and Minerals Management.

Bolten, A. B., K.A. Bjorndal, and H. R. Martins. 1994. Life history model for the loggerhead sea turtle (*Caretta caretta*) populations in the Atlantic: Potential impacts of a longline fishery. . Pp.48-55 *In:* Balazs, G.J. and S.G. Pooley (eds), Research Plan to Assess Marine Turtle Hooking Mortality: Results of an Expert Workshop Held in Honolulu, Hawaii, November 16-18, 1993. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-201, pp.48-55.

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

Bouchard, S., and coauthors. 1998. Effects of exposed pilings on sea turtle nesting activity at Melbourne Beach, Florida. Journal of Coastal Research 14(4):1343-1347.

Boulon, R. H., Jr. 1994. Growth rates of wild juvenile hawksbill turtles, *Eretmochelys imbricata*, in St. Thomas, United States Virgin Islands. Copeia 1994(3):811-814.

Bourgeois, S., E. Gilot-Fromont, A. Viallefont, F. Boussamba, and S. L. Deem. 2009. Influence of artificial lights, logs and erosion on leatherback sea turtle hatchling orientation at Pongara National Park, Gabon. Biological Conservation 142(1):85-93.

Bowen, B. W., and coauthors. 1995. TransPacific migrations of the loggerhead turtle (Caretta caretta) demonstrated with mitochondrial DNA markers. Proceedings of the National Academy of Sciences USA 92:3731-3734.

Bowen, B. W., and coauthors. 2004. Natal homing in juvenile loggerhead turtles (*Caretta caretta*). Molecular Ecology 13:3797–3808.

Bowen, B. W., and coauthors. 1996. Origin of hawksbill turtles in a Caribbean feeding area as indicated by genetic markers. Ecological Applications 6:566-572.

Bowen, B. W., A. L. Bass, L. Soares, and R. J. Toonen. 2005. Conservation implications of complex population structure lessons from the loggerhead turtle (*Caretta caretta*). Molecular Ecology 14:2389-2402.

Bowen, B. W., and coauthors. 2007. Mixed stock analysis reveals the migrations of juvenile hawksbill turtles (Eretmochelys imbricata) in the Caribbean Sea. Molecular Ecology 16:49-60.

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

Boyle, M. C., and coauthors. 2009. Evidence for transoceanic migrations by loggerhead sea turtles in the southern Pacific Ocean. Proceedings of the Royal Society B-Biological Sciences 276(1664):1993-1999.

Brandon, R. 1978. Adaptation and evolutionary theory. Studies in the History and Philosophy of Science 9:181-206.

Brashares, J. S. 2003. Ecological, behavioral, and life-history correlates of mammal extinctions in West Africa. Conservation Biology 17:733-743.

Bräutigam, A., and K. L. Eckert. 2006a. Turning the tide: Exploitation, trade, and management of marine turtles in the Lesser Antilles, Central America, Colombia, and Venezuela. TRAFFIC International, Cambridge, United Kingdom.

Bräutigam, A., and K. L. Eckert. 2006b. Turning the tide: Exploitation, trade, and management of marine turtles in the Lesser Antilles, Central America, Colombia, and Venezuela. TRAFFIC International, Cambridge, United Kingdom.

Brill, R. W., and coauthors. 1995. Daily movements, habitat use, and submergence intervals of normal and tumor-bearing juvenile green turtles (Chelonia mydas L.) within a foraging area in the Hawaiian Islands. Journal of Experimental Marine Biology and Ecology 185:203-218.

Brito, J. L. 1998. The marine turtle situation in Chile. Pages 12-15 *in* S. P. Epperly, and J. Braun, editors. Seventeenth Annual Symposium on Sea Turtle Biology and Conservation. .

Brock, K. A., J. S. Reece, and L. M. Ehrhart. 2009. The Effects of Artificial Beach Nourishment on Marine Turtles: Differences between Loggerhead and Green Turtles. Restoration Ecology 17(2):297-307.

Broderick, A., and coauthors. 2006. Are green turtles globally endangered? Global Ecology and Biogeography 15:21-26.

Broderick, A., C. F. Glen, B. J. Godley, and G. C. Hays. 2002. Estimating the number of green and loggerhead turtles nesting annually in the Mediterranean. Oryx 36(3):227-235.

Brown, C. H., and W. M. Brown. 1982. Status of sea turtles in the southeastern Pacific: emphasis on Peru. K. A. Bjorndal, editor. Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C.

Bugoni, L., L. Krause, and M. V. Petry. 2001. Marine debris and human impacts on sea turtles in southern Brazil. Marine Pollution Bulletin 42(12):1330-1334.

Busch, D. S., and L. S. Hayward. 2009. Stress in a conservation context: A discussion of glucocorticoid actions and how levels change with conservation-relevant variables. Biological Conservation 142:2844-2853.

Byles, R. A. 1988. The behavior and ecology of sea turtles, Caretta caretta and Lepidochelys kempi, in the Chesapeake Bay. College of William and MAry, Williamsburg, Virginia.

Byles, R. A. 1989a. Distribution, and abundance of Kemp's ridley sea turtle, Lepidochelys kempii, in Chesapeake Bay and nearby coastal waters. Pages 145 *in* C. W. Caillouet Jr., and A. M. Landry Jr., editors. First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management.

Byles, R. A. 1989b. Satellite telemetry of Kemp's ridley sea turtle Lepidochelys kempii in the Gulf of Mexico. Pages 25-26 *in* S. A. Eckert, K. L. Eckert, and T. H.

Richardson, editors. Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFC-232.

Byles, R. A., and P. T. Plotkin. 1994. Comparison of the migratory behavior of the congeneric sea turtles Lepidochelys olivacea and L. kempii. Pages 39 *in* B. A. Schroeder, and B. E. Witherington, editors. Thirteenth Annual Symposium on Sea Turtle Biology and Conservation.

Byles, R. A., and Y. B. Swimmer. 1994. Post-nesting migration of *Eretmochelys imbricata* in the Yucatan Peninsula. Pages 202 *in* K. A. Bjorndal, A. B. Bolten, D. A. Johnson, and P. J. Eliazar, editors. Fourteenth Annual Symposium on Sea Turtle Biology and Conservation.

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

Caillouet, C. C., T. Fontaine, S. A. Manzella-Tirpak, and T. D. Williams. 1995. Growth of head-started Kemp's ridley sea turtles (Lepidochelys kempii) following release. Chelonian Conservation and Biology 1:231-234.

Campbell, C. L., and C. J. Lagueux. 2005. Survival probability estimates for large juvenile and adult green turtles (Chelonia mydas) exposed to an artisanal marine turtle fishery in the western Caribbean. Herpetologica 61:91-103.

Cannon, A. C., and J. P. Flanagan. 1996. Trauma and treatment of Kemp's ridley sea turtles caught on hook-and-line by recreational fisherman. Sea turtles biology and conservation workshop.

Cardillo, M. 2003. Biological determinants of extinction risk: Why are smaller species less vulnerable? Animal Conservation 6:63-69.

Cardillo, M., G. M. Mace, K. E. Jones, and J. Bielby. 2005. Multiple causes of high extinction risk in large mammal species. Science 309:1239-1241.

Cardona, L., A. Aguilar, and L. Pazos. 2009. Delayed ontogenic dietary shift and high levels of omnivory in green turtles (Chelonia mydas) from the NW coast of Africa. Marine Biology 156(7):1487-1495.

Cardona, L., P. Campos, Y. Levy, A. Demetropoulos, and D. Margaritoulis. 2010. Asynchrony between dietary and nutritional shifts during the ontogeny of green turtles (Chelonia mydas) in the Mediterranean. Journal of Experimental Marine Biology and Ecology in press(in press):in press.

Carr, A., and D. K. Caldwell. 1956. The ecology, and migrations of sea turtles: 1. Results of field work in Florida, 1955. American Museum Novitates 1793:1-23.

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

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

Carrillo, E., G. J. W. Webb, and S. C. Manolis. 1999. Hawksbill Turtles (*Eretmochelys imbricata*) in Cuba: An Assessment of the Historical Harvest and its Impacts. Chelonian Conservation and Biology 3(2):264-280.

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

Casale, P., P. P. d'Astore, and R. Argano. 2009a. Age at size and growth rates of early juvenile loggerhead sea turtles (Caretta caretta) in the Mediterranean based on length frequency analysis. Herpetological Journal 19(1):29-33.

Casale, P., A. D. Mazaris, D. Freggi, C. Vallini, and R. Argano. 2009b. Growth rates and age at adult size of loggerhead sea turtles (Caretta caretta) in the Mediterranean Sea, estimated through capture-mark-recapture records. Scientia Marina 73(3):589-595.

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

Catry, P., and coauthors. 2009. Status, ecology, and conservation of sea turtles in Guinea-Bissau. Chelonian Conservation and Biology 8(2):150-160.

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

Caut, S., E. Guirlet, and M. Girondot. 2009a. Effect of tidal overwash on the embryonic development of leatherback turtles in French Guiana. Marine Environmental Research 69(4):254-261.

Caut, S., E. Guirlet, and M. Girondot. 2009b. Effect of tidal overwash on the embryonic development of leatherback turtles in French Guiana. Marine Environmental Research in press(in press):in press.

Celik, A., and coauthors. 2006. Heavy metal monitoring around the nesting environment of green sea turtles in Turkey. Water Air and Soil Pollution 169(1-4):67-79.

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

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

Chacón Chaverri, D. 1999. Anidacíon de la tortuga *Dermochelys coriacea* (Testudines: Dermochelyidae) en playa Gandoca, Costa Rica (1990 a 1997). Revista de Biologia Tropical 47(1-2):225-236.

Chacon, D. 2002. Assessment about the trade of sea turtles and their products in the Central American isthmus. Red Regional para la Conservación de last Tortugas Marinas en Centroamérica, San José, Costa Rica.

Chaloupka, M. 2001. Historical trends, seasonality, and spatial synchrony in green sea turtle egg production. Biological Conservation 101:263-279.

Chaloupka, M., and coauthors. 2007. Encouraging outlook for recovery of a once severely exploited marine megaherbivore. Global Ecology and Biogeography Dec 2007. Available online at http://www.cccturtle.org/pdf/Chaloupka_et_alGEB2007.pdf. Accessed 12/31/2007.

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

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

Chaloupka, M. Y., N. Kamezaki, and C. Limpus. 2008. Is climate change affecting the population dynamics of the endangered Pacific loggerhead sea turtle? Journal of Experimental Marine Biology and Ecology 356(1-2):136-143.

Chaloupka, M. Y., and J. A. Musick. 1997. Age, growth, and population dynamics. Pages 233-273 *in* P. L. Lutz, and J. A. Musick, editors. The biology of sea turtles. CRC Press, Boca Raton, Florida.

Chan, E. H. 2006. Marine turtles in Malaysia: on the verge of extinction? Aquatic Ecosystems Health and Management 9:175-184.

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

Chaves, G., R. Morera, J. R. Aviles, J. C. Castro, and M. Alvarado. 2005. Trends of the nesting activity of the "arribadas" of the olive ridley (*Lepidochelys olivacea*, Eschscholtz 1829), in the Ostional National Wildlife Refuge (1971-2003). .

Chen, Z., and G. Yang. 2010. Novel CHR-2 SINE subfamilies and t-SINEs identified in cetaceans using nonradioactive southern blotting. Genes and Genomics 32(4):345-352.

Cheng, I. J., and coauthors. 2009. Ten Years of Monitoring the Nesting Ecology of the Green Turtle, Chelonia mydas, on Lanyu (Orchid Island), Taiwan. Zoological Studies 48(1):83-94.

Cliffton, K. D., O. Cornejo, and R. S. Felger. 1982. Sea turtles of the Pacific coast of Mexico. Pages 199-209 *in* K. A. Bjorndal, editor. Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C.

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

Collard, S. B., and L. H. Ogren. 1990. Dispersal scenarios for pelagic post-hatchling sea turtles. . Bulletin of Marine Science 47:233-243.

Conant, T. A., and coauthors. 2009. Loggerhead sea turtle (Caretta caretta) 2009 status review under the U.S. Endangered Species Act. .

Cornelius, S. E. 1982. Status of sea turtles along the Pacific coast of middle America. Pages 211-219 *in* K. A. Bjorndal, editor. Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C.

Cornelius, S. E. 1986. The sea turtles of Santa Rosa National Park. Fundacion Parques Nacionales, San José, Costa Rica.

Cornelius, S. E., and coauthors. 2007. Effect of land-based harvest of Lepidochelys. Pages 231-251 *in* P. T. Plotkin, editor. Biology and conservation of Ridley sea turtles. Johns Hopkins University Press, Baltimore, Maryland.

Cornelius, S. E., and D. C. Robinson. 1986. Post-nesting movements of female olive ridley turtles tagged in Costa Rica. Vida Silvestre Neotropical 1(11):12-23.

Corsolini, S., A. Aurigi, and S. Focardi. 2000. Presence of polychlorobiphenyls (PCBs), and coplanar congeners in the tissues of the Mediterranean loggerhead turtle Caretta caretta. Marine Pollution Bulletin 40(11):952-960.

Cowan, D. E., and B. E. Curry. 1998. Investigation of the potential influence of fishery-induced stress on dolphins in the eastern tropical pacific ocean: Research planning. National Marine Fisheries Service, Southwest Fisheries Science Center, NOAA-TM-NMFS-SWFSC-254.

Cowan, D. E., and B. E. Curry. 2002. Histopathological assessment of dolphins necropsied onboard vessels in the eastern tropical pacific tuna fishery. National Marine Fisheries Service, Southwest Fisheries Science Center, NMFS SWFSC administrative report LJ-02-24C.

Cowan, D. E., and B. E. Curry. 2008. Histopathology of the alarm reaction in small odontocetes. Journal of Comparative Pathology 139(1):24-33.

Cowan, E., and coauthors. 2002. Influence of filtered roadway lighting on the seaward orientation of hatchling sea turtles. Pages 295-298 *in* A. Mosier, A. Foley, and B. Brost, editors. Twentieth Annual Symposium on Sea Turtle Biology and Conservation.

Coyne, M., and A. M. Landry Jr. 2007. Population sex ratios, and its impact on population models. Pages 191-211 *in* P. T. Plotkin, editor. Biology and conservation of Ridley sea turtles. Johns Hopkins University Press, Baltimore, MD.

Coyne, M., A. M. Landry Jr., D. T. Costa, and B. B. Williams. 1995. Habitat preference, and feeding ecology of the green sea turtle (*Chelonia mydas*) in south Texas waters. Pages 21-24 *in* J. I. Richardson, and T. H. Richardson, editors. Twelfth Annual Workshop on Sea Turtle Biology and Conservation.

Craig, J. K., and coauthors. 2001. Ecological effects of hypoxia on fish, sea turtles, and marine mammals in the northwestern Gulf of Mexico. American Geophysical Union, Washington, D.C.

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

Crouse, O. T., L. B. Crowder, and H. Caswell. 1987. A site based population model for loggerhead sea turtles and implications for conservation. Ecology 68(5):1412-1423.

Cruz, R. D. 2002. Marine turtle distribution in the Philippines. Pages 57-66 *in* I. Kinan, editor Western Pacific Sea Turtle Cooperative Research and Management Workshop. . Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

Cummings, V. 2002. Sea turtle conservation in Guam. Pages 37-38 *in* I. Kinan, editor Western Pacific Sea Turtle Cooperative Research and Management Workshop. . Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

Daan, N. 1996. Multispecies assessment issues for the North Sea. Pages 126-133 *in* E.K.Pikitch, D.D.Huppert, and M.P.Sissenwine, editors. American Fisheries Society Symposium 20, Seattle, Washignton.

Das, S. 2008. Hundreds of sea turtles die along Odisha coast. Kalinga Times. East Coast Media, Kalinga, India.

Davenport, J., and G. H. Balazs. 1991. “Fiery bodies” – are pyrosomas an important component of the diet of leatherback turtles? The British Herpetological Society Bulletin 31:33-38.

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

Davis, R. W., W. E. Evans, and B. Würsig. 2000. Cetaceans, Sea Turtles and Seabirds in the Northern Gulf of Mexico: Distribution, Abundance and Habitat Associations. Volume II: Technical Report. Texas A&M, OCS Study MMS 2000-03, Galveston.

De Weede, R. E. 1996. The impact of seaweed introductions on biodiversity. Global Biodiversity 6:2-9.

Deem, S. L., and coauthors. 2007. Artificial lights as asignificant cause of morbidity of leatherback sea turtles in Pongara National Park, Gabon. Marine Turtle Newsletter 116:15-17.

Deem, S. L., and coauthors. 2009. COMPARISON OF BLOOD VALUES IN FORAGING, NESTING, AND STRANDED LOGGERHEAD TURTLES (CARETTA CARETTA) ALONG THE COAST OF GEORGIA, USA. journal of wildlife diseases 45(1):41-56.

Dermawan, A. 2002. Marine turtle management, and conservation in Indonesia. Pages 67-75 *in* I. Kinan, editor Western Pacific Sea Turtle Cooperative Research and Management Workshop, Honolulu, Hawaii.

Diaz-Fernandez, R., and coauthors. 1999. Genetic sourcing for the hawksbill turtle, Eretmochelys imbricata, in the Northern Caribbean Region. Chelonian Conservation and Biology 3:296-300.

Dierauf, L., and F. Gulland. 2001. CRC Handbook of Marine Mammal Medicine. CRC Press, Boca Raton, Florida.

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

Dodd Jr., C. K. 1988. Synopsis of the biological data on the loggerhead sea turtle, Caretta caretta (Linnaeus 1758).

Dow, W. E., D. A. Mann, T. T. Jones, S. A. Eckert, and C. A. Harms. 2008. In-water and in-air hearing sensitivity of the green sea turtle (Chelonia mydas). 2nd International Confernece on Acoustic Communication by Animals, Corvalis, OR.

Duronslet, M. J., and coauthors. 1986. The effects of an underwater explosion on the sea turtles Lepidochelys kempii and Caretta caretta with observations of effects on other marine organisms. Southeast Fisheries Center, National Marine Fisheries Service, Galveston, Texas.

Dutton, D. L., B. W. Bowen, D. W. Owens, A. Barragan, and S. K. Davis. 1999. Global phylogeography of the leatherback turtle (*Dermochelys coriacea*). Journal of Zoology 248:397-409.

Dutton, P. 2005-2006. Building our knowledge of the leatherback stock structure. SWOT Report 1:10-11.

Dutton, P., G. Balazs, A. Dizon, and A. Barragan. 2000. Genetic stock identification and distribution of leatherbacks in the Pacific: potential effects on declining populations. Pages 38-39 *in* F. A. Abreu-Grobois, R. Briseño-Dueñas, R. Márquez, and L. Sarti, editors. Eighteenth International Sea Turtle Symposium.

Dutton, P., S. R. Benson, and S. A. Eckert. 2006. Identifying origins of leatherback turtles from Pacific foraging grounds off central California, U.S.A. . Pages 228 *in* N. J. Pilcher, editor 23rd Annual Symposiumon Sea Turtle Biology and

Conservation. NMFS.

Dutton, P. H. 2003. Molecular ecology of *Chelonia mydas* in the eastern Pacific Ocean. J. A. Seminoff, editor Proceedings of the 22nd annual symposium on sea turtle biology and conservation

Dutton, P. H. 2007. Genetic stock composition of loggerheads (Caretta caretta) encountered in the Hawaii-based longline fishery using mtDNA analysis. Pages 17-19 *in* North Pacific Loggerhead Sea Turtle Expert Workshop.

Dutton, P. H., and G. H. Balazs. In review. Molecular ecology of the green turtle (Chelonia mydas) in the Hawaiian Archipelago: evidence for a distinct population. Endangered Species Research.

Dutton, P. H., G. H. Balazs, and A. E. Dizon. 1998. Genetic stock identification of sea turtles caught in the Hawaii-based pelagic longline fishery. Pages 45-46 *in* S. P. Epperly, and J. Braun, editors. Seventeenth Annual Symposium on Sea Turtle Biology and Conservation.

Dutton, P. H., S. K. Davis, T. Guerra, and D. Owens. 1996. Molecular phylogeny for marine turtles based on sequences of the ND4-leucine tRNA and control regions of mitochondrial DNA. Molecular Phylogenetics and Evolution 5(3):511-521.

Dutton, P. H., and coauthors. 2007. Status and genetic structure of nesting populations of leatherback turtles (*Dermochelys coriacea*) in the western Pacific. Chelonian Conservation and Biology 6(1):47-53.

Eckert, K. L. 1993a. The biology and population status of marine turtles in the North Pacific Ocean. NOAA, NMFS, SWFSC, Honolulu, Hawaii.

Eckert, K. L. 1993b. The biology and population status of marine turtles in the North Pacific Ocean. Final Report to NOAA, NMFS, SWFSC. Honolulu, HI.

Eckert, S. A. 1997. Distant fisheries implicated in the loss of the world's largest leatherback nesting population. Marine Turtle Newsletter 78:2-7.

Eckert, S. A. 1998. Perspectives on the use of satellite telemetry and electronic technologies for the study of marine turtles, with reference to the first year long tracking of leatherback sea turtles. Pages 44-46 *in* S. P. Epperly, and J. Braun, editors. 17th Annual Symposium on Sea Turtle Biology and Conservation.

Eckert, S. A. 1999. Data acquisition systems for monitoring sea turtle behavior and physiology. Pages 88-93 *in* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois, and M. Donnelly, editors. Research and Management Techniques for the Conservation of Sea Turtles. UCN/SSC Marine Turtle Specialist Group Publication No. 4.

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

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

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

Eckert, S. A., K. L. Eckert, P. Ponganis, and G. L. Kooyman. 1989. Diving and foraging behavior of leatherback sea turtles (Dermochelys coriacea). Canadian Journal of Zoology 67:2834-2840.

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

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

Eguchi, T., T. Gerrodette, R. L. Pitman, J. A. Seminoff, and P. H. Dutton. in preperation. At-sea density and abundance estimates of the olive ridley turtle (Lepidochelys olivacea) in the Eastern Tropical Pacific.

Ehrhart, L. M., D. A. Bagley, and W. E. Redfoot. 2003. Loggerhead turtles in the Atlantic Ocean: Geographic distribution, abundance, and population status. Pages 157-174 *in* A. B. Bolten, and B. E. Witherington, editors. Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

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

Encalada, S. E., and coauthors. 1998. Population structure of loggerhead turtle (*Caretta caretta*) nesting colonies in the Atlantic and Mediterranean as inferred from mitochondrial DNA control region sequences. Pages 51 *in* S. P. Epperly, and J. Braun, editors. Proceedings of the Seventeenth Annual Sea Turtle Symposium. U.S. Department of Commerce, Orlando, Florida.

Epperly, S., and coauthors. 2002. Analysis of sea turtle bycatch in the commercial shrimp fisheries of southeast U.S. waters and the Gulf of Mexico. U.S. Department of Commerce NMFS-SEFSC-490.

Epperly, S., L. Stokes, and S. Dick. 2004. Careful release protocols for sea turtle release with minimal injury. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NMFS-SEFSC-524.

Epstein, P. R., and J. S. (Eds.). 2002. Oil, a life cycle analysis of its health and environmental impacts. Report published by the Center for Health and the Global Environment, Harvard Medical School, Boston, MA.

Erhart, L. M., D.A. Bagley, and W. E. Redfoot. 2003. Loggerhead Turtles in the Atlantic Ocean : Geographic Distribution, Abundance, and Population Status. Pp.157-174 *In:* Bolten, A.B. and B.E. Witherington (eds), Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Euroturtle. 2009. Hawksbill Sea Turtle, Eretmochelys imbricata.

Evans, K. E., and A. R. Vargas. 1998. Sea turtle egg commercialization in Isla de Cañas, Panama. Pages 45 *in* R. Byles, and Y. Fernandez, editors. Sixteenth Annual Symposium on Sea Turtle Biology and Conservation.

Feare, C. J. 1976. Desertion and abnormal development in a colony of Sooty terns infested by virus-infected ticks. Ibis 118:112-115.

Ferraroli, S., J. Y. Georges, P. Gaspar, and Y. L. Maho. 2004. Where leatherback turtles meet fisheries. Nature 429:521-522.

FFWCC. 2007a. Florida Statewide Nesting Beach Survey Data–2005 Season. Florida Fish and Wildlife Conservation Commission.

FFWCC. 2007b. Long-term monitoring program reveals a continuing loggerhead decline, increases in green turtle and leatherback nesting. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute.

Ficetola, G. F. 2008. Impacts of human activities and predators on the nest success of the hawksbill turtle, Eretmochelys imbricata, in the Arabian Gulf. Chelonian Conservation and Biology 7(2):255-257.

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

Fleming, E. H. 2001. Swimming against the tide; recent surveys of exploitation, trade, and management of marine turtles in the Northern Caribbean.

Flint, M., and coauthors. 2009. Development and application of biochemical and haematological reference intervals to identify unhealthy green sea turtles (Chelonia mydas). The Veterinary Journal.

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

Foley, A. M., B. A. Schroeder, A. E. Redlow, K. J. Fick-Child, and W. G. Teas. 2005. Fibropapillomatosis in stranded green turtles (Chelonia mydas) from the eastern United States (1980-98): Trends and associations with environmental factors. Journal of Wildlife Diseases 41(1):29-41.

Fonseca, L. G., G. A. Murillo, L. Guadamuz, R. M. Spinola, and R. A. Valverde. 2009. Downward but Stable Trend in the Abundance of Arribada Olive Ridley Sea Turtles (Lepidochelys olivacea) at Nancite Beach, Costa Rica (1971-2007). Chelonian Conservation and Biology 8(1):19-27.

Formia, A., M. Tiwari, J. Fretey, and A. Billes. 2003. Sea turtle conservation along the Atlantic Coast of Africa. Marine Turtle Newsletter 100:33-37.

Fossette, S., and coauthors. 2009a. Thermal and trophic habitats of the leatherback turtle during the nesting season in French Guiana. Journal of Experimental Marine Biology and Ecology.

Fossette, S., and coauthors. 2009b. Spatio-temporal foraging patterns of a giant zooplanktivore, the leatherback turtle. Journal of Marine Systems in press(in press):in press.

Foti, M., and coauthors. 2009. Antibiotic Resistance of Gram Negatives isolates from loggerhead sea turtles (Caretta caretta) in the central Mediterranean Sea. Marine Pollution Bulletin 58(9):1363-1366.

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

Francour, P., A. Ganteaume, and M. Poulain. 1999. Effects of boat anchoring in Posidonia oceanica seagrass beds in the Port-Cros National Park (north-western Mediterranean Sea). Aquatic Conservation: Marine and Freshwater Ecosystems 9:391-400.

Frazer, N. B., and L. M. Ehrhart. 1985. Preliminary growth models for green, *Chelonia mydas*, and loggerhead, *Caretta caretta*, turtles in the wild. Copeia 1985:73-79.

Frazier, J., and coauthors. 2007. Human-turtle interactions at sea. Pages 253-295 *in* P. T. Plotkin, editor. Biology and conservation of Ridley sea turtles. Johns Hopkins University Press, Baltimore, Maryland.

Frazier, J. G. 2001. General natural history of marine turtles. Proceedings: Marine turtle conservation in the Wider Caribbean Region: A dialogue for effective regional management, Santo Domingo, Dominican Republic.

Fretey, J. 1999. Distribution of the turtles of the genus Lepidochelys Fitzinger, 1843. I. The western Atlantic. Biogeographica 75(3):97-11.

Fretey, J. 2001a. Biogeography and conservation of marine turtles of the Atlantic coast of Africa. UNEP/CMS Secretariat, Bonn, Germany.

Fretey, J. 2001b. Biogeography and conservation of marine turtles of the Atlantic coast of Africa. CMS Technical Series Publication, No. 6, UNEP/CMS Secretariat, Bonn, Germany.

Fretey, J., A. Billes, and M. Tiwari. 2007. Leatherback, *Dermochelys coriacea*, nesting along the Atlantic coast of Africa. Chelonian Conservation and Biology 6(1):126-129.

Fretey, J., and coauthors. 2005. Presence, nesting, and conservation of Lepidochelys olivacea in the Gulf of Guinea. Pages 172 *in* M. S. Coyne, and R. D. Clark, editors. Twenty-first Annual Symposium on Sea Turtle Biology and Conservation.

Frid, A. 2003. Dall's sheep responses to overflights by helicopter and fixed-wing aircraft. Biological Conservation 110(3):387-399.

Frid, A., and L. Dill. 2002. Human-caused disturbance stimuli as a form of predation risk. Conservation Ecology 6(1).

Fritts, T. H., W. Hoffman, and M. A. McGehee. 1983. The distribution and abundance of marine turtles in the Gulf of Mexico and nearby Atlantic waters. Journal of Herpetology 17(4):327-344.

Fritts, T. H., and M. A. McGehee. 1981. Effects of petroleum on the development and survival of marine turtles embryos. U.S. Fish and Wildlife Service, Contract No. 14-16-00009-80-946, FWSIOBS-81-3, Washington, D.C.

Fritts, T. H., M. L. Stinson, and R. Márquez. 1982. Status of sea turtle nesting in southern Baja California, Mexico. Bulletin of the Southern California Academy of Sciences 81:51-60.

Fuentes, M., M. Hamann, and C. J. Limpus. 2009a. Past, current and future thermal profiles of green turtle nesting grounds: Implications from climate change. Journal of Experimental Marine Biology and Ecology 383(1):56-64.

Fuentes, M. M. P. B., and D. Abbs. 2010. Effects of projected changes in tropical cyclone frequency on sea turtles. Marine Ecology Progress Series 412:283-292.

Fuentes, M. M. P. B., M. Hamann, and C. J. Limpus. 2009b. Past, current and future thermal profiles of green turtle nesting grounds: Implications from climate change. Journal of Experimental Marine Biology and Ecology in press(in press):in press.

Fuentes, M. M. P. B., C. J. Limpus, and M. Hamann. 2010. Vulnerability of sea turtle nesting grounds to climate change. Global Change Biology in press(in press):in press.

Fuentes, M. M. P. B., and coauthors. 2009c. Proxy indicators of sand temperature help project impacts of global warming on sea turtles in northern Australia. Endangered Species Research 9:33-40.

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

Gaos, A. R., and coauthors. 2010. Signs of hope in the eastern Pacific: international collaboration reveals encouraging status for severely depleted populations of hawksbill turtle Eretmochelys imbricata. Oryx in press(in press):in press.

Garbarino, J. R., and coauthors. 1995. Heavy metals in the Mississippi River.

Garcia-Fernandez, A. J., and coauthors. 2009. Heavy metals in tissues from loggerhead turtles (Caretta caretta) from the southwestern Mediterranean (Spain). Ecotoxicology and Environmental Safety 72(2):557-563.

Garcon, J. S., A. Grech, J. Moloney, and M. Hamann. 2010. Relative Exposure Index: an important factor in sea turtle nesting distribution. Aquatic Conservation: Marine and Freshwater Ecosystems 20(2):140-149.

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

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

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

Garofalo, L., T. Mingozzi, A. Mico, and A. Novelletto. 2009. Loggerhead turtle (Caretta caretta) matrilines in the Mediterranean: further evidence of genetic diversity and connectivity. Marine Biology 156(10):2085-2095.

Giese, M. 1996. Effects of human activity on Adelie penguin (Pygoscelis adeliae) breeding success. Biological Conservation 75:157-164.

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

Gill, J. A., K. Norris, and W. J. Sutherland. 2001. Why behavioural responses may not reflect the population consequences of human disturbance. Biological Conservation 97:265-268.

Gilman, E. L. 2009. Guidelines to reduce sea turtle mortality in fishing operations. FAO, Rome.

Girard, C., A. D. Tucker, and B. Calmettes. 2009. Post-nesting migrations of loggerhead sea turtles in the Gulf of Mexico: dispersal in highly dynamic conditions. Marine Biology 156(9):1827-1839.

Girondot, M., M. H. Godfrey, L. Ponge, and P. Rivalan. 2007. Modeling approaches to quantify leatherback nesting trends in French Guiana and Suriname. Chelonian Conservation and Biology 6(1):37-46.

Gitschlag, G. R. 1996. Migration and diving behavior of Kemp’s ridley (Garman) sea turtles along the U.S. southeastern Atlantic coast. Journal of Experimental Marine Biology and Ecology 205:115-135.

Gitschlag, G. R., and B. A. Herczeg. 1994. Sea turtle observations at explosive removals of energy structures. Marine Fisheries Review 56(2):1-8.

Gitschlag, G. R., B. A. Herczeg, and T. R. Barcak. 1997. Observations of sea turtles and other marine life at the explosive removal of offshore oil and gas structures in the

Gulf of Mexico. Gulf Research Reports 9(4):247-262.

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

Godley, B., and coauthors. 2002. Long-term satellite telemetry of the movements and habitat utilization by green turtles in the Mediterranean. Ecography 25:352-362.

Godley, B. J., D. R. Thompson, and R. W. Furness. 1999. Do heavy metal concentrations pose a threat to marine turtles from the Mediterranean Sea? Marine Pollution Bulletin 38:497-502.

Godley, B. J., D. R. Thompson, S. Waldron, and R. W. Furness. 1998. The trophic status of marine turtles as determined by stable isotope analysis. Marine Ecology Progress Series 166:277-284.

Godley, B. J. E., and coauthors. 2003. Movement patterns of green turtles in Brazilian coastal waters described by satellite tracking and flipper tagging. Marine Ecology Progress Series 253:279-288.

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

Gordon, A. N., A. R. Pople, and J. Ng. 1998. Trace metal concentrations in livers and kidneys of sea turtles from south-eastern Queensland, Australia. Marine and Freshwater Research 49(5):409-414.

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

Grant, G. S., and D. Ferrell. 1993. Leatherback turtle, Dermochelys coriacea (Reptilia: Dermochelidae): Notes on near-shore feeding behavior and association with cobia. Brimleyana 19:77-81.

Green, G. A., and coauthors. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Oregon and Washington Marine Mammal and Seabird Surveys. Minerals Management Service Contract Report 14-12-0001-30426.

Green, G. A., R. A. Grotefendt, M. A. Smultea, C. E. Bowlby, and R. A. Rowlett. 1993. Delphinid aerial surveys in Oregon and Washington offshore waters. Final report. National Marine Fisheries Service, National Marine Mammal Laboratory, Seattle, Washignton.

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

Gregory, L. F., T. S. Gross, A. Bolten, K. Bjorndal, and L. J. Guillette. 1996. Plasma corticosterone concentrations associated with acute captivity stress in wild loggerhead sea turtles (Caretta caretta). General and Comparative Endocrinology 104:312-320.

Gregory, L. F., and J. R. Schmid. 2001a. Stress responses and sexing of wild Kemp's ridley sea turtles (Lepidochelys kempii) in the Northeastern Gulf of Mexico. General and Comparative Endocrinology 124(1):66-74.

Gregory, L. F., and J. R. Schmid. 2001b. Stress responses and sexing of wild Kemp's ridley sea turtles (*Lepidochelys kempii*) in the northwestern Gulf of Mexico. General and Comparative Endocrinology 124:66-74.

Groombridge, B. 1982. The IUCN Amphibia - Reptilia Red Data Book. Part 1.

Testudines, Crocodylia, Rhynchocephalia. International Union Conservation Nature and Natural Resources.

Gulko, D., and K. L. Eckert. 2003. Sea turtles: an ecological guide. Mutual Publishing, Honolulu, Hawaii.

Hamann, M., C. Limpus, G. Hughes, J. Mortimer, and N. Pilcher. 2006a. Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South East Asia, including consideration of the impacts of the December 2004 tsunami on turtles and turtle habitats. IOSEA Marine Turtle MoU Secretariat, Bangkok, Thailand.

Hamann, M., C. Limpus, G. Hughes, J. Mortimer, and N. Pilcher. 2006b. Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South East Asia, including consideration of the impacts of the December 2004 tsunami on turtles and turtle habitats. IOSEA Marine Turtle MoU Secretariat, Bangkok.

Harms, C. A., K. M. Mallo, P. M. Ross, and A. Segars. 2003. Venous blood gases and lactates of wild loggerhead sea turtles (Caretta caretta) following two capture techniques. journal of wildlife diseases 39(2):366-374.

Harrington, F. H., and A. M. Veitch. 1992. Calving success of woodland caribou exposed to low-level jet fighter overflights. Arctic 45(3):213-218.

Harvey, J., S. Benson, and T. Graham. 2006. Foraging ecology of leatherbacks in the California Current. . Pages 192 *in* M. Frick, A. Panagopoulou, A. F. Rees, and K. Williams, editors. Abstracts of the Twenty-Sixth Annual Symposium on Sea Turtle Biology and Conservation, Athens, Greece.

Hatase, H., and coauthors. 2002a. Population structure of loggerhead turtles, *Caretta caretta*, nesting in Japan: bottlenecks on the Pacific population. Marine Biology 141:299-305.

Hatase, H., Y. Matsuzawa, W. Sakamoto, N. Baba, and I. Miyawaki. 2002b. Pelagic habitat use of an adult Japanese male loggerhead turtle Caretta caretta examined by the Argos satellite system. Fisheries Science 68:945-947.

Hatase, H., and W. Sakamoto. 2004. Forage-diving behaviour of adult Japanese female loggerhead turtles (Caretta caretta) inferred from Argos location data. Journal of the Marine Biological Association of the United Kingdom 84:855-856.

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

Hatase, H., and coauthors. 2002c. Size-related differences in feeding habitat use of adult female loggerhead turtles Caretta caretta around Japan determined by stable isotope analyses and satellite telemetry. Marine Ecology Progress Series 233:273-281.

Hauser, D. D. W., M. Holst, and V. D. Moulton. 2008. Marine mammal and sea turtle monitoring during Lamont-Doherty Earth Observatory’s marine seismic program in the Eastern Tropical Pacific, April–August 2008. LGL, Ltd., King City, Ontario.

Hawkes, L. A., A. Broderick, M. H. Godfrey, and B. J. Godley. 2007a. The potential impact of climate change on loggerhead sex ratios in the Carolinas - how important are North Carolina's males? P.153 in: Frick, M.; A. Panagopoulou; A.F. Rees; K. Williams (compilers), 27th Annual Symposium on Sea Turtle Biology and Conservation [abstracts]. 22-28 February 2007, Myrtle Beach, South Carolina. 296p.

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

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

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

Hazel, J. 2009. Evaluation of fast-acquisition GPS in stationary tests and fine-scale tracking of green turtles. Journal of Experimental Marine Biology and Ecology 374(1):58-68.

Hazel, J., and E. Gyuris. 2006. Vessel-related mortality of sea turtles in Queensland, Australia. Wildlife Research 33(2):149-154.

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

Hazel, J., I. R. Lawler, H. Marsh, and S. Robson. 2007. Vessel speed increases collision risk for the green turtle *Chelonia mydas*. Endangered Species Research 3:105-113.

HDLNR. 2002. Application for an individual incidental take permit pursuant to the Endangered Species Act of 1973 for listed sea turtles in inshore marine fisheries in the main Hawaiian Islands managed by the State of Hawaii. State of Hawaii, Division of Aquatic Resources.

Heithaus, M. R., J. J. McLash, A. Frid, L. M. Dill, and G. J. Marshall. 2002. Novel insights into green sea turtle behaviour using animal-borne video cameras. Journal of the Marine Biological Association of the United Kingdom 82:1049-1050.

Henwood, T. A., and W. E. Stuntz. 1987. Analysis of sea turtle captures and mortalities during commercial shrimp trawling. Fishery Bulletin 85:813-817.

Heppell, S. S., M. L. Snover, and L. B. Crowder. 2003. Sea turtle population ecology. Chapter 11 *In*: Lutz, P.L., J.A. Musick, and J. Wyneken (eds), The Biology of Sea Turtles: Volume II. CRC Press. Pp.275-306.

Hermanussen, S., V. Matthews, O. Papke, C. J. Limpus, and C. Gaus. 2008. Flame retardants (PBDEs) in marine turtles, dugongs and seafood from Queensland, Australia. Marine Pollution Bulletin 57(6-12):409-418.

Hernández, R., J. Buitrago, H. Guada, H. Hernández-Hamón, and M. Llano. 2007. Nesting distribution and hatching success of the leatherback, *Dermochelys coriacea*, in relation to human pressures at Playa Parguito, Margarita Island, Venezuela. Chelonian Conservation and Biology 6(1):79-86.

Herraez, P., and coauthors. 2007. Rhabdomyolysis and myoglobinuric nephrosis (capture myopathy) in a striped dolphin. Journal of Wildlife Diseases 43(4):770-774.

Hildebrand, H. H. 1963. Hallazgo del area de anidacion de la tortuga marina "lora", Lepidochelys kempi (Garman), en la costa occidental del Golfo de Mexico (Rept., Chel.). Ciencia, Mexico 22:105-112.

Hildebrand, H. H. 1983. Random notes on sea turtles in the western Gulf of Mexico. Western Gulf of Mexico Sea Turtle Workshop Proceedings, January 13-14, 1983:34-41.

Hillis-Starr, Z. M. Coyne, and M. Monaco. 2000. Buck Island and back: Hawksbill turtles make their move. Pages 159 *in* H. J. Kalb, and T. Wibbels, editors. Nineteenth Annual Symposium on Sea Turtle Biology and Conservation.

Hilterman, M. L., and E. Goverse. 2003. Aspects of Nesting and Nest Success of the Leatherback Turtle (*Dermochelys coriacea*) in Suriname, 2002. Guianas Forests and Environmental Conservation Project (GFECP). Technical Report, World Wildlife Fund Guianas/Biotopic Foundation, Amsterdam, the Netherlands, 31p.

Hirth, H. F. 1997. Synopsis of the biological data on the green turtle, Chelonia mydas (Linnaeus 1758).

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

Hoegh-Guldberg, O., and J. F. Bruno. 2010. The Impact of Climate Change on the World's Marine Ecosystems. Science 328(5985):1523-1528.

Hoekert, W. E., J. A. D. Schouten, L. H. G. V. Tienen, and M. Weijerman. 1996. Is the Suriname olive ridley on the eve of extinction? First census data for olive ridleys, green turtles, and leatherbacks since 1989. Marine Turtle Newsletter 75:1-4.

Holst, M., and M. A. Smultea. 2008. Marine mammal and sea turtle monitoring during Lamont-Doherty Earth Observatory’s marine seismic program off Central America, Feburary-April 2008. Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York.

Holst, M., M. A. Smultea, W. R. Koski, and B. Haley. 2005. Marine mammal and sea turtle monitoring during Lamont-Doherty Earth Observatory’s marine seismic program in the Eastern Tropical Pacific Ocean off Central America, November–December 2004. Report from LGL Ltd., King City, Ontario, for Lamont-Doherty Earth Observatory of Columbia Univ., Palisades, NY, and National Marine Fisheries Service, Silver Spring, MD. Report TA2822-30. 125 p.

Hoopes, L. A., A. M. J. Landry, and E. K. Stabenau. 2000. Physiological effects of capturing Kemp's ridley sea turtles, *Lepidochelys kempii*, in entanglement nets. Canadian Journal of Zoology 78:1941-1947.

Hornell, J. 1927. The turtle fisheries of the Seychelles Islands. H.M. Stationery Office, London, UK.

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

Horrocks, J. A., and coauthors. 2001. Migration routes and destination characteristics of post-nesting hawksbill turtles satellite-tracked from Barbados, West Indies. Chelonian Conservation and Biology 4(1):107-114.

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

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

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

Hulin, V., V. Delmas, M. Girondot, M. H. Godfrey, and J. M. Guillon. 2009. Temperature-dependent sex determination and global change: are some species at greater risk? Oecologia 160(3):493-506.

Hutchinson, B. J., and P. Dutton. 2007. Modern genetics reveals ancient diversity in the loggerhead.

I-Jiunn, C. 2009. Changes in diving behaviour during the internesting period by green turtles. Journal of Experimental Marine Biology and Ecology.

Innis, C., and coauthors. 2009. PATHOLOGIC AND PARASITOLOGIC FINDINGS OF COLD-STUNNED KEMP'S RIDLEY SEA TURTLES (LEPIDOCHELYS KEMPII) STRANDED ON CAPE COD, MASSACHUSETTS, 2001-2006. Journal of Wildlife Diseases 45(3):594-610.

Innis, C., and coauthors. 2008. Trace metal and organochlorine pesticide concentrations in cold-stunned kuvenile Kemp’s ridley turtles (Lepidochelys kempii) from Cape Cod, Massachusetts. Chelonian Conservation and Biology 7(2):230-239.

IPCC, editor. 2000. Land use, land-use change, and forestry. Cambridge University Press, Cambridge, England.

IPCC, editor. 2001a. Climate change 2001: Impacts, adaptation and vulnerability, contribution of working group II to the third assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, England.

IPCC, editor. 2001b. Climate change 2001: The scientific basis, contribution of working group I to the third assessment report of the intergovernmental panel of climate change. Cambridge University Press, Cambridge, England.

IPCC, editor. 2002. Climate change and biodiversity.

Isaac, J. L. 2008. Effects of climate change on life history: Implications for extinction risk in mammals. Endangered Species Research.

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

Islam, M. Z. 2002. Marine turtle nesting at St. Martin’s Island, Bangladesh. Marine Turtle Newsletter 96:19-21.

Issac, J. L. 2009. Effects of climate change on life history: Implications for extinction risk in mammals. Endangered Species Research 7(2):115-123.

Iwamoto, T., M. Ishii, Y. Nakashima, H. Takeshita, and A. Itoh. 1985. Nesting cycles and migrations of the loggerhead sea turtle in Miyazaki, Japan. Japanese Journal of Ecology 35(4):505-511.

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

James, M. C., C. A. Ottensmeyer, S. A. Eckert, and R. A. Myers. 2006. Changes in the diel diving patterns accompany shifts between northern foraging and southward migration in leatherback turtles. . Canadian Journal of Zoology 84:754-765.

James, M. C., S. A. Sherrill-Mix, and R. A. Myers. 2007. Population characteristics and seasonal migrations of leatherback sea turtles at high latitudes. Marine Ecology Progress Series 337:245-254.

Kalb, H., and D. Owens. 1994. Differences between solitary and arribada nesting olive ridley females during the internesting period. Pages 68 *in* K. A. Bjorndal, A. B. Bolten, D. A. Johnson, and P. J. Eliazar, editors. Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. .

Kalb, H., R. A. Valverde, and D. Owens. 1995. What is the reproductive patch of the olive ridley sea turtle? Pages 57-60 *in* J. I. Richardson, and T. H. Richardson, editors. Twelfth Annual Workshop on Sea Turtle Biology and Conservation. .

Kamezaki, N. 1989. The nesting sites of sea turtles in the Ryukyu Archipelago and Taiwan. Pages 342-348 *in* M. Matsui, T. Hikida, and R. C. Goris, editors. Current herpetology in East Asia. Herpetological Society of Japan, Kyoto.

Kamezaki, N., and coauthors. 2003. Loggerhead turtles nesting in Japan. Pages 210-217 *in* A. B. Bolten, and B. E. Witherington, editors. Loggerhead sea turtles. Smithsonian Books, Washington D.C.

Kamezaki, N., K. Oki, K. Mizuno, T. Toji, and O. Doi. 2002. First nesting record of the leatherback turtle, Oermochelys coriacea, in Japan. Current Herpetology 21(2):95-97.

Kapurisinghe, T. 2006. Status and conservation of marine turtles in Sri Lanka. Pages 173-187 *in* K. Shanker, and B. C. Choudhury, editors. Marine Turtles of the Indian Subcontinent. Universities Press, India.

Karnad, D., K. Isvaran, C. S. Kar, and K. Shanker. 2009. Lighting the way: Towards reducing misorientation of olive ridley hatchlings due to artificial lighting at Rushikulya, India. Biological Conservation 142(10):2083-2088.

Kawamura, G., T. Naohara, Y. Tanaka, T. Nishi, and K. Anraku. 2009. Near-ultraviolet radiation guides the emerged hatchlings of loggerhead turtles Caretta caretta (Linnaeus) from a nesting beach to the sea at night. MARINE AND FRESHWATER BEHAVIOUR AND PHYSIOLOGY 42(1):19-30.

Keinath, J. A., J. A. Musick, and D. E. Barnard. 1996. Abundance and distribution of sea turtles off North Carolina. OCS Study, MMS 95-0024 (Prepared under MMS Contract 14-35-0001-30590):156.

Kelez, S., X. Velez-Zuzzo, F. Angulo, and C. Manrique. 2009. Olive ridley Lepidochelys olivacea nesting in Peru: the southernmost records in the eastern Pacific. Marine Turtle Newsletter 126:5-9.

Kelle, L., N. Gratiot, and B. de Thoisy. 2009. Olive ridley turtle Lepidochelys olivacea in French Guiana: back from the brink of regional extirpation? Oryx 43(2):243-246.

Keller, J. M., and coauthors. 2005. Perfluorinated compounds in the plasma of loggerhead and Kemp’s ridley sea turtles from the southeastern coast of the United States. Environmental Science and Technology 39(23):9101-9108.

Keller, J. M., J. R. Kucklick, C. A. Harms, and P. D. McClellan-Green. 2004a. Organochlorine contaminants in sea turtles: Correlations between whole blood and fat. Environmental Toxicology and Chemistry 23(3):726-738.

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

Keller, J. M., J. R. Kucklick, M. A. Stamper, C. A. Harms, and P. D. McClellan-Green. 2004c. Associations between organochlorine contaminant concentrations and clinical health parameters in loggerhead sea turtles from North Carolina, USA. Environmental Health Parameters 112(10):1074-1079.

Keller, J. M., and P. McClellan-Green. 2004. Effects of organochlorine compounds on cytochrome P450 aromatase activity in an immortal sea turtle cell line. Marine Environmental Research 58(2-5):347-351.

Keller, J. M., P. D. McClellan-Green, J. R. Kucklick, D. E. Keil, and M. M. Peden-Adams. 2006. Turtle immunity: Comparison of a correlative field study and in vitro exposure experiments. Environmental Health Perspectives 114(1):70-76.

Ketten, D. R., and S. M. Bartol. 2006. Functional measures of sea turtle hearing. Office of Naval Research, Arlington, VA.

Klima, E. F., G. R. Gitschlag, and M. L. Renaud. 1988. Impacts of the explosive removal of offshore petroleum platforms on sea turtles and dolphins. Marine Fisheries Review 50(3):33-42.

Kobayashi, D. R., and coauthors. 2008. Pelagic habitat characteriation of loggerhead sea turtles, Caretta caretta, in the North Pacific Ocean (1997-2006): insights from satellite tag tracking and remotely sensed data. Journal of Marine Biology and Ecology 356:96-114.

Kopitsky, K., R. L. Pitman, and P. Plotkin. 2000. Investigations on at-sea mating and reproductive status of olive ridleys, Lepidochelys olivacea, captured in the eastern tropical Pacific. Pages 160-162 *in* H. J. Kalb, and T. Wibbels, editors. Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. .

Krishna, S. 2005. Sporadic nesting of olive ridley turtles (*Lepidochelys olivacea*) and efforts to conserve them along the coast of Karnataka (South West India). Pages 218-219 *in* M. S. Coyne, and R. D. Clark, editors. Twenty-first Annual Symposium on Sea Turtle Biology and Conservation. .

Kuller, Z. 1999. Current status and conservation of marine turtles on the Mediterranean coast of Israel. Marine Turtle Newsletter 86:3-5.

L-DEO. 2006. Request by Lamont-Doherty Earth Observatory for an Incidental Harassment Authorization to Allow the Incidental Take of Marine Mammals During Seismic Testing in the Northern Gulf of Mexico, Fall 2006. Prepared by LGL, Ltd. - LGL Report TA4295-1. Submitted to the National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland, by the Lamont-Doherty Earth Observatory, Palisades, New York.149p.

LADEQ. 2010. Beach sweep and inland waterway cleanup. Louisiana Department of Environmental Quality Litter Reduction and Public Action.

Lagueux, C. J. 1998. Marine Turtle fishery of Caribbean Nicaragua: human Use Patterns and Harvest Trends. Dissertation. University of Florida.

Lagueux, C. J., C. L. Campbell, and W. A. McCoy. 2003. Nesting, and conservation of the hawksbill turtle, Eretmochelys imbricata, in the Pearl Cays, Nicaragua. Chelonian Conservation and Biology 4(3):588-602.

Laist, D. W., J. M. Coe, and K. J. O'Hara. 1999. Marine debris pollution. Pages 342-366 *in* J. Twiss, and R. R. Reeves, editors. Conservation and management of marine mammals. Smithsonian Institution Press, Washington, D.C.

Lake, J., L. R. Haebler, R. McKinney, C. A. Lake, and S. S. Sadove. 1994. PCBs and other chlorinated organic contaminants in tissues of juvenile Kemp's ridley turtles (Lepidochelys kempii). Marine Environmental Research 38:313-327.

Lal, A., R. Arthur, N. Marbà, A. W. T. Lill, and T. Alcoverro. 2010. Implications of conserving an ecosystem modifier: Increasing green turtle (Chelonia mydas) densities substantially alters seagrass meadows. Biological Conservation in press(in press):in press.

Landry, A. M., Jr., and D. Costa. 1999. Status of sea turtle stocks in the Gulf of Mexico with emphasis on the Kemp's ridley. Pages 248-268 *in* H. Kumpf, K. Steidinger, and K. Sherman, editors. The Gulf of Mexico large marine ecosystem: Assessment, sustainability, and management. Blackwell Science, Malden, Massachusetts.

Landry, A. M. J., and coauthors. 1996. Population Dynamics and Index Habitat Characterization for Kemp's Ridley Sea Turtles in Nearshore Waters of the Northwestern Gulf of Mexico. Report of Texas A&M Research Foundation pursuant to NOAA Award No. NA57FF0062:153.

Landsberg, J. H., and coauthors. 1999. The potential role of natural tumor promoters in marine turtle fibropapillomatosis. Journal of Aquatic Animal Health 11(3):199-210.

Laurance, W. F., and coauthors. 2008. Does rainforest logging threaten endangered sea turtles? Oryx 42:245-251.

Law, R. J., and J. Hellou. 1999. Contamination of fish and shellfish following oil spill incidents. Environmental Geoscience 6:90-98.

Lazar, B., and R. Gračan. 2010. Ingestion of marine debris by loggerhead sea turtles, Caretta caretta, in the Adriatic Sea. Marine Pollution Bulletin.

Le Gall, J., Y. P. Bosc, D. Chateau, and M. Taquet. 1986. Estimation du nombre de tortues vertes femelles adultes Chelonia mydas par saison de ponte á Tromelin et Europa (Océan Indien) (1973-1985). Océanographie Tropicale 21:3-22.

Leblanc, A. M., and T. Wibbels. 2009. Effect of Daily Water Treatment on Hatchling Sex Ratios in a Turtle With Temperature-Dependent Sex Determination. Journal of Experimental Zoology Part a-Ecological Genetics and Physiology 311A(1):68-72.

Lee Long, W. J., R. G. Coles, and L. J. McKenzie. 2000. Issues for seagrass conservation management in Queensland. Pacific Conservation Biology 5:321-328.

Lenhardt, M. L. 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (*Caretta caretta*). Pp.238-241 *In:* Bjorndal, K.A., A.B. Bolten, D.A. Johnson, and P.J. Eliazar (Eds), Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum, NMFS-SEFSC-351.

Lenhardt, M. L., S. Bellmund, R. A. Byles, S. W. Harkins, and J. A. Musick. 1983. Marine turtle reception of bone conducted sound. The Journal of Auditory Research 23:119-125.

LGL Ltd. 2007. Environmental Assessment of a Marine Geophysical Survey by the *R/V Marcus G. Langseth* off Central America, January–March 2008. Prepared for the Lamont-Doherty Earth Observatory, Palisades, NY, and the National Science Foundation, Arlington, VA, by LGL Ltd., environmental research associates, Ontario, Canada. LGL Report TA4342-1.

LHR. 2010. Energy, oil & gas. Louisiana Hurricane Resources.

Liew, H. C. 2002. Status of marine turtle conservation and research in Malaysia. Pages 51-56 *in* I. Kinan, editor Western Pacific Sea Turtle Cooperative Research and Management Workshop. Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

Lima, S. L. 1998. Stress and decision making under the risk of predation. Advances in the Study of Behavior 27:215-290.

Limpus, C. 2002. Conservation, and research of sea turtles in the western Pacific region: an overview. Pages 41-50 *in* I. Kinan, editor Western Pacific Sea Turtle Cooperative Research and Management Workshop. . Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

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

Limpus, C. J. 1985. A study of the loggerhead turtle, Caretta caretta, in eastern Australia. PhD thesis. University of Queensland, Brisbane, Australia.

Limpus, C. J. 1995. Global overview of the status of marine turtles: A 1995 viewpoint. Pages 605-609 *in* K. Bjorndal, editor. Biology and conservation of sea turtles, revised edition. Smithsonian Institution Press, Washington, D.C.

Limpus, C. J., and D. J. Limpus. 2003. Loggerhead turtles in the equatorial, and southern Pacific Ocean: A species in decline. Pages 199-209 *in* A. B. Bolten, and B. E. Witherington, editors. Loggerhead sea turtles. Smithsonian Books, Washington D.C.

Limpus, C. J., J. D. Miller, C. J. Parmenter, and D. J. Limpus. 2003. The green turtle, Chelonia mydas, population of Raine Island and the northern Great Barrier Reef, 1843-2001. Memoirs of the Queensland Museum 49:349-440.

Limpus, C. J., and N. Nicholls. 1988. The Southern Oscillation regulates the annual numbers of green turtles (Chelonia mydas) breeding around northern Australia. Australian Journal of Wildlife Research 15:157-161.

Lino, S. P. P., E. Gonçalves, and J. Cozens. 2010. The loggerhead sea turtle (Caretta caretta) on Sal Island, Cape Verde: nesting activity and beach surveillance in 2009. Arquipelago 27:59-63.

Lohoefener, R. R., W. Hoggard, K. Mullin, C. Roden, and C. Rogers. 1990. Association of sea turtles with petroleum platforms in the north-central Gulf of Mexico. OCS Study, MMS 90-0025:90 pp.

López-Mendilaharsu, M., C. F. D. Rocha, A. Domingo, B. P. Wallace, and P. Miller. 2009. Prolonged deep dives by the leatherback turtle Dermochelys coriacea: pushing their aerobic dive limits. Marine Biodiversity Records 2(01).

López Carcache, J., and coauthors. in press. Monitoring of isolated and arribada nests of olive ridley, Lepidochelys olivacea, in Chacocente Beach, Rio Escalante-Chacocente, Wildlife Refuge, Pacific Coast of Nicaragua (2002-2004). Twenty-fifth Annual Symposium on Sea Turtle Biology and Conservation.

López, E., and R. Arauz. 2003. Nesting records of East Pacific green turtles (*Chelonia mydas agassizii*) in south Pacific Costa Rica, including notes on incidental capture by shrimping and longline activities. Pages 84-85 *in* J. A. Seminoff, editor Twenty-second Annual Symposium on Sea Turtle Biology and Conservation. .

Lordi, B., V. Patin, P. Protais, D. Mellier, and J. Caston. 2000. Chronic stress in pregnant rats: effects on growth rate, anxiety and memory capabilities of the offspring. International Journal of Psychophysiology 37:195-205.

Lubchenco, J., and coauthors. 2010. Deepwater Horizon/BP oil budget: What happened to the oil? USGS, NMFS, and DOI, editors.

LUMCON. 2005. Mapping of dead zone completed. Louisiana Universities Marine Consortium, Chauvin, Louisiana.

Luschi, P., G. C. Hays, and F. Papi. 2003. A review of long-distance movements by marine turtles, and the possible role of ocean currents. Oikos 103:293-302.

Luschi, P., and coauthors. 2006. A review of migratory behaviour of sea turtles off southeastern Africa. South African Journal of Science 102:51-58.

Lusseau, D. 2006. The short-term behavioral reactions of bottlenose dolphins to interactions with boats in Doubtful Sound, New Zealand. Marine Mammal Science 22(4):802-818.

Lutcavage, M. E., P. Plotkin, B. Witherington, and P. L. Lutz. 1997a. Human impacts on sea turtle survival. Pages 387-409 *in* The Biology of Sea Turtles. CRC Press, Boca Raton, Florida.

Lutcavage, M. E., P. Plotkin, B. E. Witherington, and P. L. Lutz. 1997b. Human impacts on sea turtle survival. Pages 387-409 *in* P. L. Lutz, and J. A. Musick, editors. Biology of sea turtles. CRC Press, New York, New York.

Lutz, P. L., and T. B. Bentley. 1985. Respiratory Physiology of Diving in the Sea Turtle. Copeia 3:671-679.

Lutz, P. L., and A. Dunbar-Cooper. 1987. Variations in the blood chemistry of the loggerhead sea turtle, *Caretta caretta*. Fishery Bulletin 85(1):37-43.

Lux, J., R. Reina, and L. Stokes. 2003. Nesting activity of leatherback turtles (*Dermochelys coriacea*) in relation to tidal and lunar cycles at Playa Grande, Costa Rica. Pp.215-216 *In:* J.A. Seminoff (compiler), Proceedings of the 22nd Annual Symposium on Sea Turtle Biology and Conservation. Department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-503.

MacDonald, I. R., and coauthors. 1993. Natural oil slicks in the Gulf of Mexico visible from space. Journal of Geophysical Research 98(C9):16,351-16,364.

Maison, K. 2006. Do turtles move with the beach? Beach profiling and possible effects of development on a leatherback (Dermochelys coriacea) nesting beach in Grenada. Pages 145 *in* M. Frick, A. Panagopoulou, A. F. Rees, and K. Williams, editors. Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.

Maison, K. A., I. Kinan-Kelly, and K. P. Frutchey. 2010. Green turtle nesting sites and sea turtle legislation throughout Oceania. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Makowski, C., J. A. Seminoff, and M. Salmon. 2006. Home range and habitat use of juvenile Atlantic green turtles (Chelonia mydas L.) on shallow reef habitats in Palm Beach, Florida, USA. Marine Biology 148:1167-1179.

Mansfield, K. L., V. S. Saba, J. A. Keinath, and J. A. Musick. 2009. Satellite tracking reveals a dichotomy in migration strategies among juvenile loggerhead turtles in the Northwest Atlantic. Marine Biology 156(12):2555-2570.

Marcovaldi, M. A., and M. Chaloupka. 2007. Conservation status of the loggerhead sea turtle in Brazil: An encouraging outlook. Endangered Species Research 3:133-143.

Margaritoulis, D., and coauthors. 2003. Loggerhead turtles in the Mediterranean Sea: Present knowledge and conservation perspectives. Pages 175-198 *in* A. B. Bolten, and B. E. Witherington, editors. Loggerhead sea turtles. Smithsonian Books, Washington D.C.

Margaritoulis, D., and A. Demetropoulos. 2003. Proceedings of the First Mediterranean Conference on Marine Turtles. Barcelona Convention-Bern Convention- Bonn Convention (CMS), Nicosia, Cyprus.

Marquez-M., R. 1994. Synopsis of biological data on the Kemp's ridley turtle, *Lepidochelys kempii*, (Garman, 1880). NOAA Technical Memorandum NMFS-SEFSC-343, or OCS Study MMS 94-0023. 91p.

Márquez, M. R. 1990. Sea turtles of the world. An annotated and illustrated catalogue of sea turtle species known to date. FAO Species Catalog, FAO Fisheries Synopsis 11(125):81p.

Márquez, M. R., M. A. Carrasco, M. C. Jimenez, C. P.-. S., and R. Bravo-G. 2005. Kemp’s, and olive ridley sea turtles populations status. Pages 273-239 *in* M. S. Coyne, and R. D. Clark, editors. Twenty-first Annual Symposium on Sea Turtle Biology and Conservation. .

Márquez, M. R., C. Peñaflores, and J. Vasconcelos. 1996. Olive ridley turtles (Lepidochelys olivacea) show signs of recovery at La Escobilla, Oaxaca. Marine Turtle Newsletter 73:5-7.

Marquez, M. R., A. Villanueva, and P. M. Burchfield. 1989. Nesting population, and production of hatchlings of Kemp's ridley sea turtle at Rancho Nuevo, Tamaulipas, Mexico. Pages 16-19 *in* C. W. Caillouet Jr., and A. M. Landry Jr., editors. First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation, and Management.

Marsh, J. W., J. K. Chipman, and D. R. Livingstone. 1992. Activation of xenobiotics to reactive and mutagenic products by the marine invertebrates Mytilus edulis, Carcinus maenus, and Asterias rubens. Aquatic Toxicology 22:115-128.

Marshall, C. D., A. L. Moss, and A. Guzman. 2009. Loggerhead Sea Turtle (Caretta caretta) Feeding on Mackerel-Baited Longline Hooks. Integrative and Comparative Biology 49:E266-E266.

MASGC. 2010. Mississippi coastal cleanup. Mississippi Alabama Sea Grant Consortium.

Mazaris, A. D., A. S. Kallimanis, S. P. Sgardelis, and J. D. Pantis. 2008. Do long-term changes in sea surface temperature at the breeding areas affect the breeding dates and reproduction performance of Mediterranean loggerhead turtles? Implications for climate change. Journal of Experimental Marine Biology and Ecology.

Mazaris, A. D., A. S. Kallimanis, J. Tzanopoulos, S. P. Sgardelis, and J. D. Pantis. 2009a. Sea surface temperature variations in core foraging grounds drive nesting trends and phenology of loggerhead turtles in the Mediterranean Sea. Journal of Experimental Marine Biology and Ecology.

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

McCarthy, A. L., S. Heppell, F. Royer, C. Freitas, and T. Dellinger. 2010. Identification of likely foraging habitat of pelagic loggerhead sea turtles (Caretta caretta) in the

North Atlantic through analysis of telemetry track sinuosity. Progress in Oceanography.

McCauley, S. J., and K. A. Bjorndal. 1999. Conservation implications of dietary dilution from debris ingestion: Sublethal effects in post-hatchling loggerhead sea turtles. Conservation Biology 13(4):925-929.

McClellan, C. M., J. Braun-McNeill, L. Avens, B. P. Wallace, and A. J. Read. 2010. Stable isotopes confirm a foraging dichotomy in juvenile loggerhead sea turtles. Journal of Experimental Marine Biology and Ecology 387:44-51.

McClellan, C. M., A. J. Read, B. A. Price, W. M. Cluse, and M. H. Godfrey. 2009. Using telemetry to mitigate the bycatch of long-lived marine vertebrates. Ecological Applications 19(6):1660-1671.

McDonald Dutton, D., and P. H. Dutton. 1998. Accelerated growth in San Diego Bay green turtles? Pages 175-176 *in* S. P. Epperly, and J. Braun, editors. Seventeenth Annual Sea Turtle Symposium.

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

McMahon, C. R., C. J. A. Bradshaw, and G. C. Hays. 2007. Satellite tracking reveals unusual diving characteristics for a marine reptile, the olive ridley turtle *Lepidochelys olivacea*. Marine Ecology Progress Series 329:239-252.

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

Meador, J. P., R. Stein, and U. Varanasi. 1995. Bioaccumulation of polycyclic aromatic hydrocarbons by marine organisms. Reviews of Environmental Contamination and Toxicology 143:79-165.

Mellgren, R. L., and M. A. Mann. 1996. Comparative behavior of hatchling sea turtles. Pages 202-204 *in* J. A. Keinath, D. E. Barnard, J. A. Musick, and B. A. Bell, editors. Fifteenth Annual Symposium on Sea Turtle Biology and Conservation.

Mellgren, R. L., M. A. Mann, M. E. Bushong, S. R. Harkins, and V. K. Krumke. 1994. Habitat selection in three species of captive sea turtle hatchlings. Pages 259-260 *in* K. A. Bjorndal, A. B. Bolten, D. A. Johnson, and P. J. Eliazar, editors. Fourteenth Annual Symposium on Sea Turtle Biology and Conservation.

Mendonca, M. T., and P. C. H. Pritchard. 1986. Offshore movements of post-nesting Kemp's ridley sea turtles (Lepidochelys kempii). Herpetologica 42:373-380.

Meylan, A., B. Schroeder, and A. Mosier. 1995. Sea turtle nesting activity in the State of Florida 1979-1992. Florida Marine Research Publications 52(1-51).

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

Miao, X., G. H. Balazsb, S. K. K. Murakawa, and Q. X. Li. 2001. Congener-specific profile, and toxicity assessment of PCBs in green turtles (Chelonia mydas)from the Hawaiian Islands. The Science of the Total Environment 281:247-253.

Miller, J. D., K. A. Dobbs, C. J. Limpus, N. Mattocks, and A. M. Landry. 1998. Long-distance migrations by the hawksbill turtle, Eretmochelys imbricata, from north-eastern Australian. Wildlife Research 25:89-95.

Milliken, T., and H. Tokunaga. 1987. The Japanese sea turtle trade 1970-1986. A special report prepared by TRAFFIC (Japan). Center for Environmental Education, Washington D.C.

Mills, S. K., and J. H. Beatty. 1979. The propensity interpretation of fitness. Philosophy of Science 46:263-286.

Milton, S. L., S. Leone-Kabler, A. A. Schulman, and P. L. Lutz. 1994. Effects of Hurricane Andrew on the sea turtle nesting beaches of South Florida. Bulletin of Marine Science 54:974-981.

Milton, S. L., and P. L. Lutz. 2003. Physiological and genetic responses to environmental stress. Pages 163-197 *in* P. L. Lutz, J. A. Musick, and J. Wyneken, editors. The Biology of Sea Turtles, Volume II. CRC Press, Boca Raton, Florida.

MMS. 1998. Pages III-3 to III-72 in Gulf of Mexico OCS oil and gas lease sales 171, 174, 177, and 180—Western Planning Area. Minerals Management Service, New Orleans, Louisiana.

MMS. 2007a. Gulf of Mexico OCS oil and gas lease sale 224, Eastern planning area. Final supplemental environmental impact statement. Minerals Management Service.

MMS. 2007b. Gulf of Mexico OCS oil and gas lease sales: 2007-2012, Western planning area sales 204, 207, 210, 215, and 218; Central planning area sales 205, 206, 208, 213, 216, and 222. Final environmental impact statement. Minerals Management Service.

Moein Bartol, S., and D. R. Ketten. 2006. Turtle and tuna hearing. Pp.98-103 In: Swimmer, Y. and R. Brill (Eds), Sea Turtle and Pelagic Fish Sensory Biology: Developing Techniques to Reduce Sea Turtle Bycatch in Longline Fisheries. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-PIFSC-7.

Moein Bartol, S., J. A. Musick, and M. Lenhardt. 1999. Auditory evoked potentials of the loggerhead sea turtle (*Caretta caretta*). Copeia 1999(3):836-840.

Monagas, P., J. Oros, J. Anana, and O. M. Gonzalez-Diaz. 2008. Organochlorine pesticide levels in loggerhead turtles (Caretta caretta) stranded in the Canary Islands, Spain. Marine Pollution Bulletin 56:1949-1952.

Monzon-Arguello, C., and coauthors. 2009. Variation in spatial distribution of juvenile loggerhead turtles in the eastern Atlantic and western Mediterranean Sea. Journal of Experimental Marine Biology and Ecology 373(2):79-86.

Monzon-Arguello, C., C. Rico, A. Marco, P. Lopez, and L. F. Lopez-Jurado. 2010. Genetic characterization of eastern Atlantic hawksbill turtles at a foraging group indicates major undiscovered nesting populations in the region. Journal of Experimental Marine Biology and Ecology in press(in press):in press.

Moreira, L., and K. A. Bjorndal. 2006. Estimates of green turtle (*Chelonia mydas*) nests on Trindade Island, Brazil, South Atlantic. Pages 174 *in* N. Pilcher, editor Twenty-third Annual Symposium on Sea Turtle Biology and Conservation.

Morreale, S. J., P. T. Plotkin, D. J. Shaver, and H. J. Kalb. 2007. Adult migration and habitat utilization. Pages 213-229 *in* P. T. Plotkin, editor. Biology and conservation of Ridley sea turtles. Johns Hopkins University Press, Baltimore, Maryland.

Morreale, S. J., E. A. Standora, F. V. Paladino, and J. R. Spotila. 1994. Leatherback migrations along deepwater bathymetric contours. Pp.109-110 In: Schoeder, B.A. and B.E. Witherington (Eds), Proceedings of the 13th Annual Symposium on Sea

Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-341, Miami, Florida.

Mortimer, J. A. 1982. Factors influencing beach selection by nesting sea turtles. Pages 45-51 *in* K. Bjorndal, editor. The biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C.

Mortimer, J. A., and coauthors. 2003. Growth rates of immature hawksbills (*Eretmochelys imbricata*) at Aldabra Atoll, Seychelles (Western Indian Ocean). Pages 247-248 *in* J. A. Seminoff, editor Twenty-second Annual Symposium on Sea Turtle Biology and Conservation.

Mortimer, J. A., and M. Donnelly. in review. 2007 IUCN red list status assessment: hawksbill turtle (*Eretmochelys imbricata*).

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

Mrosovsky, N., S. R. Hopkins-Murphy, and J. I. Richardson. 1984. Sex ratio of sea turtles: seasonal changes. Science 225(4663):739-741.

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

Mullner, A., K. E. Linsenmair, and W. Wikelski. 2004. Exposure to ecotourism reduces survival and affects stress response in hoatzin chicks (Opisthocomus hoazin). Biological Conservation 118:549-558.

Murakawa, S. K. K., G. H. Balazs, D. M. Ellis, S. Hau, and S. M. Eames. 2000. Trends in fibropapillomatosis among green turtles stranded in the Hawaiian Islands, 1982-98. K. H. J., and T. Wibbels, editors. Nineteenth Annual Symposium on Sea Turtle Biology and Conservation.

Murphy, T. M., and S. R. Hopkins. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region. Final Report to NOAA/NMFS/SEFC, U.S. Department of Commerce, 73p.

Musick, J. A., and C. J. Limpus. 1997. Habitat utilization, and migration in juvenile sea turtles. Pages 137-163 *in* P. L. Lutz, and J. A. Musick, editors. The biology of sea turtles. CRC Press, Boca Raton, Florida.

Mysing, J. O., and T. M. Vanselous. 1989. Status of satellite tracking of Kemp's ridley sea turtles. Pages 122-115 *in* C. W. Caillouet Jr., and A. M. Landry Jr., editors. First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation, and Management. . Texas A&M University

Nichols, W. J. 2005. Following redwood logs, rubber ducks, and drift bottles: Transoceanic developmental migrations of loggerhead turtles in the North Pacific Ocean. Pages 66 *in* M. S. Coyne, and R. D. Clark, editors. Proceedings of the Twenty-First Annual Symposium on Sea Turtle Biology and Conservation.

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

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

NMFS. 1988. Biological Opinion on the removal of oil and gas platforms and related structures in the Gulf of Mexico.

NMFS. 2001a. Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the western North Atlantic.

NMFS. 2001b. Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-455.

NMFS. 2002. Endangered Species Act - Section 7 consultation, biological opinion. Shrimp trawling in the southeastern United States under the sea turtle conservation regulations and as managed by the fishery management plans for shrimp in the South Atlantic and Gulf of Mexico. National Marine Fisheries Service, Southeast Regional Office, St. Petersburg, Florida.

NMFS. 2004a. Biological Opinion on the Proposed Marine Seismic Survey in the Southeast Caribbean Sea and adjacent Atlantic Ocean, and the Proposed Issuance of an MMPA authorization to Lamont-Doherty Earth Observatory [F/FPR/2003/01492]. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland. 69p.

NMFS. 2004b. Endangered Species Act section 7 consultation on the proposed regulatory amendments to the FMP for the pelagic fisheries of the western Pacific region. Biological Opinion, February 23, 2004.

NMFS. 2005. Biological Opinion on the Issuance of ESA Section 10(a)(1)(A) Permit No. 1451 to the National Marine Fisheries Service - Office of Sustainable Fisheries for Research on Sea Turtles.National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland. 48p.

NMFS. 2006. Biological Opinion on Permitting Structure Removal Operations on the Gulf of Mexico Outer Continental Shelf and the Authorization for Take of Marine Mammals Incidental to Structure Removals on the Gulf of Mexico Outer Continental Shelf. National Marine Fisheries Service, Silver Spring, Maryland. 131p.

NMFS. 2006e. Biological Opinion on Permitting Structure Removal Operations on the Gulf of Mexico Outer Continental Shelf and the Authorization for Take of Marine Mammals Incidental to Structure Removals on the Gulf of Mexico Outer Continental Shelf. National Marine Fisheries Service, Silver Spring, Maryland. 131p.

NMFS. 2006f. National Marine Fisheries Service, Office of Protected Resources website: http://www.nmfs.noaa.gov/pr/.

NMFS. 2006g. Biological Opinion on the 2006 Rim-of-the-Pacific Joint Training Exercises (RIMPAC). National Marine Fisheries Service, Silver Spring, Maryland. 123p.

NMFS. 2008. Sea turtle research techniques manual National Marine Fisheries Service.

NMFS. 2010. Other significant oil spills in the Gulf of Mexico. N. M. F. Service, editor. National Marine Fisheries Service, Office of Response and Restoration, Emergency Response Division, Silver Sprirng, Maryland.

NMFS. 2011. Biological Opinion on the Issuance of a permit to André Landry, Texas A&M University at Galveston (Permit number 15606). National Marine Fisheries Service.

NMFS, and USFWS. 1991. Recovery Plan for U.S. Population of Atlantic Green Turtle

Chelonia mydas. National Marine Fisheries Service and U.S. Fish and Wildlife Service, Washington, D.C.

NMFS, and USFWS. 1993. Recovery Plan for the hawksbill turtle in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico, St. Petersburg, Florida.

NMFS, and USFWS. 1998a. Recovery plan for U.S. Pacific populations of the green turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, Maryland.

NMFS, and USFWS. 1998b. Recovery plan for U.S. Pacific populations of the olive ridley turtle (*Lepidochelys olivacea*). National Marine Fisheries Service, Silver Spring, Maryland.

NMFS, and USFWS. 2007a. Kemp's Ridley sea turtle (*Lepidochelys kempii*) 5-year review: Summary and evaluation. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources

U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, JSilver Spring, Maryland

acksonville, Florida.

NMFS, and USFWS. 2007b. Olive ridley sea turtle (*Lepidochelys olivacea*) 5-year review: Summary and evaluation. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources

U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Silver Spring, Maryland

Jacksonville, Florida.

NMFS and USFWS. 1991b. Recovery Plan for U.S. Population of Loggerhead Turtle (*Caretta caretta*). National Marine Fisheries Service, Washington, D.C.

NMFS and USFWS. 1998c. Recovery plan for U.S. Pacific populations of the loggerhead turtle (Caretta caretta). NMFS and USFWS, Silver Spring, Maryland

Portland, Oregon.

NMFS and USFWS. 1998d. Recovery Plan for U.S. Pacific Populations of the Loggerhead Turtle (*Caretta caretta*). National Marine Fisheries Service, Silver Spring, MD.

NMFS and USFWS. 2007c. Hawksbill sea turtle (*Eretmochelys imbricata*) 5-year review: Summary and evaluation U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources

U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Silver Spring, Maryland

Jacksonville, Florida.

NMFS and USFWS. 2007d. Leatherback Sea Turtle (*Dermochelys coriacea*) 5-Year Review: Summary and Evaluation. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland; and U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Jacksonville, Florida. 81p.

NMFS and USFWS. 2007e. Loggerhead Sea Turtle (*Caretta caretta*) 5-Year Review:

Summary and Evaluation. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland; and U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Jacksonville, Florida. 67p.

NMFS and USFWS. 2007f. Olive Ridley Sea Turtle (*Lepidochelys olivacea*) 5-Year Review: Summary and Evaluation. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland; and U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Jacksonville, Florida. 67p.

NMFS/SEFSC. 2001. Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the western North Atlantic.U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-455.

NMMA. 2007. 2006 Recreational boating statistical abstract. National Marine Manufacturers Association, Chicago, Illinois.

NOAA. 2003. Oil and sea turtles: Biology, planning, and response. National Oceanic and Atmospheric Administration, National Ocean Service, Office of Response and Restoration.

NOAA. 2010a. Deepwater Horizon.

NOAA. 2010b. NOAA's oil spill response: Sea turtle strandings and the Deepwater oil spill. N. O. a. A. Administration, editor.

NOAA. 2010c. NOAA web update July 26, 2010: Deepwater Horizon incident. National Oceanic and Atmospheric Administration.

Norrgard, J. 1995. Determination of stock composition and natal origin of a juvenile loggerhead turtle population (*Caretta caretta*) in Chesapeake Bay using mitochondrial DNA analysis. Master’s thesis. College of William and Mary, Williamsburg, Virginia.

NPS. 2006. Padre Island National Seashore, 2006 sea turtle nesting season. National Park Service.

NRC. 1990a. Decline of the Sea Turtles: Causes and Prevention.National Academy of Sciences, National Academy Press, Washington, D.C.

NRC. 1990b. Decline of the sea turtles: Causes and prevention. (National Research Council). National Academy Press, Washington, D.C.

NRC. 1990c. Decline of the sea turtles: Causes and prevention. National Research Council, Washington, D.C.

O'Hara, J., and J. R. Wilcox. 1990. Avoidance responses of loggerhead turtles, *Caretta caretta*, to low frequency sound. Copeia 1990(2):564-567.

O'Hara, K. J., S. Iudicello, and R. Bierce. 1988. A citizens guide to plastics in the ocean: More than a litter problem. Center for Marine Conservation, Washington, D.C.

Ogren, L. H. 1989. Distribution of juvenile and subadult Kemp's ridley sea turtles: Preliminary results from 1984-1987 surveys. Pages 116-123 *in* C. W. Caillouet Jr., and A. M. Landry Jr., editors. First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation, and Management.

Ogren, L. H., J. W. J. Watson, and D. A. Wickham. 1977. Loggerhead Sea Turtles, *Caretta caretta*, Encountering Shrimp Trawls. Marine Fisheries Review 39(11):15-17.

Okemwa, G. M., and A. Wamukota. 2006. An overview of the status of green turtles (Chelonia mydas) in Kenya. Pages 311 *in* M. Frick, A. Panagopoulou, A. F. Rees, and K. Williams, editors. Book of Abstracts. Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.

Okuyama, J., and coauthors. 2009. Ontogeny of the dispersal migration of green turtle (Chelonia mydas) hatchlings. Journal of Experimental Marine Biology and Ecology.

Omsjoe, E. H., and coauthors. 2009. Evaluating capture stress and its effects on reproductive success in Svalbard reindeer. Canadian Journal of Zoology-Revue Canadienne De Zoologie 87(1):73-85.

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

Orvik, L. M. 1997. Trace metal concentration in blood of the Kemp's ridley sea turtle (*Lepidochelys kempii*). Master’s thesis. Texas A & M University, College Station, Texas.

Pandav, B., and B. C. Choudhury. 1999. An update on the mortality of the olive ridley sea turtles in Orissa, India. Marine Turtle Newsletter 83:10-12.

Parker, D. M., and G. H. Balazs. in press. Diet of the oceanic green turtle, Chelonia mydas, in the North Pacific. Twenty-fifth Annual Symposium on Sea Turtle Biology and Conservation.

Parker, D. M., W. J. Cooke, and G. H. Balazs. 2005. Diet of oceanic loggerhead sea turtles (*Caretta caretta*) in the central North Pacific. Fishery Bulletin 103:142-152.

Parker, D. M., P. H. Dutton, K. Kopitsky, and R. L. Pitman. 2003. Movement and dive behavior determined by satellite telemetry for male and female olive ridley turtles in the Eastern Tropical Pacific. Pages 48-49 *in* J. A. Seminoff, editor Proceedings of the Twenty-second Annual Symposium on Sea Turtle Biology and Conservation. . NOAA.

Parker, R. O., Jr., D. R. Colby, and T. D. Willis. 1983. Estimated amount of reef habitat on a portion of the U.S. South Atlantic and Gulf of Mexico continental shelf. Bulletin of Marine Science 33(4):935-940.

Peckham, S. H., and coauthors. 2008. High mortality of loggerhead turtles due to bycatch, human consumption and strandings at Baja California Sur, Mexico, 2003 to 2007. Endangered Species Research 5:171-183.

Pelletier, D., D. Roos, and S. Ciccione. 2003. Oceanic survival and movements of wild and captive-reared immature green turtles (Chelonia mydas) in the Indian Ocean. Aquatic Living Resources 16:35-41.

Perugini, M., and coauthors. 2006. Polychlorinated biphenyls and organochlorine pesticide levels in tissues of Caretta caretta from the Adriatic Sea. Diseases of Aquatic Organisms 71(2):155-161.

Petersen, S. L., M. B. Honig, P. G. Ryan, R. Nel, and L. G. Underhill. 2009. Turtle bycatch in the pelagic longline fishery off southern Africa. African Journal of

Marine Science 31(1):87-96.

Pike, D. A. 2009. Do Green Turtles Modify Their Nesting Seasons in Response to Environmental Temperatures? Chelonian Conservation and Biology 8(1):43-47.

Pilcher, N. J. 2000. The green turtle, Chelonia mydas, in the Saudi Arabian Gulf. Chelonian Conservation and Biology 3(4):730-734.

Pitman, R. L. 1990. Pelagic distribution and biology of sea turtles in the eastern tropical Pacific. Pp.143-148 *In:* T.H. Richardson, J.I. Richardson, and M. Donnelly (compilers), Proceedings of the 10th Annual Symposium on Sea Turtle Biology and Conservation. Department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-278.

Pitman, R. L. 1991. Sea turtle associations with flotsam in the eastern tropical Pacific Ocean. Pages 94 *in* M. Salmon, and J. Wyneken, editors. Proceedings of the Eleventh Annual Workshop on Sea Turtle Biology and Conservation. .

Pitman, R. L. 1993. Seabird associations with marine turtles in the eastern Pacific Ocean. Colonial Waterbirds 16(2):194-201.

Pitman, R. L., and P. H. Dutton. 2004. Killer whale predation on a leatherback turtle in the Northeast Pacific. Northwest Science 58:497-498.

Plotkin, P. 2003. Adult migrations and habitat use. Pages 225-241 *in* P. L. Lutz, J. A. Musick, and J. Wyneken, editors. Biology of sea turtles, volume II. CRC Press, Boca Raton, Florida.

Plotkin, P., R. Byles, and D. Owens. 1993. Migratory and reproductive behaviour of Lepidochelys in the eastern Pacific Ocean. B. A. Schroeder, and B. E. Witherington, editors. 13th Annual Sea Turtle Symposium on Sea Turtle Biology and Conservation. NOAA.

Plotkin, P. T. 1994. Migratory and reproductive behavior of the olive ridley turtle, Lepidochelys olivacea (Eschscholtz, 1829), in the eastern Pacific Ocean. Texas A&M University, College Station, Texas.

Plotkin, P. T., (Ed). 1995. National Marine Fisheries Service and the U.S. Fish and Wildlife Service Status Reviews for Sea Turtles Listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland.

Plotkin, P. T., R. A. Byles, and D. W. Owens. 1994a. Migratory and reproductive behavior of *Lepidochelys olivacea* in the eastern Pacific Ocean. Pages 138 *in* Proceedings of the 13th Annual Symposium on Sea Turtle Biology and Conservation, Jekyll Island, Georgia.

Plotkin, P. T., R. A. Byles, and D. W. Owens. 1994b. Post-breeding movements of male olive ridley sea turtles *Lepidochelys olivacea* from a nearshore breeding area. Department of Commerce.

Plotkin, P. T., R. A. Byles, D. C. Rostal, and D. W. Owens. 1991. Arribadas: Social events or simply aggregations? Preliminary results from satellite telemetry. Pages 95 *in* Proceedings of the Eleventh Annual Workshop on Sea Turtle Biology and Conservation. .

Plotkin, P. T., R. A. Byles, D. C. Rostal, and D. W. Owens. 1995. Independent versus socially facilitated oceanic migrations of the olive ridley, Lepidochelys olivacea. Marine Biology 122:137-143.

Plotkin, P. T., D. W. Owens, R. A. Byles, and R. Patterson. 1996. Departure of male olive ridley turtles (Lepidochelys olivacea) from a nearshore breeding ground.

Herpetologica 52(1):1-7.

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

Podreka, S., A. Georges, B. Maher, and C. J. Limpus. 1998. The environmental contaminant DDE fails to influence the outcome of sexual differentiation in the marine turtle Chelonia mydas. Environmental Health Perspectives 106(4):185-188.

Poloczanska, E. S., C. J. Limpus, and G. C. Hays. 2009. Vulnerability of marine turtles in climate change. Pages 151-211 *in* Advances in Marine Biology, volume 56. Academic Press, New York.

Polovina, J., and coauthors. 2006. The Kuroshio Extension Bifurcation Region: a pelagic hotspot for juvenile loggerhead sea turtles. Deep-Sea Research II 53:362-339.

Polovina, J. J., and coauthors. 2004. Forage and migration habitat of loggerhead (Caretta caretta) and olive ridley (Lepidochelys olivacea) sea turtles in the central North Pacific Ocean. Fisheries Oceanography 13(1):36-51.

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

Polovina, J. J., D. R. Kobayashi, D. M. Parker, M. P. Seki, and G. H. Balazs. 2000. Turtles on the edge: Movement of loggerhead turtles (Caretta caretta) along oceanic fronts, spanning longline fishing grounds in the central North Pacific, 1997-1998. Fisheries Oceanography 9:71-82.

Prieto, A., and coauthors. 2001. Biological and ecological aspects of the hawksbill turtle population in Cuban waters. Report from the Republic of Cuba. First CITES wider Caribbean hawksbill turtle dialogue meeting, Mexico City.

Pritchard, P. C. H. 1969. Studies of the systematics and reproductive cycles of the genus Lepidochelys. University of Florida.

Pritchard, P. C. H. 1971. The leatherback or leathery turtle, Dermochelys coriacea. IUCN Monograph 1:1-39.

Pritchard, P. C. H. 1982. Nesting of the leatherback turtle, Dermochelys coriacea in Pacific Mexico, with a new estimate of the world population status. Copeia 1982 (4):741-747.

Pritchard, P. C. H. 1997. Evolution, phylogeny, and current status. Pages 1-28 *in* P. L. Lutz, and J. A. Musick, editors. The biology of sea turtles. CRC Press, Boca Raton, Florida.

Pugh, R. S., and P. R. Becker. 2001a. Sea turtle contaminants: A review with annotated bibliography. U.S. Department of Commerce, National Institute of Standards and Technology, Chemical Science and Technology Laboratory, Charleston, South Carolina.

Pugh, R. S., and P. R. Becker. 2001b. Sea turtle contaminants: A review with annotated bibliography. U.S. Department of Commerce, National Institute of Standards and Technology, Chemical Science and Technology Laboratory, Charleston, South Carolina.

Purvis, A., J. L. Gittleman, G. Cowlishaw, and G. M. Mace. 2000. Predicting extinction risk in declining species. Proceedings of the Royal Society B-Biological Sciences 267:1947-1952.

Rabalais, N. N., R. E. Turner, and D. Scavia. 2002. Beyond science into policy: Gulf of Mexico hypoxia and the Mississippi River. Bioscience 52(2):129-142.

Rabalais, S. C., and N. N. Rabalais. 1980. The Occurrence of Sea Turtles on the South Texas Coast. Contributions in Marine Science Vol. 23:123-129.

Rankin-Baransky, K. 1997. Origin of loggerhead turtles (*Caretta caretta*) in the western North Atlantic Ocean as determined by mtDNA analysis.Masters Thesis submitted to Drexel University, June 1997. 49p.

Read, A. J. 2007. Do circle hooks reduce the mortality of sea turtles in pelagic longlines? A review of recent experiments. Biological Conservation 135(2):155-169.

Rees, A. F., and D. Margaritoulis. 2004. Beach temperatures, incubation durations, and estimated hatchling sex ratio for loggerhead sea turtle nests in southern Kyparissia Bay, Greece. British Chelonia Group Testudo 6(1):23-36.

Rees, A. F., A. Saad, and M. Jony. 2005. Marine turtle nesting survey, Syria 2004: discovery of a "major" green turtle nesting area. Page 38 in Book of Abstracts of the Second Mediterranean Conference on Marine Turtles. Antalya, Turkey, 4-7 May 2005.

Reich, K. J., and coauthors. 2010. Polymodal foraging in adult female loggerheads (Caretta caretta). Marine Biology 157:113-121.

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

Reina, R. D., J. R. Spotila, F. V. Paladino, and A. E. Dunham. 2008. Changed reproductive schedule of eastern Pacific leatherback turtles Dermochelys coriacea following the 1997–98 El Niño to La Niña transition. Endangered Species Research.

Renaud, M. L. 1995a. Movements and submergence patterns of Kemp's ridley turtles (Lepidochelys kempii). Journal of Herpetology 29(3):370-374.

Renaud, M. L. 1995b. Movements and submergence patterns of Kemp's ridley turtles (*Lepidochelys kempii*). Journal of Herpetology 29(No. 3):370-374.

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

Renaud, M. L., J. A. Carpenter, J. A. Williams, and A.M. Landry, Jr. 1996. Kemp's ridley sea turtle (Lepidochelys kempii) tracked by satellite telemetry from Louisiana to nesting beach at Rancho Nuevo, Tamaulipas, Mexico. Chelonian Conservation and Biology 2(1):108-109.

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

Rester, J., and R. Condrey. 1996. The occurrence of the hawksbill turtle, Eretmochelys imbricata, along the Louisiana coast. Gulf of Mexico Science 1996(2):112-114.

Richardson, T. H., J. I. Richardson, C. Ruckdeshel, and M. W. Dix. 1978. Remigration patterns of loggerhead sea turtles (*Caretta caretta*) nesting on Little Cumberland and Cumberland Islands, Georgia. Florida Marine Research Publications 33:39-

44.

Ridgway, S. H., E. G. Wever, J. G. McCormick, J. Palin, and J. H. Anderson. 1969. Hearing in the giant sea turtle, *Chelonia mydas*. Proceedings of the National Academy of Sciences of the United States of America 64:884-890.

Rivalan, P., P. H. Dutton, E. Baudry, S. E. Roden, and M. Girondot. 2006. Demographic scenario inferred from genetic data in leatherback turtles nesting in French Guiana and Suriname. Biological Conservation 130(1):1-9.

Roark, A. M., K. A. Bjorndal, and A. B. Bolten. 2009. Compensatory responses to food restriction in juvenile green turtles (Chelonia mydas). Ecology 90(9):2524-2534.

Robinson, R. A., and coauthors. 2008. Travelling through a warming world: climate change and migratory species. Endangered Species Research.

Romero, L. M. 2004. Physiological stress in ecology: lessons from biomedical research. TRENDS in Ecology and Evolution 19(5):249-255.

Rosman, I., G. S. Boland, L. Martin, and C. Chandler. 1987. Underwater Sightings of Sea Turtles in the Northern Gulf of Mexico. OCS Study; MMS 87-0107:37.

Ross, J. P. 1979. Sea turtles in the Sultanate of Oman.

Ross, J. P. 1998. Estimations of the nesting population size of loggerhead sea turtles, Caretta caretta, Masirah Island, Sultanate of Oman. Pages 84-87 *in* S. P. Epperly, and J. Braun, editors. Proceedings of the Seventeenth Annual Sea Turtle Symposium. .

Ross, J. P., and M. A. Barwani. 1982. Review of sea turtles in the Arabian area. Pages 373-383 *in* K. A. Bjorndal, editor. Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C.

Rostal, D. C. 2007. Reproductive physiology of the ridley sea turtle. Pages 151-165 in: Plotkin P.T., editor. Biology and conservation of ridley sea turtles. Johns Hopkins University Press, Baltimore, Maryland.

Rostal, D. C., J. S. Grumbles, R. A. Byles, M. R. Márquez, and D. W. Owens. 1997. Nesting physiology of wild Kemp’s ridley turtles, Lepidochelys kempii, at Rancho Nuevo, Tamaulipas, Mexico. Chelonian Conservation and Biology 2:538-547.

Ruiz, G. A. 1994. Sea turtle nesting population at Playa La Flor, Nicaragua: An olive ridley "arribada" beach. Pages 129-130 *in* K. A. Bjorndal, A. B. Bolten, D. A. Johnson, and P. J. Eliazar, editors. Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. .

Rybitski, M. J., R. C. Hale, and J. A. Musick. 1995. Distribution of organochlorine pollutants in Atlantic sea turtles. Copeia 1995 (2):379-390.

Saad, M. A. 1999. Title Hadramaut coast importance in conservation of endangered green turtle. Marine Sciences Resources Research Center, Aden. Unpublished report. 8.

Saba, V. S., J. R. Spotila, F. P. Chavez, and J. A. Musick. 2007. Bottom-up and climatic forcing on the global population of leatherback turtles. Pages 162-163 in: Frick, M., A. Panagopoulou, A.F. Rees, and K. Williams, editors. Twenty-seventh Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Myrtle Beach, South Carolina.

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

Sahoo, G., R. K. Sahoo, and P. Mohanty-Hejmadi. 1996. Distribution of heavy metals in the eggs and hatchlings of olive ridley sea turtle, Lepidochelys olivacea, from Gahirmatha, Orissa. Indian Journal of Marine Sciences 25(4):371-372.

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

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

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

Sale, A., and coauthors. 2006. Long-term monitoring of leatherback turtle diving behaviour during oceanic movements. Journal of Experimental Marine Biology and Ecology 328:197-210.

Salm, R. V. 1991. Turtles in Oman: Status, threats, and management options.

Salm, R. V., R. A. C. Jensen, and V. A. Papastavrou. 1993. Marine fauna of Oman: Cetaceans, turtles, seabirds, and shallow water corals. IUCN, Gland, Switzerland.

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

Santidrián Tomillo, P., and coauthors. 2007. Reassessment of the leatherback turtle (*Dermochelys coriacea*) nesting population at Parque Nacional Marino Las Baulas, Costa Rica: Effects of conservation efforts. Chelonian Conservation and Biology 6(1):54-62.

Sapolsky, R. M., L. M. Romero, and A. U. Munck. 2000. How do glucocorticoids influence stress responses? Integrating permissive, suppressive, stimulatory, and preparative actions. Endocrine Reviews 21(1):55-89.

Sarti, L. M., S. A. Eckert, N. T. Garcia, and A. R. Barragan. 1996. Decline of the world’s largest nesting assemblage of leatherback turtles. Marine Turtle Newsletter 74:2-5.

Sasso, C. R., and S. P. Epperly. 2006. Seasonal sea turtle mortality risk from forced submergence in bottom trawls. Fisheries Research 81(1):86-88.

Sato, K., and coauthors. 1998. Internesting intervals for loggerhead turtles, Caretta caretta, and green turtles, Chelonia mydas, are affected by temperature. Canadian Journal of Zoology 76:1651-1662.

Schmid, J. R. 1998. Marine turtle populations on the west central coast of Florida: Results of tagging studies at the Cedar Keys, Florida, 1986-1995. Fishery Bulletin 96:589-602.

Schmid, J. R., A. B. Bolten, K. A. Bjorndal, and W. J. Lindberg. 2002. Activity patterns of Kemp's ridley turtles, Lepidochelys kempii, in the coastal waters of the Cedar Keys, Florida. Marine Biology 140(2):215-228.

Schmid, J. R., and W. N. Witzell. 1997. Age and growth of wild Kemp's ridley turtles (Lepidochelys kempii): Cumulative results of tagging studies in Florida. Chelonian Conservation and Biology 2(4):532-537.

Schmidt, J. 1916. Marking experiments with turtles in the Danish West Indies. Meddelelser Fra Kommissionen For Havundersogelser. Serie: Fiskeri. Bind V. Nr. 1. Kobenhavn.

Schofield, G., and coauthors. 2009. Microhabitat selection by sea turtles in a dynamic thermal marine environment. Journal of Animal Ecology 78(1):14-21.

Schroeder, B. A., and N. B. Thompson. 1987. Distribution of the loggerhead turtle, Caretta caretta, and the leatherback turtle, Dermochelys coriacea, in the Cape Canaveral, Florida area: Results of aerial surveys. Pages 45-53 *in* W. N. Witzell, editor Proceedings of the Cape Canaveral, Florida Sea Turtle Workshop.

Schroth, W., B. Streit, and B. Schierwater. 1996. Evolutionary handicap for turtles. Nature 384:521-522.

Schulz, J. P. 1984. Turtle conservation strategy in Indonesia. IUCN/WWF Report.

Schulz, J. P. 1987. Status of and trade in Chelonia mydas and Eretmochelys imbricata in Indonesia. Consultancy report prepared for IUCN Conservation Monitoring Centre.

Sea Turtle Association of Japan. 2010. Sea turtles of Japan.

Sears, C. J. 1994. Preliminary genetic analysis of the population structure of Georgia loggerhead sea turtles. NOAA Technical Memorandum NMFS-SEFSC-351. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, Florida.

Sears, C. J., and coauthors. 1995. Demographic composition of the feeding population of juvenile loggerhead sea turtles (Caretta caretta) off Charleston, South Carolina: evidence from mitochondrial DNA markers. Marine Biology 123:869-874.

Seminoff, J. A. 2004. 2004 global status assessment: Green turtle (Chelonia mydas). IUCN Marine Turtle Specialist Group Review.

Seminoff, J. A., and T. T. Jones. 2006. Diel movements and activity ranges of green turtles (*Chelonia mydas*) at a temperate foraging area in the Gulf of California, Mexico. Herpetological Conservation and Biology 1(2):81-86.

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

Seminoff, J. A., A. Resendiz, and W. J. Nichols. 2002a. Diet of East Pacific green turtles (Chelonia mydas) in the central Gulf of California, Mexico. Journal of Herpetology 36(3):447-453.

Seminoff, J. A., A. Resendiz, W. J. Nichols, and T. T. Jones. 2002b. Growth rates of wild green turtles (Chelonia mydas) at a temperate foraging area in the Gulf of California, México. Copeia 2002(3):610-617.

Senko, J., and coauthors. 2010a. Fine scale daily movements and habitat use of East Pacific green turtles at a shallow coastal lagoon in Baja California Sur, Mexico. Journal of Experimental Marine Biology and Ecology in press(in press):in press.

Senko, J., M. C. Lopez-Castro, V. Koch, and W. J. Nichols. 2010b. Immature East Pacific green turtles (Chelonia mydas) use multiple foraging areas off the Pacific Coast of Baja California Sur, Mexico: First evidence from mark-recapture data. Pacific Science 64(1):125-130.

Shanker, K., and B. Mohanty. 1999. Operation Kachhapa: In search of a solution for the olive ridley of Orissa. Marine Turtle Newsletter 86:1-3.

Shanker, K., B. Pandav, and B. C. Choudhury. 2003. An assessment of the olive ridley turtle (Lepidochelys olivacea) nesting population in Orissa, India. Biological Conservation 115(1):149-160.

Shaver, D. J. 1999. Kemp's ridley sea turtle project at Padre Island National Seashore, Texas. Pages 342-347 in: McKay, M., and J. Nides, editors. Proceedings of the Seventeenth Annual Gulf of Mexico Information Transfer Meeting, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, MMS 99-0042.

Shaver, D. J. 2002. Kemp's ridley sea turtle project at Padre Island National Seashore and Texas sea turtle nesting, and stranding 2001 report. U.S. Department of the Interior, U.S. Geological Survey, Corpus Christi, Texas.

Shaver, D. J., A. F. Amos, B. Higgins, and J. Mays. 2005. Record 42 Kemp's ridley nests found in Texas in 2004. Marine Turtle Newsletter 108:1-3.

Shaver, D. J., and T. Wibbels. 2007a. Head-starting the Kemp's ridley sea turtle. Pages 297-323 *in* P. T. Plotkin, editor. Biology and Conservation of Ridley Sea Turtles. The Johns Hopkins University Press, Baltimore, MD.

Shaver, D. J., and T. Wibbels. 2007b. Head-starting the Kemp's ridley sea turtle. Pages 297-323 in: Plotkin P.T., editor. Biology and conservation of ridley sea turtles. Johns Hopkins University Press, Baltimore, Maryland.

Shillinger, G. L., and coauthors. 2010. Four years and fourty-six turtles: tracking the movements and behaviors of leatherback sea turtles in the eastern Pacific. Pages 53 *in* K. Dean, and M. C. L. Castro, editors. 28th Annual Symposium on Sea Turtle Biology and Conservation. National Marine Fisheries Service.

Shoop, C. R., and R. D. Kenney. 1992a. Seasonal distributions and abundances of loggerhead and leatherback sea turtles in waters of the northeastern United States. Herpetological Monographs 6:43-67.

Shoop, C. R., and R. D. Kenney. 1992b. Seasonal distributions and abundances of loggerhead and leatherback seaturtles in waters of the northeastern United States. Herpetological Monographs 6:43-67.

Simmonds, M. P., and W. J. Eliott. 2009. Climate change and cetaceans: Concerns and recent developments. Journal of the Marine Biological Association of the United Kingdom 89(1):203-210.

Smultea, M., and M. Holst. 2003. Marine mammal monitoring during Lamont-Doherty Earth Observatory's seismic study in the Hess Deep area of the eastern equatorial tropical Pacific, July 2003. Prepared for Lamont-Doherty Earth Observatory, Palisades, New York, and the National Marine Fisheries Service, Silver Spring, Maryland, by LGL Ltd., environmental research associates. LGL Report TA2822-16.

Snoddy, J. E., M. Landon, G. Blanvillain, and A. Southwood. 2009. Blood Biochemistry of Sea Turtles Captured in Gillnets in the Lower Cape Fear River, North Carolina, USA. Journal of Wildlife Management 73(8):1394-1401.

Snover, M. L., A. A. Hohn, L. B. Crowder, and S. S. Heppell. 2007. Age and growth in Kemp's ridley sea turtles: Evidence from mark-recapture and skeletochronology. Pages 89-106 in: Plotkin P.T., editor. Biology and conservation of ridley sea turtles. Johns Hopkins University Press, Baltimore, Maryland.

Solow, A. R., K. A. Bjorndal, and A. B. Bolten. 2002. Annual variation in nesting numbers of marine turtles: The effect of sea surface temperature on re-migration intervals. Ecology Letters 5:742-746.

Southwood, A. L., and coauthors. 1999. Heart rates and dive behavior of leatherback sea turtles in the eastern Pacific Ocean. Journal of Experimental Biology 202:1115-1125.

Spotila, J. R. 2004a. Sea turtles: A complete guide to their biology, behavior, and conservation. John Hopkins University Press, Baltimore. 227p.

Spotila, J. R. 2004b. Sea turtles: A complete guide to their biology, behavior, and conservation. The Johns Hopkins University Press and Oakwood Arts, Baltimore, Maryland.

Spotila, J. R., and coauthors. 1996. Worldwide population decline of *Dermochelys coriacea*: Are leatherback turtles going extinct? Chelonian Conservation and Biology 2(2):209-222.

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

SPREP. 2007. Pacific Islands regional marine species programme 2008–2012. Pacific ISlands Regional Marine Species Programme, Apia, Samoa.

Spring, C. S. 1982. Status of marine turtle populations in Papua New Guinea. Pages 281-289 *in* K. A. Bjorndal, editor. Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D. C.

Stabenau, E. K., T. A. Heming, and J. F. Mitchell. 1991. Respiratory, acid-base and ionic status of Kemp's ridley sea turtles (*Lepidochelys kempi*) subjected to trawling. Comparative Biochemistry and Physiology - Part A: Molecular & Integrative Physiology 99A(1/2):107-111.

Stabenau, E. K., and K. R. N. Vietti. 2003. The physiological effects of multiple forced submergences in loggerhead sea turtles (Caretta caretta). Fishery Bulletin 101(4):889-899.

STAJ. 2002. Population trends and mortality of Japanese loggerhead turtles, Caretta caretta in Japan. Western Pacific Sea Turtle Cooperative Research and Management Workshop, Honolulu, Hawaii.

Stamper, M. A., C. W. Spicer, D. L. Neiffer, K. S. Mathews, and G. J. Fleming. 2009. MORBIDITY IN A JUVENILE GREEN SEA TURTLE (CHELONIA MYDAS) DUE TO OCEAN-BORNE PLASTIC. Journal of Zoo and Wildlife Medicine 40(1):196-198.

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

Stanley, D. R., and C. A. Wilson. 2003. Utilization of offshore platforms by recreational fishermen and scuba divers off the Louisiana coast. Bulletin of Marine Science 44(2):767-775.

Starbird, C. H., A. Baldridge, and J. T. Harvey. 1993. Seasonal occurrence of leatherback sea turtles (Dermochelys coriacea) in the Monterey Bay region, with notes on other sea turtles, 1986-1991. California Fish and Game 79(2):54-62.

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

Stearns, S. C. 1992. The evolution of life histories.Oxford University Press, 249p.

Sternberg, J. 1981. The worldwide distribution of sea turtle nesting beaches. Sea Turtle Rescue Fund, Center for Environmental Education, Washignton, D. C.

Stinson, M. L. 1984a. Biology of sea turtles in San Diego Bay, California, and in northeastern Pacific Ocean. San Diego State University, San Diego, California.

Stinson, M. L. 1984b. Biology of sea turtles in San Diego Bay, California, and in northeastern Pacific Ocean. Master's thesis. San Diego State University, San Diego, California.

Stokes, L. W., and S. P. Epperly. 2006. Lepidochelys olivacea (olive ridley sea turtle). Western North Atlantic Ocean. Herpetological Review 37(1):105.

Storelli, M., M. G. Barone, and G. O. Marcotrigiano. 2007a. Polychlorinated biphenyls and other chlorinated organic contaminants in the tissues of Mediterranean loggerhead turtle Caretta caretta. Science of the Total Environment 273(2-3):456-463.

Storelli, M., M. G. Barone, and G. O. Marcotrigiano. 2007b. Polychlorinated biphenyls and other chlorinated organic contaminants in the tissues of Mediterranean loggerhead turtle Caretta caretta. Science of the Total Environment 273 (2-3:456-463.

Storelli, M., M. G. Barone, A. Storelli, and G. O. Marcotrigiano. 2008. Total and subcellular distribution of trace elements (Cd, Cu and Zn) in the liver and kidney of green turtles (Chelonia mydas) from the Mediterranean Sea. Chemosphere 70(5):908-913.

Sunderraj, S. F., W. J. Joshua, and V. V. Kumar. 2006. Sea turtles and their nesting habitats in Gujarat. Pages 156-169 in Shanker, K. and B.C. Choudhury (editors). Marine Turtles of the Indian Subcontinent. Universities Press, India.

Sutherland, W. J., and N. J. Crockford. 1993. Factors affecting the feeding distribution of red breasted geese, Branta ruficollis, wintering in Romania. Biological Conservation 63:61-65.

Swimmer, Y., and coauthors. 2006. Diving behavior and delayed mortality of olive ridley sea turtles *Lepidochelys olivacea* after their release from longline fishing gear. Marine Ecology Progress Series 323:253-261.

Talavera-Saenz, A., S. C. Gardner, R. R. Rodriquez, and B. A. Vargas. 2007. Metal profiles used as environmental markers of green turtle (Chelonia mydas) foraging resources. Science of the Total Environment 373(1):94-102.

Tanaka, E. 2009. Estimation of temporal changes in the growth of green turtles Chelonia mydas in waters around the Ogasawara Islands. Fisheries Science 75(3):629-639.

Taquet, C., and coauthors. 2006. Foraging of the green sea turtle Chelonia mydas on seagrass beds at Mayotte Island (Indian Ocean), determined by acoustic transmitters. Marine Ecology Progress Series 306:295-302.

TEWG. 1998a. An assessment of the Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the western North Atlantic. A report of the Turtle Expert Working Group (TEWG); NOAA Technical Memorandum NMFS-SEFSC-409. 96p.

TEWG. 1998b. An assessment of the Kemp's ridley (Lepidochelys kempii) and loggerhead (Caretta caretta) sea turtle populations in the Western North Atlantic. Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and

Conservation. Turtle Expert Working Group.

TEWG. 2000. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-444.

TEWG. 2007. An assessment of the leatherback turtle population in the Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-555. 116p.

TGLO. 2006. News release: Patterson signs lease for biggest offshore wind farm in U.S. history. Texas General Land Office.

TGLO. 2010. Adopt a beach newletter. Texas General Land Office.

Thorbjarnarson, J. B., S. G. Platt, and S. T. Khaing. 2000. Sea turtles in Myanmar: Past, and present. Marine Turtle Newsletter 88:10-11.

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

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

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

Tomas, J., J. Castroviejo, and J. A. Raga. 1999. Sea turtles in the south of Bioko Island (Equatorial Guinea). Marine Turtle Newsletter 84:4-6.

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

Tomas, J., and J. A. Raga. 2008. Occurrence of Kemp's ridley sea turtle (Lepidochelys kempii) in the Mediterranean. Marine Biodiversity Records 1(01).

Tourinho, P. S., J. A. I. d. Sul, and G. Fillmann. 2009. Is marine debris ingestion still a problem for the coastal marine biota of southern Brazil? Marine Pollution Bulletin in press(in press):in press.

Trinidad, H., and J. Wilson. 2000. The bio-economics of sea turtle conservation and use in Mexico: History of exploitation and conservation policies for the olive ridley (Lepidochelys olivacea). Proceedings of the International Institute of Fisheries Economics, and Trade Conference. , Corvallis, Oregon.

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

Troëng, S., and E. Rankin. 2005. Long term conservation efforts contribute to positive green turtle Chelonia mydas nesting trend at Tortuguero, Costa Rica. Biological Conservation 121:111–116.

Tuato'o-Bartley, N., T. E. Morrell, and P. Craig. 1993. Status of sea turtles in American Samoa in 1991. Pacific Science 47(3):215-221.

Tucker, A. D. 2009. Nest site fidelity and clutch frequency of loggerhead turtles are better elucidated by satellite telemetry than by nocturnal tagging efforts: Implications for stock estimation. Journal of Experimental Marine Biology and Ecology in press(in press):in press.

Turkozan, O., and C. Yilmaz. 2008. Loggerhead turtles, Caretta caretta, at Dalyan Beach, Turkey: Nesting activity (2004–2005) and 19-year abundance trend (1987–2005). Chelonian Conservation and Biology 7(2):178-187.

Uchida, I., and M. Nishiwaki. 1995. Sea turtles in the waters adjacent to Japan. Pages 317-319 *in* K. A. Bjorndal, editor. Biology and Conservation of Sea Turtles, volume Revised Edition. Smithsonian Institution Press, Washington, D.C.

USACOE. 2010. Sea turtle data warehouse. U.S. Army Corps of Engineers.

USAF. 1996. Sea turtles in the Gulf. Air Force Material Command, Eglin Air Force Base.

USBLS. 2010a. Employment and output by industry, 1998, 2008 and projected 2018. U. S. B. o. L. Statistics, editor.

USBLS. 2010b. Industries with the fastest growing and most rapidly declining output, 2008 and projected 2018. U. S. B. o. L. Statistics, editor.

USCB. 2005a. Interim state population projections, 2005. Table 7: Interim projections: Change in total population for regions, divisions, and states: 2000 to 2030. U.S. Census Bureau, Population Division.

USCB. 2005b. U.S. Census Bureau, Population Division, Interim State Population Projections, 2005. Table 6: Interim Projections: Total Population for Regions, Divisions, and States: 2000 to 2030. United States Census Bureau.

USCB. 2005c. U.S. Census Bureau, Population Division, Interim State Population Projections, 2005. Table 7: Interim Projections: Change in Total Population for Regions, Divisions, and States: 2000 to 2030. United States Census Bureau.

USCB. 2008a. Cumulative estimates of population change for metropolitan statistical areas and rankings: April 1, 2000 to July 1, 2007 (CBSA-EST2007-07). U. S. C. Bureau, editor.

USCB. 2008b. Estimates of population change for metropolitan statistical areas and rankings: July 1, 2006 to July 1, 2007 (CBSA-EST2007-05). U. S. C. Bureau, editor.

USCG. 2003. 2002 national recreational boating survey state data report. United States Coast Guard, Columbus, Ohio.

USCG. 2005. Boating statistics—2005. United States Coast Guard, Washigton D.C.

USCOP. 2004. An ocean blueprint for the 21st century. Final report. U.S. Commission on Ocean Policy, Washington, D. C.

USFWS. 1999. South Florida multi-species recovery plan. United States Fish and Wildlife Service, Atlanta, Georgia.

USFWS. 2000. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas, and Veracruz, Mexico. United States Fish and Wildlife Service.

USFWS. 2001. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas, and Veracruz, Mexico. United States Fish and Wildlife Service.

USFWS. 2002. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas, and Veracruz, Mexico. United States Fish and Wildlife Service.

USFWS. 2003. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas, and Veracruz, Mexico. United States Fish and Wildlife Service.

USFWS. 2004. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas, and Veracruz, Mexico. United States Fish and Wildlife Service.

USFWS. 2005. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas, and Veracruz, Mexico. United States Fish and Wildlife Service.

USFWS. 2006. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas, and Veracruz, Mexico. United States Fish and Wildlife Service.

USFWS, and NMFS. 1992. Recovery plan for the Kemp's ridley sea turtle (Lepidochelys kempii). National Marine Fisheries Service, St. Petersburg, Florida.

USFWS, N. a. 1995. Status reviews for sea turtles listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland.

USFWS, N. a. 1998. Recovery Plan for U.S. Pacific Populations of the Loggerhead Turtle (*Caretta caretta*). National Marine Fisheries Service, Silver Spring, Maryland.

USGS. 2010. Hypoxia in the Gulf of Mexico.

USN. 2008. Biological evaluation for the Gulf of Mexico rangle complex. U.S. Navy.

USN. 2009. Gulf of Mexico range complex final environmental impact statement/overseas environmental impact statement (EIS/OEIS) volume 1 (version 3). United States Navy, Norfolk, Virginia.

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

van de Merwe, J. P. V., and coauthors. 2009. Chemical Contamination of Green Turtle (Chelonia mydas) Eggs in Peninsular Malaysia: Implications for Conservation and Public Health. Environmental Health Perspectives 117(9):1397-1401.

Vander Zanden, H. B., K. A. Bjorndal, K. J. Reich, and A. B. Bolten. 2010. Individual specialists in a generalist population: results from a long-term stable isotope series. Biology Letters in press(in press):in press.

Varanasi, U., J. E. Stein, and M. Nishimoto. 1989. Biotransformation and disposition of polycyclic aromatic hydrocarbons (PAH) in fish. Pages 94-149 *in* U. Varanasi, editor. Metabolism of polycyclic aromatic hydrocarbons in the aquatic environment. CRC Press, Boca Raton, Florida.

Vargo, S., P. Lutz, D. Odell, E. V. Vleet, and G. Bossart. 1986a. Study of the effects of oil on marine turtles. Minerals Management Service, Vienna, Virginia.

Vargo, S., P. Lutz, D. Odell, E. V. Vleet, and G. Bossart. 1986b. Study of the effects of oil on marine turtles. Minerals Management Service, Vienna, Virginia.

Vargo, S., P. Lutz, D. Odell, E. V. Vleet, and G. Bossart. 1986c. Study of the effects of oil on marine turtles. Minerals Management Service, Vienna, Virginia.

Velez-Zuazo, X., and coauthors. 2008. Dispersal, recruitment and migratory behavior in a hawksbill sea turtle aggregation. Molecular Ecology 17:839-853.

Vera, V. 2007. Nesting of green turtles in Aves Island Wildlife Refuge. 2006 season. Pages 275 *in* M. Frick, A. Panagopoulou, A. F. Rees, and K. Williams, editors. Twenty-seventh Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Myrtle Beach, South Carolina.

Villegas-Amtmann, S., and D. P. Costa. 2010. Oxygen stores plasticity linked to foraging behaviour and pregnancy in a diving predator, the Galapagos sea lion. Functional

Ecology 24(4):785-795.

Walker, B. G., P. Dee Boersma, and J. C. Wingfield. 2005. Physiological and behavioral differences in magellanic Penguin chicks in undisturbed and tourist-visited locations of a colony. Conservation Biology 19(5):1571-1577.

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

Wallace, B. P., and coauthors. 2010. Global patterns of marine turtle bycatch. Convervation Letters in press(in press):in press.

Washington Post. 2006. Offshore wind farm is approved; Plant off Texas coast to be biggest of its kind in U.S. Washigton Post, Washington, D.C.

Waycott, M. B., J. Longstaff, and J. Mellors. 2005. Seagrass population dynamics and water quality in the Great Barrier Reef region: A review and future research directions. Marine Pollution Bulletin 51:343-350.

Weijerman, M. L., H. G. v. Tienen, A. D. Schouten, and W. E. J. Hoekert. 1998. Sea turtles of Galibi, Suriname. Pages 142-144 *in* R. Byles, and Y. Fernandez, editors. Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. .

Wibbels, T. 2003. Critical approaches to sex determination in sea turtle biology and conservation. Pages 103-134 *in* P. Lutz, J. Musik, and J. Wynekan, editors. Biology of sea turtles, volume 2. CRC Press.

Wibbels, T. 2007. Sex determination and sex ratio in ridley turtles. Pages 167-189 in: Plotkin P.T., editor. Biology and conservation of ridley sea turtles. Johns Hopkins University Press, Baltimore, Maryland.

Wibbels, T., K. Marion, D. Nelson, J. Dindo, and A. Geis. 2005. Evaluation of the bay systems of Alabama (US) as potential foraging habitat for juvenile sea turtles. Pages 275-276 in: Mosier, A., A. Foley, and B. Brost, editors. Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-477.

Wilkinson, C. 2000. Status of coral reefs of the world: 2000. Global Coral Reef Monitoring Network, Australian Institute of Marine Science.

Wilkinson, C., and D. Souter. 2008. Status of Caribbean coral reefs after bleaching and hurricanes in 2005. Global Coral Reef Monitoring Network, and Reef and Rainforest Research Centre, Townsville.

Williams, K. L., and coauthors. 1996. Population ecology, nesting, and sucess of leatherback turtles, *Dermochelys coriacea*, at Las Baulas de Guanacaste National Park, Costa Rica. P.340 *In:* J.A. Keinath, D.E. Barnard, J.A. Musick, and B.A. Bell (Compilers), Proceedings of the 15th Annual Symposium on Sea Turtle Biology and Conservation. Department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-351.

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

Witherington, B., S. Hirama, and A. Mosier. 2003. Effects of beach armoring structures on marine turtle nesting. Florida Fish and Wildlife Conservation Commission.

Witherington, B., S. Hirama, and A. Mosier. 2007. Change to armoring and other barriers to sea turtle nesting following severe hurricanes striking Florida beaches. Florida Fish and Wildlife Conservation Commission.

Witherington, B., P. Kubilis, B. Brost, and A. Meylan. 2009. Decreasing annual nest counts in a globally important loggerhead sea turtle population. Ecological Applications 19(1):30-54.

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

Witherington, B. E., and K. A. Bjorndal. 1991. Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles Caretta caretta. Biological Conservation 55:139-149.

Witherington, B. E., R. Herren, and M. Bresette. 2006. *Caretta caretta* – Loggerhead Sea Turtle. Chelonian Research Monographs 3:74-89.

Witherington, B. E., R. Herren, and M. Bresette. 2006b. *Caretta caretta* – Loggerhead Sea Turtle. Chelonian Research Monographs 3:74-89.

Witt, M. J., and coauthors. 2009. Aerial surveying of the world's largest leatherback turtle rookery: A more effective methodology for large-scale monitoring. Biological Conservation 142(8):1719-1727.

Witzell, W. N. 1981. Predation on Juvenile Green Sea Turtles, Chelonia mydas , By a Grouper, Promicrops lanceolatus (Pisces: Serranidae) in the Kingdom of Tonga, South Pacific. Bulletin of Marine Science. Vol. 31:no. 4.

Witzell, W. N. 1983. Synopsis of biological data on the hawksbill turtle *Eretmochelys imbricata* (Linnaeus, 1766). FAO.

Witzell, W. N., A. A. Geis, J. R. Schmid, and T. Wibbels. 2005a. Sex ratio of immature Kemp's ridley turtles (Lepidochelys kempii) from Gullivan Bay, Ten Thousand Islands, south-west Florida. Journal of the Marine Biological Association of the United Kingdom 85:205-208.

Witzell, W. N., A. A. Geis, J. R. Schmid, and T. Wibbels. 2005b. Sex ratio of immature Kemp's ridley turtles (*Lepidochelys kempii*) from Gullivan Bay, Ten Thousand Islands, south-west Florida. Journal of the Marine Biological Association of the U.K. 85:205-208.

Wolfe, S. H., J. A. Reidenauer, and D. B. Means. 1988. An ecological characterization of the Florida Panhandle. U.S. Fish and Wildlife Service and MMS, New Orleans, Louisiana.

Work, P. A., A. L. Sapp, D. W. Scott, and M. G. Dodd. 2010. Influence of small vessel operation and propulsion system on loggerhead sea turtle injuries. Journal of Experimental Marine Biology and Ecology.

Work, T. M., and coauthors. 2009. In vitro biology of fibropapilloma-associated turtle herpesvirus and host cells in Hawaiian green turtles (Chelonia mydas). Journal of General Virology 90:1943-1950.

Yañez, I. L., A. R. Gaos, and R. M. Aruaz. 2010. Eastern Pacific leatherback, green, and olive ridley sea turtle nesting at Playa Naranjo; first census in eight years K. Dean, and M. C. L. Castro, editors. 28th Annual Symposiumon Sea Turtle Biology and Conservation. National Marine Fisheries Service.

Yender, R., J. Michel, and C. Lord. 2002. Managing seafood safety after an oil spill. National Oceanic and Atmospheric Administration, National Ocean Service, Office of Response and Restoration, Seattle, Washington.

Zárate, P. M., S. S. Cahoon, M. C. D. Contato, P. H. Dutton, and J. A. Seminoff. 2006. Nesting beach monitoring of green turtles in the Galapagos Islands: a 4-year evaluation. Pages 337 *in* M. Frick, A. Panagopoulou, A. F. Rees, and K. Williams, editors. Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.

Zárate, P. M., M. A. Parra, M. Robles, P. H. Dutton, and J. A. Seminoff. 2010. Sea turtle strandings and mortality in the Galapagos Archipelago: causes and threats Pages 126 *in* K. Dean, and M. C. L. Castro, editors. 28th Annual Symposiumon Sea Turtle Biology and Conservation. National Marine Fisheries Service.

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

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

Zug, G. R., H. J. Kalb, and S. J. Luzar. 1997. Age and growth on wild Kemp's ridley sea turtles Lepidochelys kempii from skeletochronological data. Biological Conservation 80:261-268.