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

Biological Opinion

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

Activity Considered: Biological Opinion on the proposal to issue permit amendment 15566-01 to the South Carolina Department of Natural Resources to authorize research on green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles in the southeastern United States, pursuant to Section 10(a)(1)(A) of the Endangered Species Act of 1973

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

Approved by: [signature]

Date: MAY 0 3 2012

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA) (16 U.S.C. 1536(a)(2)) 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 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 action described in this document, the action agency is the NMFS' Office of Protected Resources – Permits and Conservation Division. The consulting agency is the NMFS' Office of Protected Resources – Endangered Species Act Interagency Cooperation Division.

This document represents the NMFS' biological opinion (Opinion) of the effects of the proposed research on the threatened loggerhead sea turtle and the endangered green[1], hawksbill, Kemp's ridley, and leatherback sea turtles, and Atlantic sturgeon, and these species' designated critical habitat, and has been prepared in accordance with Section 7 of the ESA. This Opinion is based on our review of the Permits and Conservation

[1] Green sea turtles in U.S. waters are listed as threatened except for Mexico's Pacific coast breeding population and the Florida breeding population, which are listed as endangered. Due to the inability to distinguish between these populations away from the nesting beach, green turtles are considered endangered wherever they occur in U.S. waters.

Division’s draft Environmental Assessment, draft permit 15566-01, the amendment application from the South Carolina Department of Natural Resources, the EA and biological opinion for the original permit 15566, annual reports of past research completed by the applicant, recovery plans for listed species, status and 5-year reviews, scientific and technical reports from government agencies, peer-reviewed literature, biological opinions on similar research, and other sources of information.

Consultation history

The NMFS’ Permits and Conservation Division (Permits Division) requested consultation with the NMFS’ Endangered Species Act Interagency Coordination Division (ESA IC Division) on the proposal to issue an amendment to a scientific research permit authorizing studies on green, hawksbill, Kemp’s ridley, leatherback, and loggerhead sea turtles. Issuance of the permit amendment constitutes a federal action, which may affect marine species listed under the ESA.

On February 16, 2011, the Permits Division requested initiation of Section 7 consultation to issue a new permit to South Carolina Department of Natural Resources. The consultation was completed April 7, 2011, and NMFS concluded that issuance of the permit was not likely to jeopardize listed species or destroy or modify critical habitat.

In 2011, the South Carolina Department of Natural Resources reported to the Permits Division that they had exceeded their permitted take for Kemp’s ridley sea turtles, and submitted an application to amend their permit.

On January 25, 2012 the Permits Division requested re-initiation of Section 7 consultation to issue an amendment to the existing permit, increasing the number of Kemp’s ridley sea turtles that could be captured by the permit holder. The ESA IC Division formally initiated consultation on the same day.

Description of the proposed action

NMFS’ Office of Protected Resources – Permits and Conservation Division proposes to amend a scientific research permit pursuant to Section 10(a)(1)(A) of the ESA. Issuance of permit amendment 15566-01 to the South Carolina Department of Natural Resources would increase the number of Kemp’s ridley sea turtles that could be captured by the permit holder in the Atlantic Ocean, off the coast of the southeastern United States.

Proposed permit amendment 15566-01

The Permits Division proposes to authorize the South Carolina Department of Natural Resources to capture and handle 79 Kemp’s ridley sea turtles, increased from the previously authorized 29. The suite of actions that would be included in handling are: photograph/video, weigh and measure, ultrasound, flipper and PIT tag, blood and fecal sample, collect tumors, remove epibiota, and transport. These actions are the same as were previously authorized in permit 15566, and no other changes would be authorized. For reference, a description of the actions already authorized under the Department of Natural Resources’ permit is provided below.

Current permit 15566

The South Carolina Department of Natural Resources' permit authorizes them to conduct research to document sea turtle movement, size distributions, sex ratios, genetic contributions, and the health of study green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles in the southeastern United States. The permit is valid for five years, and will expire on April 30, 2016. The currently authorized actions and "take" [2] levels for the threatened and endangered species can be found in Table 1. All turtles are captured by in-water trawling from May through September. Sampling is completed during six multi-day and overnight research cruises. Three cruises are conducted to the north and three cruises are conducted to the south of the homeport of each vessel. Sampling is conducted during daylight, commencing approximately an hour after sunrise and ceasing approximately an hour before sunset. Researchers attempt to conduct 300 sampling events along the South Carolina coast and 300 along the Georgia coast to St. Augustine, Florida each year.

Turtles are handled, blood sampled, measured, flipper and passive integrated transponder (PIT) tagged, photographed, and released. A subsample of animals are authorized for barnacle, keratin, tissue and fecal sampling, cloacal swabs, ultrasound, and attachment of satellite and/or VHF transmitters.

Capture

Sampling is conducted aboard 75-foot double-rigged shrimp trawlers towing at speeds of 2.5-3.0 kts. Vessels use standardized nets routinely used in turtle surveys associated with channel dredging operations: paired 60' (head-rope), 4-seam, 4-legged, 2-bridal; net body of 4" bar and 8" stretch mesh; top and sides of #36 twisted with the bottom of #84 braided nylon line; cod end consisting of 2" bar and 4" stretch mesh. Trawl perimeter around the mouth is 137 ft (60 ft head rope + 65 ft foot rope + 2 x 6 ft wing end height). Maximum tow times are 42 minutes (doors in the water to doors out of the water) with no more than 30-minute bottom trawl time (doors on the bottom to doors off the bottom). Nets are brought on-board using winches and turtles are removed from nets and immediately checked for health status and existing tags.

Flipper and PIT tagging

All sea turtles receive a PIT tag (125 kHz) and turtles greater than 5 kg would also receive two Inconel flipper tags. Triple tagging will minimize the probability of complete tag loss. PIT tags are sterile-packed; Inconel flipper tags are cleaned to remove oil and residue prior to application. Inconel tag insertion sites, located between the first and second scales on the trailing edge of the front flippers, are swabbed with Betadine prior to tag application. The PIT tag insertion point, located in the right front shoulder, is also swabbed with betadine prior to intramuscular injection.

---

[2] The ESA defines "take" as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." The term "harm" is further defined by regulations (50 CFR §222.102) as "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering."

Table 1. Current research on sea turtles under Permit No. 15566

Species and lifestage	Number of animals annually	Procedures
Loggerhead sea turtle – adult/ subadult/ juvenile	295	Photograph/video, weigh and measure, ultrasound, flipper and PIT tag, mark carapace (temporary), blood and fecal sample, collect tumors, remove epibiota, transport.
Loggerhead sea turtle – juvenile/ subadult	40	Photograph/video, weigh and measure, ultrasound, flipper and PIT tag, mark carapace (temporary), keratin biopsy (tissue sample and scute scraping), blood and fecal sample, cloacal swab, collect tumors, remove epibiota, instrument with epoxy attachment (e.g., satellite tag, VHF tag).
Loggerhead sea turtle – adult males only	10	Photograph/video, weigh and measure, ultrasound, flipper and PIT tag, mark carapace (temporary), keratin biopsy (tissue sample and scute scraping), blood and fecal sample, cloacal swab, collect tumors, remove epibiota, instrument with epoxy attachment (e.g., satellite tag, VHF tag), transport.
Kemp's ridley sea turtle - adult/ subadult/ juvenile	29	Photograph/video, weigh and measure, ultrasound, flipper and PIT tag, blood and fecal sample, collect tumors, remove epibiota, transport.
Green sea turtle - adult/ subadult/ juvenile	9	Photograph/video, weigh and measure, ultrasound, flipper and PIT tag, blood and fecal sample, collect tumors, remove epibiota, transport.
Leatherback sea turtle - adult/ subadult/ juvenile	1	Photograph/video, weigh and measure, ultrasound, flipper and PIT tag, blood and fecal sample, collect tumors, remove epibiota.
Hawksbill sea turtle - adult/ subadult/ juvenile	1	Photograph/video, weigh and measure, ultrasound, flipper and PIT tag, blood and fecal sample, collect tumors, remove epibiota.
Loggerhead sea turtle - adult/ subadult/ juvenile	5	Unintentional mortality; over the course of the 5 year permit
Green sea turtle - adult/ subadult/ juvenile	1	Unintentional mortality; over the course of the 5 year permit
Kemp's ridley sea turtle - adult/ subadult/ juvenile	1	Unintentional mortality; over the course of the 5 year permit
Hawksbill sea turtle - adult/ subadult/ juvenile	1	Unintentional mortality; over the course of the 5 year permit
Leatherback sea turtle - adult/ subadult/ juvenile	1	Unintentional mortality; over the course of the 5 year permit

Measuring

Turtles are measured, weighed, and photographed. A suite of morphometric measurements is collected for all sea turtle species. Six straight-line measurements are made using tree calipers. Curved measurements are recorded using a nylon tape measure. All measurements represent standard measurements accepted by sea turtle researchers globally (Bolten 1999). Placing turtles on top of foam-filled go-kart tires restricts movements (for ease and greater accuracy) while measurements were completed. Body weight is measured using spring scales; turtles are placed in a nylon mesh harness and carefully raised off of the deck using on-board winches.

Prior to release, the turtles are digitally photographed in a standard pose (dorsal surface exposed, taken looking from anterior to posterior) including a marker board with the turtle identification number. The identification number and trawl collection number are recorded. Additional photographs of unusual markings or injuries are taken.

Blood sampling

Blood samples are collected from all sea turtles over 5kg. Blood is collected in vacutainer tubes (with or without a heparin agent) using a vacutainer hub and a sterile 21-guage, 1.5" vacutainer needle from the dorsal cervical sinus as described by Owens and Ruiz (1980). Turtles are oriented head-down in a reclined position to facilitate blood flow to the cervical sinus. Prior to inserting the sterile vacutainer needle, the blood draw site is prepped with a Betadine-soaked cotton ball. A maximum of four blood sticks (two per side of the neck) are attempted per sea turtle. Blood samples consist of a maximum of 45 ml total volume and no more than 3ml per kg of body weight (<10% of total blood volume).

Removal of epibiota

Barnacles are removed from sea turtles as needed to ensure accurate measurements for morphometric studies. Carapace barnacles are removed by gently positioning the terminal end of a metal chisel under the barnacle foot and rotating/twisting the chisel handle to pry the barnacle loose. Skin and flipper barnacles are removed by simply pulling them off with gentle tactile traction. Five barnacles from each of the carapace, skin, and flippers are collected per turtle and stored in 95% ethanol for later identification to species and genetic sequencing of barnacle DNA.

Keratin biopsies, fecal sampling, cloacal swabs

Keratin biopsies are collected from the posterior margin of the third caudal scute (left or right side) in an area devoid of abnormalities or epibionts but cleaned with an alcohol swab. A sterile 6 mm biopsy punch is pushed and twisted/rotated through the carapace approximately 6 mm deep. Once the scute bottom has been reached, the biopsy punch is gently rocked side-to-side to sever the sample, which is removed from the biopsy punch using sterile foreceps and cryo-preserved for later analysis. The biopsy wound is swabbed with betadine and SSD (silver sulfadiazine) cream applied after sample extraction.

Fecal material is collected from the deck after deposition and therefore does not require any manipulation of turtles. Fecal samples are collected and double bagged in ziplock bags and refrigerated for later analysis. Personnel wear latex gloves during collection and samples are refrigerated separate from food items, minimizing human health risks to individuals.

Cloacal swabs are collected from a subset of loggerheads. The sterile-packed swab penetrate the cloaca approximately 5 cm, after which the swab is inserted into a media tube and stored between at -80° C (in liquid nitrogen). Swabs samples are processed to culture bacteria that may be present. The goal is to document bacterial communities found in turtles as they relate to possible antibacterial release in marine systems.

Tumor collection

Unusual growths or lesions on soft or hard tissues are photographed and gently removed using a 6 mm biopsy tool as appropriate. The sample site is prepped with 10% betadine/topical disinfectant solution and allowed 5-10 minutes of contact time before sampling. If the vertical surface of the growth is <6 mm, the biopsy punch is passed perpendicular to the growth (i.e., along the body axis of the turtle) to gently 'shave off' the sample at the surface of the growth; however, if the vertical surface of the growth is deeper than the biopsy punch, the punch is gently pushed downward to isolate the sample (which is then cut away from rest of the growth using surgical scissors). Bleeding caused by sampling is treated with ice and pressure or cauterizing powder as needed. The sample is split into a vial containing 10% neutral buffered formalin to preserve the sample for histology and a second vial containing 95% ethanol for genetic testing of the sample.

Satellite and acoustic tags

Satellite and acoustic transmitters are attached to a subset of captured loggerheads. Satellite transmitters are similar to or smaller than Telonics ST-20 tags used previously by the applicant (13.97 cm (L) x 3.0 cm (W) x 3.8 cm (H), and approximately 0.3 kg) and would be less than one percent of the body weight of median-sized juveniles in the survey.

Transmitters are attached directly to the second vertebral scute on the carapace using epoxy (Arendt *et al.* 2009). Prior to attachment, barnacles and other organisms are removed from the carapace with a chisel. The carapace is then sanded, washed with betadine, and dried with acetone. Quick-setting T-308™ marine epoxy resin is used to form an attachment base for each tag. Sonic Weld™ is used secondarily to coat the tag and create a smooth hydrodynamic surface (Mansfield et al. 2009). Heat generated by curing epoxy is noted by researchers during the application process; however, the methods described here are standard among global sea turtle satellite-telemetry studies (McClellan *et al.* 2010). Anti-fouling paint may be applied to the cured epoxy. The time elapsed between initiation of epibiont removal and the completion of epoxy curing is roughly 30 minutes.

Acoustic transmitters are no larger than the largest transmitter (16 mm diameter by 98 mm length; weight = 36 g in water) made by Vemco. Transmitters are no more than 1/10 of one percent of the body weight for median sized juvenile loggerheads (36 kg) collected in the survey. Transmitters are attached directly to the fourth vertebral scute on the carapace using epoxy, a small amount of which is used to build a tear drop shaped, hydro-dynamically efficient fairing in front of transmitter.

Prior to attaching transmitters, the attachment site is cleared of epibionts using a combination of gentle leverage and mild scraping with a chisel and scrubbing via plastic mesh pad. The cleared area is rinsed, then dried prior to sanding the same area with sand paper (100 grit) to produce a smooth finish (i.e., devoid of shedding keratin) for the epoxy to adhere to. After sanding, the preparation area is treated with betadine and then rinsed with acetone to ensure a dry surface for the epoxy to contact. Anti-fouling paint (e.g., Interlux Micron 66) may be applied to the cured epoxy. Time lapse between removing the epibionts to completion of epoxy curing is approximately 30 minutes.

Ultrasound

Ultrasonography is conducted on a subset of loggerheads to help evaluate the gonadal condition. This procedure allows the imaging of gonadal tissue and takes a maximum of 15 minutes per turtle. While the turtle is restrained by hand on its carapace on a rubber tire, the probe is placed on the inguinal region cranial to the hind leg. A coupling gel is used to ensure transmission of the ultrasonic signal.

Transport and holding

If an injured turtle is caught while sampling, the turtle is transferred to shore to receive medical attention at the closest rehabilitation facility (e.g., the Georgia Sea Turtle Center on Jekyll Island or the South Carolina Aquarium in Charleston).

Permit conditions

The proposed permit lists general and special conditions that are followed as part of the proposed research activities. These conditions are intended to minimize the potential adverse effects of the research activities on targeted endangered species and include the following that are relevant to the proposed permit:

- In the event of serious injury or mortality or if the permitted "take" is exceeded, researchers must suspend permitted activities and contact the Permits Division by phone within two business days, and submit a written incident report. The Permits Division may grant authorization to resume permitted activities.
- Permit holders must exercise caution when approaching animals and must retreat from animals if behaviors indicate the approach may be interfering with reproduction, feeding, or other vital functions.
- **Equipment.** All equipment that comes in contact with sea turtles must be cleaned and disinfected between the processing of each turtle, and special care must be taken for animals displaying fibropapilloma tumors or legions. All turtles must be examined for existing 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.
- **Flipper tagging with metal tags.** All tags must be cleaned and disinfected before being used. Applicators must be cleaned between animals. The application site must be cleaned and then scrubbed with disinfectant (e.g. Betadine) before the tag pierces the animal's skin.
- **PIT Tagging.** New, sterile tag applicators (needles) must be used. The application site must be cleaned and then scrubbed with a disinfectant (e.g. Betadine) before the

applicator pierces the animal's skin. The injector handle shall be disinfected if it has been exposed to fluids from other animals.

- **Handling.** Researchers must use care when handling live animals to minimize any possible injury, and appropriate resuscitation techniques must be used on any comatose turtle prior to returning it to the water. Whenever possible, injured animals should be transferred to rehabilitation facilities and allowed an appropriate period of recovery before return to the wild. An experienced veterinarian, veterinary technician, or rehabilitation facility must be named for emergencies. If an animal becomes highly stressed, injured, or comatose during the course of the research activities the 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.
- 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.
- During release, turtles must be lowered as close to the water's surface as possible to prevent potential injuries. Newly released turtles must be monitored for abnormal behavior. Extra care must be exercised when handling, sampling and releasing leatherbacks.
- **Blood sampling.** If an animal cannot be adequately immobilized for blood sampling, efforts to collect blood must be discontinued. Attempts (needle insertions) to extract blood from the neck must be limited to a total of four, two on either side. No blood sample will be taken should conditions on the boat preclude the safety and health of the turtle. The permit includes limits on the amount of blood that can be drawn based on the turtle's body weight (3 ml per kg), and the cumulative blood volume taken from an individual over a 45-day period. Researchers must, to the best of their ability, attempt to determine if any of the turtles they blood sample may have been sampled within the past 3 months or will be sampled within the next 3 months by other researchers.
- **Biopsy (keratin) sampling.** A sterile biopsy punch must be used on each turtle. The biopsy location must be cleaned with alcohol before sampling and with Betadine after sampling. If it can be easily determined (through markings, tag number, etc.) that a sea turtle has been recaptured and has been already sampled under the activities authorized by this permit, no further biopsy samples must be collected from the animal.
- **Biopsy (tissue-skin) sampling.** A new biopsy punch must be used on each turtle. Sterile techniques must be used at all times. The tissue surface must be thoroughly swabbed once with both betadine and alcohol, sampled, and then thoroughly swabbed again with just betadine.
- **Satellite tagging and marking.** Total weight of transmitter attachments must not exceed 5% of the body mass of the animal. The transmitter attachment must either

contain a weak link (where appropriate) or have no gap between the transmitter and the turtle that could result in entanglement. The lanyard length (if used) must be less than 1/2 of the carapace length of the turtle. It must include a corrodible, breakaway link that will corrode and release the tag-transmitter after the tag-transmitter life is finished. Researchers must make attachments as hydrodynamic as possible.

- Adequate ventilation around the head of the turtle must be provided during the attachment of satellite tags or attachment of radio/sonic tags if attachment materials produce fumes. To prevent skin or eye contact with harmful chemicals used to apply tags, turtles must not be held in water during the application process.
- **Trawling methods**. Tow times must not exceed 30 minutes bottom time (42 minutes doors in to doors out). Trawling must not be initiated when marine mammals (with the exception of dolphins or porpoises) are observed within the vicinity of the research, and the marine mammals must be allowed to either leave or pass through the area safely before trawling is initiated.
- **Transport and holding.** Turtles must be transported via a climate-controlled environment. Transport of sea turtles to the docking site must not exceed 2 hours (one way), and total land and sea transit time must not exceed 4 hours.
- **Compromised or injured turtles.** Researchers 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. 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.
- **Non-target species.** The Permit Holder must ensure that staff conducts observations for whales, including North Atlantic Right Whales. Monitoring is required on all vessels and must be conducted by research staff with at-sea large whale identification experience. In accordance with 50 CFR 224.103(c)(1), the Permit Holder must not get within 500 yards of a right whale. If a right whale is sighted within 500 yards of the vessel, immediate avoidance measures must be taken and researchers must immediately report the sighting and location data to either the U.S. Coast Guard or the appropriate NMFS Regional Administrator.
- **Sturgeon.** Sturgeon tend to inflate their swim bladder when stressed and in air. If the fish has air in its bladder, it will float and be susceptible to sunburn or bird attacks. Efforts must be made to return the fish to neutral buoyancy prior to and during release. Air must be released by gently applying ventral pressure in a posterior to anterior direction. The specimen must then be propelled rapidly downward during release.

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

When individual listed plants or animals are expected to experience reductions in fitness in response to an action, those fitness reductions are likely to reduce the abundance, reproduction, or growth rates (or increase the variance in these measures) of the populations those individuals represent (see Stearns 1992). Reductions in at least one of these variables (or one of the variables we derive from them) is a necessary condition for reductions in a population's viability, which is itself a necessary condition for reductions in a species' viability. As a result, when listed plants or animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (e.g., Brandon 1978; Anderson 2000; 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 analysis, 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 the 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 NMFS Permits Division when it initiates formal consultation
- 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.

During the consultation, we conducted electronic searches of the general scientific literature. 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 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

Activities would occur from May through September in coastal waters of the Northwest Atlantic Ocean between Winyah Bay, SC and St. Augustine, FL, almost exclusively in state territorial waters within 12 nm of shore. Trawling is targeted for waters 15 and 40 feet deep and would be conducted predominantly over sand bottom that defines the sea floor in this region, though patches of low-profile "live bottom" communities consisting of sponges, soft corals and occasionally hard corals are also present.

Status of listed resources

NMFS has determined that the actions considered in this Opinion may affect the following listed resources provided protection under the ESA of 1973, as amended (16 U.S.C. 1531 *et seq*.):

Cetaceans		
Humpback whale	*Megaptera novaeangliae*	Endangered
North Atlantic right whale*	*Eubalaena glacialis*	Endangered
Sea Turtles		
Green sea turtle – most areas	*Chelonia mydas*	Threatened
Florida and Mexico's Pacific coast breeding colonies		Endangered
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Leatherback sea turtle	*Dermochelyts coriacea*	Endangered
Loggerhead sea turtle Northwest Atlantic Ocean DPS	*Caretta caretta*	Threatened
Fish		
Atlantic sturgeon Carolina and South Atlantic DPS	*Acipenser oxyrinchus*	Endangered
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered

Species not considered further in this opinion

To refine the scope of this Opinion, NMFS used two criteria (risk factors) to determine whether any endangered or threatened species or critical habitat are not likely to be adversely affected by vessel traffic, aircraft traffic, or human disturbance associated with the proposed actions. The first criterion was *exposure*: if we conclude that particular endangered or threatened species or designated critical habitat are not likely to be exposed to vessel traffic, aircraft traffic, or human disturbance, we must also conclude that those listed species or designated critical habitat are not likely to be adversely affected by the proposed action. The second criterion is *susceptibility* upon exposure: species or critical habitat may be exposed to vessel traffic, aircraft traffic, or human disturbance, but may not be unaffected by those activities—either because of the circumstances associated with the exposure or the intensity of the exposure-- are also not likely to be adversely affected by the vessel traffic, aircraft traffic, or human disturbance. This section summarizes the results of our evaluations.

The permit specifies that the South Carolina Department of Natural Resources must ensure that staff conducts observations for whales. Monitoring is required on all vessels and must be conducted by research staff with at-sea large whale identification experience. Trawling is not initiated when marine mammals such as humpbacks or North Atlantic right whales are observed in the area, and the marine mammals must be allowed to either leave or pass through the area safely before trawling is initiated. The Permit Holder must not get within 500 yards of a right whale, and if one is sighted within 500 yards, researchers must take immediate avoidance measures.

Designated North Atlantic right whale critical habitat (50 FR 28793) can be found in the action area from the mouth of the Altamaha River, Georgia, to Jacksonville, Florida, out 15 nautical miles (nm) and from Jacksonville, Florida, to Sebastian Inlet, Florida, out 5 nm. The action would not alter the physical and biological features (water depth, water temperature, and the distribution of right whale cow/calf pairs in relation to the distance from the shoreline to the 40-m isobath) that were the basis for determining this habitat to be critical; therefore this habitat is not considered further.

Shortnose sturgeon appear to spend most of their life in their natal river systems, only occasionally entering the marine environment. Shortnose sturgeon have never been captured in past trawls by the South Carolina Department of Natural Resources, and we do not consider it likely that they would be adversely affected by this action.

Although these listed resources may occur in the action area, we believe they are either not likely to be exposed to the proposed research or are not likely to be adversely affected. Therefore, they will not be considered further in this Opinion.

Status of species considered in this opinion

The species narratives that follow focus on attributes of life history and distribution that influence the manner and likelihood that these species may be exposed to the proposed action, as well as the potential response and risk when exposure occurs. Consequently, the species' narrative is a summary of a larger body of information on localized movements, population structure, feeding, diving, and social behaviors. Summaries of the status and trends of the listed sea turtles are presented to provide a foundation for the analysis of the species as a whole. We also provide a brief summary of the species' status and trends as a point of reference for the jeopardy determination, made later in this Opinion. That is, we rely on a species' status and trend to determine whether an action's direct or indirect effects are likely to increase the species' probability of becoming extinct. Similarly, each species narrative is followed by a description of its critical habitat with particular emphasis on any essential features of the habitat that may be exposed to the proposed action and may warrant special attention.

Green sea turtle

Distribution

Green sea turtles have a circumglobal distribution, occurring throughout tropical, subtropical waters, and, to a lesser extent, temperate waters. Green turtles appear to prefer waters that usually remain around 20º C in the coldest month, but may be found considerably north of these regions during warm-water events, such as El Niño. Stinson

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

Populations are distinguished generally by ocean basin and more specifically by nesting location. Based upon genetic differences, two distinct regional clades are thought to exist in the Pacific: western Pacific and South Pacific islands, and eastern Pacific and central Pacific, including the rookery at French Frigate Shoals, Hawaii. 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).

Reproduction

Estimates of reproductive longevity range from 17 to 23 years (Fitzsimmons *et al.* 1995; Carr *et al.* 1978; Chaloupka *et al.* 2004). 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 during her lifetime.

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 (Okuyama *et al.* 2009; Ischer *et al.* 2009). Factors in the ocean environment have a major influence on reproduction (Chaloupka 2001; Solow *et al.* 2002; Limpus and Nicholls 1988). 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 affect 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 (Seminoff *et al.* 2002; Seminoff and Jones 2006; Godley *et al.* 2003; Makowski *et al.* 2006; Taquet *et al.* 2006). However, 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 (Seminoff *et al.* 2003; Chaloupka and Limpus 2005; 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).

Movement and migration

Green sea turtles are highly mobile and undertake complex movements through geographically disparate habitats during their lifetimes (Plotkin 2003; Musick and Limpus 1997). 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 (Meylan *et al.* 1990; Carr *et al.* 1978). However, 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).

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 (Seminoff *et al.* 2002; Hatase *et al.* 2006; Heithaus *et al.* 2002; Godley *et al.* 1998; Parker and Balazs 2008). However, 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). Localized movement in foraging areas can be strongly influenced by tidal movement (Brooks et al. 2009).

Based on the behavior of post-hatchlings and juvenile green turtles raised in captivity, it is presumed that those in pelagic habitats live and feed at or near the ocean surface, and that their dives do not normally exceed several meters in depth (NMFS and USFWS 1998b; Hazel *et al.* 2009). The maximum recorded dive depth for an adult green turtle was just over 106 m (Berkson 1967).

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. Additionally, these numbers are not compared to larger historical numbers. 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.

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

Green turtles are thought to be declining throughout the Pacific Ocean, with the exception of Hawaii, from a combination of overexploitation and habitat loss (Seminoff *et al.* 2002; Eckert 1993). 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).

There are no reliable estimates of the overall number of green turtles inhabiting foraging areas within the southeast United States, and it is likely that green turtles foraging in the region come from multiple genetic stocks. However, information from some sites is available. A long-term in-water monitoring study in the Indian River Lagoon of Florida has tracked the populations of juvenile green turtles in a foraging environment and noted significant increases in catch-per-unit effort (more than doubling) between the years 1983-85 and 1988-90. An extreme, short-term increase in catch per unit effort of ~300% was seen between 1995 and 1996 (Ehrhart *et al.* 1996). Catches of benthic immature turtles at the St. Lucie Nuclear Power Plant intake canal, which acts as a passive turtle collector on Florida's east coast, have also been increasing since 1992 (Martin and Ernst 2000).

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. The proposed research would not take place in designated green sea turtle critical habitat.

Hawksbill sea turtle

Distribution

The hawksbill sea turtle has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical waters of the Atlantic, Indian, and Pacific oceans. Populations are distinguished generally by ocean basin and more specifically by nesting location. 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; Miller *et al.* 1998; Horrocks *et al.* 2001; Hillis-Starr *et al.* 2000; Prieto *et al.* 2001; Lagueux *et al.* 2003). Hawksbill turtles are considered common in French Polynesian waters, but are not known to nest on the islands. Confirmed sightings have also been made near the proposed study area off Tonga, Fiji, and Niue (SPREP 2007).

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 (Musick and Limpus 1997), and mud flats (R. von Brandis, unpublished data in NMFS and USFWS 2007). 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 (Musick and Limpus 1997; Mortimer *et al.* 2003; Blumenthal *et al.* 2009). Larger individuals may prefer deeper habitats than their smaller counterparts (Blumenthal et al. 2009).

Reproduction

Hawksbill sea turtles breed while in the water, but eggs are laid on beaches worldwide. Females typically lay 3-5 clutches at 2-week intervals during a single nesting season (Witzell 1983; Mortimer and Bresson 1999; Richardson *et al.* 1999; Beggs *et al.* 2007). Nesting for each female occurs between 1.8-7 year intervals, depending upon nesting site (Mortimer and Bresson 1999; Richardson *et al.* 1999; Limpus 2004; Pita and Broderick 2005; Beggs *et al.* 2007; Chan and Liew 1999; Pilcher and Ali 1999; Garduño-Andrade 1999). Following incubation, hatchlings emerge from sand-covered pits in which their eggs were laid and enter the sea.

Hawksbill sea turtles reach sexual maturity at >20 years in Atlantic waters (León and Diez 1999; Diez and Dam 2002; Boulon 1983; Boulon 1994). Ages of 30-38 years have been estimated for individuals from Indo-Pacific waters, with males reaching maturity later than females (Limpus and Miller 2000). Duration of reproductive potential in the Caribbean is 14-22 years (Parrish and Goodman 2006). Based on the reasonable means of 3-5 nests per season (Mortimer and Bresson 1999; Richardson *et al.* 1999) and 130 eggs per nest (Witzell 1983), a female may lay 9 to 55 egg clutches, or about 1,170-7,190 eggs during her lifetime. However, up to 276 eggs have been recorded in a single nest (Kamel and Delcroix 2009). In the Cayman Islands, juvenile growth has been estimated at 3.0 cm/year (Blumenthal et al. 2009).

Movement and migration

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.

Feeding

Dietary data from oceanic stage hawksbills are limited, but indicate a combination of plant and animal material (Bjorndal 1997). Studies have shown post-oceanic hawksbills to feed on sponges throughout their range (reviewed by Bjorndal 1997), but appear to be especially spongivorous in the Caribbean (Van Dam and Diez 1997; León and Bjorndal 2002; Meylan 1988). Jellyfish are also ingested on occasion (Blumenthal et al. 2009).

Status and trends

Hawksbill sea turtles were protected on June 2, 1970 (35 FR 8495) under the Endangered Species Conservation Act and since 1973 have been listed as endangered under the ESA. This species is currently listed as endangered throughout its range.

Only five regional nesting populations remain with more than 1,000 females nesting annually (Seychelles, Mexico, Indonesia, and two in Australia) (Meylan and Donnelly 1999). Most populations are declining, depleted, or remnants of larger aggregations.

The most significant nesting within the U.S. occurs in Puerto Rico and the U.S. Virgin Islands, specifically on Mona Island and Buck Island, respectively. Each year, about 500-1000 hawksbill nests are laid on Mona Island, Puerto Rico (Diez and van Dam 2006) and another 100-150 nests on Buck Island Reef National Monument off St. Croix in the U.S. Virgin Islands (Meylan 1999).

Critical habitat

On September 2, 1998, critical habitat was declared 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. The proposed research would not take place in designated hawksbill sea turtle critical habitat.

Kemp’s ridley sea turtle

Distribution

Adult Kemp’s ridley turtles are restricted to the Gulf of Mexico in shallow near shore waters, although adult-sized individuals sometimes are found on the eastern seaboard of the United States. Females rarely leave the Gulf of Mexico and adult males do not migrate. Juveniles feed along the east coast of the United States up to the waters off Cape Cod, Massachusetts (Spotila 2004). A small number of individuals reach European waters (Spotila 2004; Brongersma 1972) and the Mediterranean (Pritchard and Mtirquez 1973).

Juvenile Kemp’s ridley sea turtles are the second most abundant sea turtle in the mid-Atlantic region from New England, New York, and the Chesapeake Bay, south to coastal areas off North Carolina. Juvenile Kemp’s ridley sea turtles migrate into the region during May and June and forage for crabs in submerged aquatic vegetation (Keinath *et al.* 1987; Musick and Limpus 1997). In the fall, they migrate south along the coast, forming one of the densest concentrations of Kemp’s ridley sea turtles outside of the Gulf of Mexico (Musick and Limpus 1997).

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 (Rostal *et al.* 1997; Bernardo and Plotkin 2007). 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; USFWS 2000; USFWS 2001; USFWS 2002; USFWS 2003; USFWS 2004; USFWS 2005; USFWS 2006; Rostal 2007). 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 (Wibbels 2007; Coyne and Landry Jr. 2007).

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 (Ogren 1989; Caillouet *et al.* 1995; Zug *et al.* 1997; Schmid 1998; Schmid and Witzell 1997; TEWG 2000; Snover *et al.* 2007). 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).

Movement and migration

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.

Stranding data indicate that immature turtles in their benthic stage are found in coastal habitats of the entire Gulf of Mexico and U.S. Atlantic coast (TEWG 2000; Morreale *et al.* 2007). Developmental habitats for juveniles occur throughout the entire coastal Gulf of Mexico and U.S. Atlantic coast northward to New England (Schmid 1998; Wibbels *et al.* 2005; Morreale *et al.* 2007). 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; Ogren 1989; Coyne *et al.* 1995; Schmid 1998; Schmid *et al.* 2002; Witzell *et al.* 2005). 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 2007).

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 1995). Sightings are less frequent during winter and spring, but this is likely due to lesser sighting effort during these times (Shoop and Kenney 1992; Keinath *et al.* 1996).

Feeding

Kemp's ridley diet consists mainly of swimming crabs, but may also include fish, jellyfish, and an array of mollusks. 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 1995). 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 (USFWS 1999; National Research Council 1990).

In 1947, 40,000 female Kemp's ridley sea turtles were observed nesting on the beaches at Rancho Nuevo on a single day (Carr 1963; Hildebrand 1963). By the early 1970s, the estimate of mature female Kemp's ridleys had been reduced to 2,500-5,000 individuals. Between the years of 1978 and 1991 only 200 Kemp's ridleys nested annually. Today the Kemp's ridley population appears to be in the early stages of recovery. Nesting has increased steadily over the past decade. During the 2000 nesting season, an estimated 2,000 females nested at Rancho Nuevo, a single arribada of 1,000 turtles was reported in 2001, and an estimated 3,600 turtles produced over 8,000 nests in 2003. In 2006, a record number of nests were recorded since monitoring began in 1978; 12,143 nests were documented in Mexico, with 7,866 of those at Rancho Nuevo. By 2004, the number of adult females in the Gulf of Mexico is estimate to have increased to about 5,000 individuals (Spotila 2004).

The Turtle Expert Working Group (2000) estimated that the population size of Kemp's ridley sea turtles grew at an average rate of l1.3 percent per year (95% C.I. slope = 0.096-0.130) between 1985 and 1998. Over the same time interval, hatchling production increased at a slightly slower rate (9.5% per year).

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; NMFS and USFWS 1995). Leatherbacks typically associate with continental shelf and pelagic environments and are sighted in offshore waters of 7-27˚ C (CETAP 1982). However, 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).

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 have been documented in Gabon, Sao Tome and Principe, French Guiana, Suriname, and Florida (Márquez 1990; Bräutigam and Eckert 2006; 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 2001).

Caribbean Sea. Nesting occurs in Puerto Rico, St. Croix, Costa Rica, Panama, Colombia, Trinidad and Tobago, Guyana, Suriname, and French Guiana (Márquez 1990; Bräutigam and Eckert 2006; Spotila *et al.* 1996). Beaches bordering the action area along the western Puerto Rican coast are home to roughly 15-30 nests per year (Scharer pers. comm.).

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

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 1993; Stinson 1984; 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 Malaysia, Papua New Guinea, Indonesia, Thailand, Australia, Fiji, the Solomon Islands, and Central America (Limpus 2002; Dutton *et al.* 2007). Significant nesting also occurs along the Central American coast (Márquez 1990).

Movement and migration

Leatherback sea turtles migrate throughout open ocean convergence zones and upwelling areas, along continental margins, and in archipelagic waters (Morreale *et al.* 1994; Eckert 1998; Eckert 1999). In a single year, a leatherback may swim more than 9,600 km to nesting and foraging areas throughout ocean basins (Eckert 1998; Eckert 2006; Eckert *et al.* 2006; Hays *et al.* 2004; Ferraroli *et al.* 2004; Benson *et al.* 2007a; Benson *et al.* 2007b; Sale *et al.* 2006). However, 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.* 2009).

Reproduction

Leatherback sea turtles probably mate outside of tropical waters (Eckert and Eckert 1988). Mating may occur starting at 3-6 years (Rhodin 1985). However, this is disputed at least in the western North Atlantic and may not occur until 29 years (Rhodin 1985; Pritchard and Trebbau 1984; Avens and Goshe 2007; Dutton *et al.* 2005; Zug and Parham 1996). Leatherback turtles tend to forage in temperate waters except for nesting females; males are generally absent from nesting areas. Females can deposit up to seven nests per season of 100 eggs or more and return to nest every 2-3 years, although this varies geographically, and some eggs in each clutch are infertile. Nesting along the Pacific coast of Mexico runs from November-February, but may occur as early as August and as late as March (Fritts *et al.* 1982; NMFS and USFWS 1998a). In the late 1970's, roughly one-half of the world's leatherbacks nested along these shores (Pritchard 1982). Here, females deposit from 1-11 nests per season at 9- to 10-day intervals (NMFS and USFWS 1998a). Nesting in other Pacific locations occurs in China from May-June, Malaysia from June-July, and Queensland, Australia from December-January.

Temperature is important to leatherback egg survival, with higher temperatures increasing mortality (Tomillo et al. 2009). Along Costa Rica, eggs laid earlier in the nesting season have higher hatching success than those deposited later in the season. Possibly because of this, females who nest more frequently (for more years) appear to lay their nests earlier in the season than leatherback females who nest less frequently. Survival is extremely low in early life, but greatly increases with age.

Feeding

Leatherbacks may forage in high-invertebrate prey density areas formed by favorable features (Ferraroli *et al.* 2004; Eckert 2006). 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 *et al.* 2000; Dutton *et al.* 1998; Dutton 2005-2006). 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 (Stinson 1984; Eisenberg and Frazier 1983).

Status and trends

Leatherback sea turtles were protected on June 2, 1970 (35 FR 8491) under the Endangered Species Conservation Act and since 1973 have been listed as endangered under the ESA. However, recent 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 2004). The species as a whole is declining and local populations are in danger of extinction (NMFS 2001).

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 nesting 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). Decline 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). Drastic overharvesting of eggs and mortality from fishing activities is likely responsible for this tremendous decline (Sarti *et al.* 1996; Eckert 1997).

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. The proposed research would not take place in designated leatherback sea turtle critical habitat.

Loggerhead sea turtle – Northwest Atlantic Ocean DPS

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.

On September 22, 2011, the NMFS designate nine distinct population segments (DPSs) of loggerhead sea turtles. Four were listed as threatened: Northwest Atlantic Ocean, South Atlantic Ocean, Southeast Indo-Pacific Ocean, and Southwest Indian Ocean; and five were listed as endangered: Northeast Atlantic Ocean, Mediterranean Sea, North Indian Ocean, North Pacific Ocean, and South Pacific Ocean (76 FR 58868). The DPS that could be exposed to the proposed action is the Northwest Atlantic Ocean DPS.

In the Northwest Atlantic, the majority of loggerhead nesting is concentrated along the coasts of the United States from southern Virginia through Alabama. Additional nesting beaches are found along the northern and western Gulf of Mexico, eastern Yucatan Peninsula, at Cay Sal Bank in the eastern Bahamas (Addison 1997; Addison and Morford 1996), on the southwestern coast of Cuba (F. Moncada-Gavilan, personal communication, cited in Ehrhart *et al.* 2003), and along the coasts of Central America, Colombia, Venezuela, and the eastern Caribbean Islands.

Reproduction

Loggerhead nesting is confined to lower latitudes temperate and subtropic zones but absent from tropical areas (NMFS and USFWS 1991; Witherington *et al.* 2006; National Research Council 1990). 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. At 15-38 years, loggerhead sea turtles become sexually mature, although the age at which they reach maturity varies widely among populations (NMFS 2001; Witherington *et al.* 2006; Frazer and Ehrhart 1985; Casale *et al.* 2009).

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 (NMFS and USFWS 1998c; Dodd 1988). 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).

Movement and migration

As post-hatchlings, Northwest Atlantic loggerheads use the North Atlantic Gyre and enter Northeast Atlantic waters (Carr 1987). They are also found in the Mediterranean Sea. In these areas, they overlap with animals originating from the Northeast Atlantic and the Mediterranean Sea (Carreras *et al.* 2006; Eckert *et al.* 2008).

After departing the oceanic zone, neritic juvenile loggerheads in the Northwest Atlantic inhabit continental shelf waters from Cape Cod Bay, Massachusetts, south through Florida, The Bahamas, Cuba, and the Gulf of Mexico (Musick and Limpus 1997; Spotila *et al.* 1997; Hopkins-Murphy *et al.* 2003). As adults, loggerheads shift to a benthic habitat, where immature individuals forage in the open ocean and coastal areas along continental shelves, bays, lagoons, and estuaries (NMFS 2001; Bowen *et al.* 2004).

Feeding

Loggerheads are omnivorous and opportunistic feeders (Parker et al. 2005). Hatchling loggerheads feed on macroplankton associated with *Sargassum* spp. communities (NMFS and USFWS 1991). Pelagic and benthic juveniles forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd 1988; Wallace *et al.* 2009). 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 1998c).

Status and trends

Loggerhead sea turtles were listed as threatened under the ESA of 1973 on July 28, 1978 (43 FR 32800). On September 22, 2011, the NMFS designate nine distinct population segments (DPSs) of loggerhead sea turtles. Four were listed as threatened: Northwest Atlantic Ocean, South Atlantic Ocean, Southeast Indo-Pacific Ocean, and Southwest Indian Ocean; and five were listed as endangered: Northeast Atlantic Ocean, Mediterranean Sea, North Indian Ocean, North Pacific Ocean, and South Pacific Ocean (76 FR 58868). The DPS that could be exposed to the proposed action is the Northwest Atlantic Ocean DPS.

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.

Collectively, the Northwest Atlantic Ocean hosts the most significant nesting assemblage of loggerheads in the western hemisphere and is one of the two largest loggerhead nesting assemblages in the world. Analyses by NMFS and USFWS (2008), Witherington *et al.* (2009), and TEWG (2009) indicate that there had been a significant, overall nesting decline within this DPS. However, nesting in 2008 showed a substantial increase compared to the low of 2007, and nesting in 2010 reached the highest level seen since 2000. The most current nesting trend for the Northwest Atlantic Ocean DPS, from 1989–2010, is very slightly negative, but the rate of decline is not statistically different from zero (76 FR 58868).

Critical habitat

NMFS has not designated critical habitat for loggerhead sea turtles.

Atlantic sturgeon

Life history

While intensely studied since the 1970s, many important aspects of Atlantic sturgeon life history are still unknown. Although specifics vary latitudinally, the general life history pattern of Atlantic sturgeon is that of a long lived, late maturing, estuarine-dependent, anadromous species. The species' historic range included major estuarine and riverine systems that spanned from Hamilton Inlet on the coast of Labrador to the Saint Johns River in Florida (reviewed in Murawski and Pacheco 1977; Smith and Clugston 1997).

Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in the spring/early summer; February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems (Bain 1997; Caron *et al.* 2002; Murawski and Pacheco 1977; Smith 1985; Smith and Clugston 1997). In some southern rivers, a fall spawning migration may also occur.

Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (e.g., cobble) (Gilbert 1989; Smith and Clugston 1997). Hatching occurs approximately 94-140 hrs after egg deposition, and larvae assume a demersal existence (Smith *et al.* 1980). The yolksac larval stage is completed in about 8-12 days, during which time the larvae move downstream to rearing grounds over a 6 – 12 day period (Kynard and Horgan 2002). During the first half of their migration downstream, movement is limited to night. During the day, larvae use benthic structure (e.g., gravel matrix) as refugia (Kynard and Horgan 2002). During the latter half of migration when larvae are more fully developed, movement to rearing grounds occurs both day and night. Juvenile sturgeon continue to move further downstream into brackish waters, and eventually become residents in estuarine waters for months or years.

Upon reaching a size of approximately 76-92 cm, the subadults may move to coastal waters (Murawski and Pacheco 1977; Smith 1985), where populations may undertake long range migrations (Bain 1997; Dovel and Berggren 1983). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Subadult Atlantic sturgeon wander among coastal and estuarine habitats, undergoing rapid growth (Dovel and Berggren 1983; Stevenson 1997). These migratory subadults, as well as adult sturgeon, are normally captured in shallow (10-50m) near shore areas dominated by gravel and sand substrate (Stein *et al.* 2004). Despite extensive mixing in coastal waters, Atlantic sturgeon return to their natal river to spawn as indicated from tagging records (Collins *et al.* 2000).

Atlantic sturgeon have been aged to 60 years (Mangin 1964); however, this should be taken as an approximation as the only age validation study conducted to date shows variations of ±5 years (Stevenson and Secor 1999). Vital parameters of sturgeon populations show clinal variation with faster growth and earlier age at maturation in more southern systems, though not all data sets conform to this trend. Atlantic sturgeon likely do not spawn every year, where multiple studies have shown that spawning intervals range from 1-5 years for males (Caron *et al.* 2002; Collins *et al.* 2000; Smith 1985) and 2-5 for females (Stevenson and Secor 1999; Van Eenennaam and Doroshov 1998;

Vladykov and Greely 1963). Fecundity of Atlantic sturgeon has been correlated with age and body size (ranging from 400,000 – 8 million eggs) (Dadswell 2006; Smith *et al.* 1982; Van Eenennaam and Doroshov 1998). The average age at which 50% of maximum lifetime egg production is achieved estimated to be 29 years, approximately 3-10 times longer than for other bony fish species examined (Boreman 1997).

Status and trends of Atlantic sturgeon populations

Historically, Atlantic sturgeon were present in approximately 38 rivers in the United States from St. Croix, ME to the Saint Johns River, FL, of which 35 rivers have been confirmed to have had a historical spawning population. Atlantic sturgeon are currently present in 35 rivers, and spawning occurs in at least 20 of these rivers. In the mid-1800s, incidental catches of Atlantic sturgeon in the shad and river herring haul seine fisheries indicated that the species was very abundant (reviewed in Armstrong and Hightower 2002)(reviewed in Armstrong and Hightower 2002).

A major fishery for this species did not exist until 1870 when a caviar market was established (reviewed in Smith and Clugston 1997). Record landings were reported in 1890, where over 3350 metric tons (mt) of Atlantic sturgeon were landed from coastal rivers along the Atlantic Coast (reviewed in Smith and Clugston 1997; Secor and Waldman 1999). The majority of these landings (75%) were dominated by the Delaware River fishery, which presumably supported the largest population along the Atlantic Coast (reviewed in Secor and Waldman 1999).

Ten years after peak landings, the fishery collapsed in 1901, when less than 10% (295 mt) of its 1890 peak landings were reported. The landings continued to decline to about 5% of the peak until 1920 and have remained between 1-5% since then. During the 1950s, the remaining fishery switched to targeting sturgeon for flesh, rather than caviar. The Atlantic sturgeon fishery was closed by the Atlantic States Marine Fisheries Commission in 1998, when a coastwide fishing moratorium was imposed for 20-40 years, or at least until 20 year classes of mature female Atlantic sturgeon were present (ASMFC 1998).

Presently, there are only two U.S. populations for which an abundance estimate is available; the Hudson (~870 spawning adults/yr) and Altamaha (~343 spawning adults/yr) (Kahnle *et al.* 2007; Schuller and Peterson 2006). The Hudson and Altamaha are presumed to be the healthiest populations within the U.S. Thus, other spawning populations within the U.S. are predicted to have less than 300 adults spawning per year.

Listing status

A petition to list the Atlantic sturgeon was submitted in 1997. After a status review, it was determined that the species did not merit listing under the Endangered Species Act (ESA) at that time.

In 2003, a workshop sponsored by NMFS and U.S. Fish and Wildlife Service was held to review the status of Atlantic sturgeon. The workshop attendees concluded that some populations seemed to be recovering while other populations continued to be depressed. As a result, NMFS initiated a second status review of Atlantic sturgeon in 2005 to reevaluate whether this species required protection under the ESA. That status review was completed in 2007 (Atlantic Sturgeon Status Review Team 2007), and final listing rules for five DPSs of Atlantic sturgeon were issued on February 6, 2012 (77 FR 5914 and 77 FR 5880).

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 green, Kemp's ridley, hawksbill, leatherback, and loggerhead sea turtles and Atlantic sturgeon in the action area. The *Environmental baseline* focuses primarily on past and present impacts to these species.

The following discussion summarizes the natural and human phenomena in the action area that may affect the likelihood these species will survive and recover in the wild. These include predation, cold stunning, beach erosion, disease and parasites, fisheries interactions, habitat degradation and climate change, marine debris, poaching, contaminants, vessel strikes, scientific research, lack of international protection, and conservation and management efforts.

Natural sources of stress and mortality

Predation

While in the water, sea turtles face predation primarily by sharks and to a lesser extent by killer whales (Pitman and Dutton 2004). Tiger sharks (*Galeocerdo cuvieri*) and bull sharks (*Carcharhinus leucas*) are the species most often reported to contain sea turtle remains (Compagno 1984; Simpfendorfer *et al.* 2001; Witzell 1987). Predation by white sharks (*Carcharodon carcharias*) has also been reported (Fergusson *et al.* 2000). Hatchlings are preyed upon by herons, gulls, dogfish, and sharks.

Land 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).

Natural beach erosion

Natural beach erosion events may influence the quality of nesting habitat in the action area. Nesting females may deposit eggs at the base of an escarpment formed during an erosion event where they are more susceptible to repeated tidal inundation. Erosion, frequent or prolonged tidal inundation, and accretion can negatively affect incubating egg clutches. Short-term erosion events (e.g., atmospheric fronts, northeasters, tropical storms, and hurricanes) are common phenomena throughout sea turtles' nesting range and may vary considerably from year to year. Sea turtles have evolved a strategy to offset these natural events by laying large numbers of eggs and by distributing their nests both spatially and temporally. Thus, the total annual hatchling production is never fully affected by storm-generated beach erosion and inundation, although local effects may be high. 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.* 2009).

Disease and parasites

Diseases caused by bacteria, fungus, and viruses affect sea turtles in the action area. Sea turtles are also found to have endo- and ectoparasites. Fibropapilloma (possibly viral in origin) is a major threat to listed turtles in many areas of the world. The disease is characterized by tumorous growths, which can range in size from very small to extremely large, and are found both internally and externally. Large tumors can interfere with feeding and essential behaviors, and tumors on the eyes can cause permanent blindness (Foley *et al.* 2005). For unknown reasons, the frequency of fibropapillomatosis is much higher in green sea turtles than in other species and threatens a large number of existing subpopulations.

At least two bacterial diseases have been described in wild loggerhead populations, including bacterial encephalitis and ulcerative stomatitis/obstructive rhinitis/pneumonia (George 1997), and *Bartonella* was recently reported in wild loggerheads from North Carolina (Valentine *et al.* 2007). There are few reports of fungal infections in wild loggerhead populations. Homer *et al*. (2000) documented systemic fungal infections in stranded loggerheads in Florida.

Parasites also affect sea turtles in the action area. For example, a variety of endoparasites, including trematodes, tapeworms, and nematodes have been described in loggerheads (Herbst and Jacobson 1995). Heavy infestations of endoparasites may cause or contribute to debilitation or mortality in sea turtles. Trematode eggs and adults were seen in a variety of tissues including the spinal cord and brain of debilitated loggerheads during an epizootic in South Florida during late 2000 and early 2001. These were implicated as a possible cause of the epizootic (Jacobson *et al.* 2006).

Ectoparasites, including leeches and barnacles, may have debilitating effects on loggerheads. Large marine leech infestations may result in anemia and act as vectors for other disease producing organisms (George 1997). Barnacles are generally considered innocuous although some burrowing species may penetrate the body cavity resulting in mortality (Herbst and Jacobson 1995). 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). Heavy loads of barnacles are associated with unhealthy or dead stranded loggerheads (Deem *et al.* 2009).

Although many health problems have been described in wild populations through the necropsy of stranded turtles, the significance of diseases on the ecology of wild populations is not known (Herbst and Jacobson 1995). However, several researchers have initiated health assessments to study health problems in free-ranging turtle populations.

Cold stunning

All sea turtles except leatherbacks can undergo “cold stunning” if water temperatures drop below a threshold level, which can be lethal. Kemp’s ridley sea turtles are particularly prone to this phenomenon along Cape Cod (Innis *et al.* 2009).

Anthropogenic sources of stress and mortality

Fisheries interactions

Fisheries interactions are the largest in-water threat to sea turtle recovery. 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).

Of all commercial and recreational fisheries in the U.S., shrimp trawling is the most detrimental to the recovery of sea turtle populations. In a 1990 study, the National Academy of Sciences estimated that between 5,000 and 50,000 loggerheads were killed annually by the offshore shrimping fleet in the southeast U.S. Atlantic and Gulf of Mexico (National Research Council 1990). Mortality associated with shrimp trawls was estimated to be 10 times greater than that of all other human-related factors combined (Smith 1990). Most of these turtles were neritic juveniles, the life stages most critical to the stability and recovery of sea turtle populations (Crouse *et al.* 1987; Crowder *et al.* 1994).

Harvest records indicate that fisheries for sturgeon were conducted in every major coastal river along the Atlantic coast at one time and were concentrated during the spawning migration (Smith 1985). By 1860, commercial fisheries were established in Delaware, Georgia, Maryland, New Jersey, New York, North Carolina, Pennsylvania, South Carolina, and Virginia (Smith 1990). Records of landings were first kept in 1880 when the U.S. Fisheries Commission started compiling statistical information on commercial fishery landings (ASMFC 1990). Harvest in these early years was heavy, and approximately 3350 metric tons were landed in 1890 (Smith and Clugston 1997). The majority of the fishery for a fifty-year time period (from 1870-1920) was conducted on the Delaware River and the Chesapeake Bay System with New Jersey and Delaware reporting the greatest landings. Landings reported until 1967 likely included both Atlantic and shortnose sturgeon. Shortnose sturgeon were granted federal protection in 1967, and therefore harvest was illegal in subsequent years. During the 1970's and 1980's, the focus of fishing effort shifted to South Carolina, North Carolina, and Georgia, which accounted for nearly 80% of the total U.S. landings. Catch between 1990 and 1996 was centered in the Hudson River and coastal New York and New Jersey (Smith and Clugston 1997).

Bycatch of Atlantic sturgeon has been reported in many different fisheries conducted in rivers, estuaries, the nearshore ocean, and the exclusive economic zone. Since Atlantic sturgeon spend portions of their lives in all these areas, they are subject to incidental capture. Atlantic sturgeon recaptures came from commercial fisheries ranging from Maine to North Carolina. The majority of recaptures (61%) came from ocean waters within 4.8 km of shore, 20% of the recaptures came from rivers and estuaries, 18% from the EEZ, and 1% were captured at unreported locations (Atlantic Sturgeon Status Review Team 2007). However, effects of bycatch at the species level are not readily available.

Habitat degradation and climate change

Coastal development can deter or interfere with nesting, affect nest success, and degrade foraging habitats for sea turtles. Many nesting beaches have already been significantly degraded or destroyed. Nesting habitat is threatened by rigid shoreline protection or "coastal armoring" such as sea walls, rock revetments, and sandbag installations. Many miles of once productive nesting beach have been permanently lost to this type of shoreline protection. Nesting habitat can be reduced by beach renourishment projects, which result in altered beach and sand characteristics, affecting nesting activity and nest success. Beach nourishment also hampers nesting success of loggerhead sea turtles, but only in the first year post-nourishment, after which hatching success increases (Brock et al. 2009). In some areas, timber and marine debris accumulation as well as sand mining reduce available nesting habitat (Bourgeois et al. 2009). Because hawksbills prefer to nest under vegetation (Horrocks and Scott 1991; Mortimer 1982), they are particularly affected by beachfront development and clearing of dune vegetation (Mortimer and Donnelly 2007).

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 sea, with up to 50% of some olive ridley hatchlings disoriented upon emergence in some years (Witherington 1992; Witherington and Bjorndal 1991; Karnad *et al.* 2009).

Coasts can also be threatened by contamination from herbicides, pesticides, oil spills, and other chemicals, as well as structural degradation from excessive boat anchoring and dredging (Waycott *et al.* 2005; Lee Long *et al.* 2000; Francour *et al.* 1999).

At sea, there are numerous potential threats to sea turtles 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.* 1997). Hawksbills are typically associated with coral reefs, which are among the world's most endangered marine ecosystems (Wilkinson 2000).

Loss of habitat and poor water quality contributed to the decline of Atlantic sturgeon since European settlement; however, the importance of this threat has varied over time and from river to river. Some important aspects of habitat quality, especially water quality, have improved during the last twenty-five to thirty years.

Dams for hydropower generation and flood control can have profound effects on anadromous species by blocking access to spawning habitat, changing free-flowing rivers to reservoirs, and altering downstream flows and water temperatures. Riverine, nearshore, and offshore areas are dredged for commercial shipping and recreational boating, construction of infrastructure, and marine mining. Dredging activities pose significant impacts to aquatic ecosystems by removing, disturbing and resuspending bottom sediments. Indirect harm to sturgeon from either mechanical or hydraulic dredging includes destruction of benthic feeding areas, disruption of spawning migrations, and deposition of resuspended fine sediments in spawning habitat.

Climate change

Although climate change may expand foraging habitats into higher latitude waters and increasing ocean temperatures may also lead to reduced primary productivity and eventual food availability, climate change could reduce nesting habitat due to sea level rise, as well as affect egg development and nest success. Rising temperatures may increase feminization of leatherback nests (Hawkes *et al.* 2007b; James *et al.* 2006; Mrosovsky *et al.* 1984; McMahon and Hays 2006). Hawksbill turtles exhibit temperature-dependent sex determination (Wibbels 2003) suggesting that there may be a skewing of future hawksbill cohorts toward strong female bias. 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 has also been linked to the timing of nesting, with higher temperatures leading to earlier nesting (Mazaris *et al.* 2009; Schofield *et al.* 2009). 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). However, warmer temperatures may also decrease the energy needs of a developing embryo (Reid et al. 2009).

Marine debris

Ingestion of marine debris can be a serious threat to sea turtles. When feeding, sea turtles can mistake debris (e.g., tar and plastic) for natural food items. Some types of marine debris may be directly or indirectly toxic, such as oil. Other types of marine debris, such as discarded or derelict fishing gear, may entangle and drown sea turtles. Plastic ingestion is very common in leatherbacks and can block gastrointestinal tracts leading to death (Mrosovsky et al. 2009).

Poaching

In the U.S., killing of nesting turtles is infrequent. However, on some beaches, human poaching of turtle nests and clandestine markets for eggs has been a problem (Ehrhart and Witherington. 1987). Egg poaching is a more serious problem in Puerto Rico (Matos 1987).

Contaminants

In sea turtles, heavy metals, including arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc, have been found in a variety of tissues in levels that increase with turtle size (Godley *et al.* 1999; Fujihara *et al.* 2003; Storelli *et al.* 2008; Anan *et al.* 2001; Saeki *et al.* 2000; Gardner *et al.* 2006; Garcia-Fernandez *et al.* 2009; Barbieri 2009). Cadmium has been found in leatherbacks at the highest concentration compared to any other marine vertebrate (Gordon *et al.* 1998; Caurant *et al.* 1999). 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). Arsenic has been found to be very high in green sea turtle eggs (van de Merwe et al. 2009).

Sea turtle tissues have been found to contain organochlorines, including chlorobiphenyl, chlordane, lindane, endrin, endosulfan, dieldrin, PFOS, PFOA, DDT, and PCB (Keller *et al.* 2004b; Keller *et al.* 2004a; Keller *et al.* 2005; Gardner *et al.* 2003; Storelli *et al.* 2007; McKenzie *et al.* 1999; Corsolini *et al.* 2000; Rybitski *et al.* 1995; Alava *et al.* 2006; Perugini *et al.* 2006; Monagas *et al.* 2008; Oros *et al.* 2009; Miao *et al.* 2001). 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; Oros *et al.* 2009; Davenport *et al.* 1990). Levels of PCBs found in green sea turtle eggs are considered far higher than what is fit for human consumption (van de Merwe et al. 2009).

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.* 2006; Keller *et al.* 2004c; Oros *et al.* 2009). These contaminants could cause deficiencies in endocrine, developmental, and reproductive health (Storelli et al. 2007), and are known to depress immune function in loggerhead sea turtles (Keller et al. 2006). Females from sexual maturity through reproductive life should have lower levels of contaminants than males because contaminants are shared with progeny through egg formation.

Exposure to sewage effluent may also result in green sea turtle eggs harboring antibiotic-resistant strains of bacteria (Al-Bahry et al. 2009).

Vessel strikes

Propeller and collision injuries from boats and ships are common in sea turtles. From 1997 to 2005, 14.9% of all stranded loggerheads in the U.S. Atlantic and Gulf of Mexico were documented as having sustained some type of propeller or collision injuries although it is not known what proportion of these injuries were post or ante-mortem. The incidence of propeller wounds has risen from approximately 10% in the late 1980s to a record high of 20.5% in 2004 (NMFS, unpublished data).

Military activities

Vessel operations and ordnance detonations adversely affect listed species of sea turtles. U.S. Navy aerial bombing training in the ocean off the southeast U.S. coast involving drops of live ordnance (500 and 1,000-lb bombs) have been estimated to have injured or killed 84 loggerhead, 12 leatherback, and 12 green or Kemp‘s ridley sea turtles, in combination (NMFS 1997). The Navy ship-shock trials for the USS Winston S. Churchill was conducted in the proposed Action Area, although the U.S. Navy employed a suite of measures that appeared to protect marine mammal and sea turtle from being exposed to shock waves produced by the underwater detonations associated with the trial (Clarke and Norman 2005).

In August and September 2008, the U.S. Navy conducted a ship shock trial on the Mesa Verde in waters east of Jacksonville, Florida, using High Blast Explosive (HBX-1) for the detonations (U.S. Navy 2008). NMFS' biological opinion on the ship shock trial expected up to 36 sea turtles to be injured as a result of the ship shock trial and up to 1,727 turtles to be harassed as a result of their behavioral responses to the underwater detonations. The after action report for the ship shock trial could neither refute nor confirm these estimated number of animals that might have been harassed by the trials; however, surveys associated with the trial did not detect any dead or injured sea turtles during the shock trial event or during post-mitigation monitoring. In addition, no sea turtle stranding events have been attributed to the shock trial.

Military training activities that occur on coastal bases in the southeast U.S. have the potential to increase non-nesting emergences of nesting females, run over nesting females and emerging hatchlings, and destroy nests.

Scientific research

Sea turtles in the action area have been the subject of numerous scientific research activities as authorized by NMFS permits. Research activities for sea turtles range from photographing, weighing, and tagging sea turtles incidentally taken in fisheries, instrument attachment, blood and fecal sampling, biopsy sampling, lavage, and performing laparoscopy on intentionally captured turtles. Four permits, including the proposed action, authorize takes for sea turtle mortality. There are currently 10 active permits directed towards sea turtles in the action area.

Table 2. Existing permits authorizing takes for the target sea turtle species in or near the action area. The proposed amendment would replace the permit in **bold.**

Permit Number	Permit Holder	Expiration Date
1551	NMFS SEFSC	July 1, 2013
1552	NMFS SEFSC	July 30, 2011
1557	Molly Lutcavage	June 30, 2012
1570	NMFS SEFSC	December 31, 2011
1571	NMFS SEFSC	December 31, 2011
1576	NMFS NEFSC	October 31, 2012
13543	South Carolina Department of Natural Resources	April 30, 2014
14726	Blair Witherington	September 15, 2015
15552	NMFS SEFSC	July 25, 2016
15566	**SCDNR**	**April 30, 2016**

Table 3. Types of research activities authorized by active permits. The sex and age class of animals affected varies by permit, as does the time of year and frequency of activity. The Proposed Action appears in ***italics***.

Permit No.	Capture	Blood sampling	Fecal sampling/ lavage	Laparo -scopy	Tissue sampling	Attach instru- ments	Tags or marks	Mortality
1551	✓	✓	✓	✓	✓	✓	✓	
1552					✓		✓	
1557	✓	✓				✓	✓	✓
1570	✓				✓		✓	✓
1571					✓		✓	
1576	✓				✓		✓	✓
13543							✓	
14726	✓		✓		✓	✓	✓	
15552					✓		✓	
15566-01	✓	✓	✓		✓	✓	✓	✓

Before any research permit is issued, the proposal must be reviewed under the permit regulations (i.e., must show a benefit to the species). In addition, since issuance of the permit is a federal activity, issuance of the permit by the NMFS must also be reviewed for compliance with section 7(a)(2) of the ESA to ensure that issuance of the permit does not result in jeopardy to the species. Authorized "takes" by harassment represent substantial research effort relative to species abundance in the action area with repeated disturbances of individuals likely to occur each year. However, all permits for sea turtles contain conditions requiring the permit holders to coordinate their activities with the NMFS regional offices and other permit holders and, to the extent possible, share data to avoid unnecessary duplication of research.

The fact that multiple permitted "takes" of listed sea turtles is already permitted and is expected to continue to be permitted in the future, means that short-term behavioral harassment expected to listed sea turtles from similar research activities has the ability to contribute to or even exacerbate the non-lethal stress responses generated from other threats occurring in the action area. The point at which this leads to a measurable cumulative impact on the survival and recovery of listed sea turtles, however, is uncertain. Our ability to detect long-term effects from research activities will depend on several factors including our ability to better detect sub-lethal effects from research actions as well as funding and prioritizing long-term studies investigating survival and reproductive abilities of listed species targeted by similar types of research in the past. This may lead to statistically significant trends showing whether or not repeated non-lethal disturbances by research activities are affecting the ability of listed sea turtles to survive and recover in the wild to an appreciable degree.

International protection

Sea turtles are migratory and therefore require participation between multiple countries to create an umbrella of protection and recovery techniques throughout their entire range. The Inter-American Convention for the Protection and Conservation of Sea Turtles provides the legal framework for countries in the Americas and the Caribbean to take actions for the benefit of sea turtles. Regional Fishery Management Organizations (RFMO's) such as the International Commission for the Conservation of Atlantic Tunas can create recommendations aimed at sea turtle bycatch under its managed fisheries; however, this is not an RFMO's main function. The Convention on Trade in Endangered Species (CITES) regulates the trade of sea turtles; most, but not all nations have signed on to CITES and some nations have been found in violation of their signatory duties under CITES. The lack of a major international agreement to conserve and protect sea turtles is a major obstacle to sea turtle protection and recovery.

Conservation and management

NMFS has implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles from commercial fisheries in the action area. These include sea turtle release gear requirements for the Atlantic Highly Migratory Species Fishery, Gulf of Mexico reef fish, and South Atlantic snapper-grouper fishery, and TED requirements for Southeast shrimp trawl fishery. NMFS published a final rule on July 6, 2004, to implement management measures to reduce bycatch and bycatch mortality of Atlantic sea turtles in the Atlantic pelagic longline fishery (69 FR 40734). The management measures include mandatory circle hook and bait requirements, and mandatory possession and use of sea turtle release equipment to reduce bycatch mortality. In the Hawaii-based longline swordfish fishery which required vessels to switch from using a J-shaped hook with squid bait to a wider circle-shaped hook with fish bait has reduced capture rates of leatherback and loggerhead turtles significantly by 83% and 90% respectively (Gilman *et al.* 2007). There was also a highly significant reduction in the proportion of turtles that swallowed hooks (versus being hooked in the mouth or body or entangled) and a highly significant increase in the proportion of caught turtles that were released after removal of all terminal tackle, which could lead to the likelihood of turtles surviving the interaction (Read 2007).

NMFS has implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles in commercial shrimp trawl fisheries. In particular, NMFS has required the use of TEDs in southeast United States shrimp trawls since 1989 and in summer flounder trawls in the Mid-Atlantic area (south of Cape Charles, Virginia) since 1992. It has been estimated that TEDs exclude 97 percent of the sea turtles caught in such trawls (Cox *et al.* 2007). These regulations have been refined over the years to ensure that TEDs are properly installed and used where needed to minimize the impacts on sea turtles. On August 3, 2007, NMFS published a final rule required selected fishing vessels to carry observers on board to collect data on sea turtle interactions with fishing operations, to evaluate existing measures to reduce sea turtle takes, and to determine whether additional measures to address prohibited sea turtle takes may be necessary (72 FR 43176).

NMFS published a final rule (66 FR 67495, December 31, 2001) detailing handling and resuscitation techniques for sea turtles that are incidentally caught during scientific research or fishing activities. Those participating in fishing activities or scientific research are required to handle and resuscitate (as necessary) sea turtles as prescribed in the final rule. These measures help to prevent mortality of hard-shelled turtles caught in fishing or scientific research gear. There is also an extensive network of Sea Turtle Stranding and Salvage Network participants along the Atlantic and Gulf of Mexico coasts who not only collect data on sea turtle mortality, but also rescue and rehabilitate any live stranded sea turtles that are encountered.

Effects of the proposed actions

Pursuant to Section 7(a)(2) of the ESA, federal agencies are required to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The proposed permit by the Permits Division would expose listed sea turtles to actions that constitute “take” from tagging activities. 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, and lifetime reproductive success), the assessment would consider the risk posed to the viability of the population. The purpose of this assessment is to determine if it is reasonable to expect the proposed studies to have effects on listed sea turtles affected by this permit that could appreciably reduce the species' likelihood of surviving and recovering in the wild.

For this consultation, we are particularly concerned about behavioral 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, and therefore species level, consequences. The proposed permit would authorize non-lethal "takes" by harassment of listed species during research activities, as well as authorizing a limited number of unintentional mortalities of sea turtles.

Potential stressors

The Permits Division has already authorized the researchers to photograph and video, approach and capture by trawl, mark carapace (temporary), biopsy keratin, flipper and PIT tag, measure and weigh, ultrasound, transport, collect tumors, remove epibiota, collect blood and fecal samples, perform cloacal swabs and scute scrapes, and attach satellite tags using epoxy to sea turtles. The researchers are also authorized a limited number of unintentional mortalities of sea turtles. These activities would not change.

In this opinion, we are also considering the potential for Atlantic sturgeon to be captured in the trawls.

Exposure analysis

Exposure analyses identify the co-occurrence of ESA-listed species with the action's effects 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 action's effects and the populations(s) or subpopulation(s) those individuals represent.

The Permits Division proposes to issue a permit amendment for scientific research to the South Carolina Department of Natural Resources. Activities would occur from May through September in coastal waters of the Northwest Atlantic Ocean between Winyah Bay, SC and St. Augustine, FL, almost exclusively in state territorial waters within 12 nm of shore, at depths of 15 and 40 feet. Researchers would attempt to conduct 300 sampling events along the South Carolina coast and 300 along the Georgia coast to St. Augustine, Florida each year, for a total of 3,000 trawls over a 5-year period.

Table 1 identifies the numbers of sea turtles that the Department of Natural Resources are currently authorized to capture annually under the five-year permit, the procedures that would be authorized, and the number of sea turtles that could be unintentional killed during research.

The proposed permit amendment would increase the number of Kemp's ridley sea turtles that could be taken from 29 to 79. This is the only change to the permit that would be authorized under the proposed amendment.

In 2011, the permit holders exceeded their permitted takes of Kemp's ridley sea turtles, catching 33 in their net trawl, instead of 29. This occurred despite their sampling effort being 20% lower than their target of 250+ stations per vessel. The reduced sampling effort occurred due to mechanical issues for one of their vessels, and having to cut off sampling early due to exceeding their permitted takes for Kemp's ridleys.

To determine the expected take over the next 4 years of the permit, we took the 2011 number of takes (33) and increased it by 20%, estimating that 40 Kemp's ridley sea turtles could have been caught in 2011 if conditions had allowed for a full sampling season. Heppell et al. (2005) predicts the population of Kemp's ridleys to increase 16% annually. This increase could lead to future capture rates of in 46 in 2012, 54 in 2013, 62 in 2014, and 72 in 2015, the year that the current permit expires. The applicant has requested for a 10% increase to account for uncertainty, which would bring the requested annual take for Kemp's ridley sea turtles to 79.

Based on this explanation for the request for increased takes, we think it is possible that up to 79 Kemp's ridley sea turtles could be annually exposed to the permit holder's action by the last year of the permit.

In May 2005, the permit holder caught 5 Atlantic salmon in 5 separate trawls in the Charleston, SC shipping entrance channel; all 5 were active and released alive. We believe that these 5 sturgeon were likely from the South Atlantic or Carolina DPS, but it is possible that they came from one of the other 3 DPSs. In 2006, one decayed carcass of an Atlantic sturgeon was captured in a trawl. We conducted a Poisson analysis, based on the number of Atlantic sturgeon caught (6) and the total number of trawls (5237 over 10 years). Given that the applicant expects to conduct approximately 600 trawls per year for the next five years, we estimate that up to 3 Atlantic sturgeon could be caught over the course of the five-year permit. Although past experience tells us that it is possible for the researchers to catch more than 3 Atlantic sturgeon in this time period, the Poisson analysis indicates that this is not likely.

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 being exposed 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 (or physiological), or behavioral responses that might reduce the fitness of individuals. Ideally, response analyses would consider and weigh evidence of adverse consequences as well as evidence suggesting the absence of such consequences.

Evidence indicates that wild animals respond to human disturbance in the same way they respond to predators (Lima 1998; Beale and Monaghan 2004; Frid and Dill 2002; Frid 2003; Gill *et al.* 2001; Romero 2004). These responses may manifest themselves as stress responses, interruptions of essential behavioral or physiological events, alteration of an animal's time budget, or some combinations of these responses (Frid and Dill 2002; Romero 2004; Sapolsky *et al.* 2000; Walker *et al.* 2005).

The responses to stressors that are part of the proposed amendment were already assessed in the consultation for Permit 15566, and are assessed again in this Opinion, because the increased permitted take would result in an increased number of turtles that could have the responses described below.

Sea turtles

Response to capture

Permit 15566-01 would authorize researchers to capture sea turtles using trawls. Sea turtles forcibly submerged in any type of restrictive gear eventually suffer fatal consequences from prolonged anoxia and/or seawater infiltration of the lung (Lutcavage *et al.* 1997). A study examining the relationship between otter trawl tow time and sea turtle mortality showed that mortality was dependent on trawling duration. The studies analyzing the shrimp fishery show that tows of short duration have little effect on mortality, intermediate tow times result in a rapid escalation to mortality, and eventually reach a plateau of high mortality (Epperly *et al.* 2002). It is probable that different sea turtle species have different physiological responses to lengthy forced submergence by entanglement nets due to differing average body sizes and corresponding oxygen capacities. In the absence of species-specific estimates, however, the trawl studies represent the best available scientific information available.

The proportion of dead or comatose turtles rose from 0% for the first 50 minutes of capture to 70% after 90 minutes of capture in work by Henwood and Stuntz (1987) done on forced submergence in the shrimp fishery. However, metabolic changes that can impair a sea turtle's ability to function can occur within minutes of a forced submergence. While most voluntary dives appear to be aerobic, showing little if any increases in blood lactate and only minor changes in acid-base status, forcibly submerged turtles can experience rapid consumption of oxygen stores, activation of anaerobic glycolysis, and disturbance of acid-base balance, sometimes to lethal levels (Lutcavage and Lutz 1997). Forced submergence of Kemp's ridley sea turtles in shrimp trawls resulted in an blood chemistry imbalance after just a few minutes (times that were within the normal dive times for the species) (Stabenau *et al.* 1991) and recovery times for blood chemistry levels to return to normal may be prolonged as long as 20 hours or more (Henwood and Stuntz 1987).

This effect is expected to be worse for sea turtles that are recaptured before metabolic levels have returned to normal. Respiratory and metabolic stress due to forced submergence is also correlated with additional factors such as size and activity of the turtle, water temperatures, and biological and behavioral differences between species.

South Carolina Department of Natural Resources has conducted trawl sampling research on sea turtles for 10 years (under permits 1540 and 1245). It has not had a sea turtle mortality in those 10 years. The current permit includes unintentional mortalities of up to 5 loggerhead, 1 green, 1 hawksbill, 1 Kemp's ridley, and 1 leatherback sea turtle for the duration of the permit. The applicant supported their request by stating that the total requested loggerhead mortality (0.4% of the max 5-year captures) is a more conservative estimate than the mortality experienced in shrimp trawl fisheries.

With the exception of possible unintentional mortalities, NMFS does not expect the applicant's proposal to conduct the capture activities listed in Table 1 to result in more than short-term effects on individual animals due to the conditions concerning animal handling and follow-up monitoring placed on the Permit Holder. In addition, NMFS does not expect any delayed mortality of turtles following their release as a direct result of the research based on past research efforts by other researchers and adherence to protocols identified in the proposed action.

Response to handling, carapace marking, measuring, weighing, and ultrasound

Handling, measuring, and weighing can result in raised levels of stress hormones in sea turtles. However, the procedures are simple and not invasive. NMFS expects that individual turtles would normally experience no more than short-term stresses as a result of these activities. No injury would be expected from these activities, and turtles would be measured and weighed as quickly as possible to minimize stresses resulting from their capture. The applicant would also be required to follow procedures designed to minimize the risk of either introducing a new pathogen into a population or amplifying the rate of transmission from animal to animal of an endemic pathogen when handling animals. The proposed action would only allow the use of a non-toxic marker. This activity would not injure or compromise the animal and would not add appreciably to the stress the animal would experience during handling and other activities.

Given the precautions that would be taken by the researchers to ensure the safety of the turtles and the permit conditions relating to handling, NMFS expects that the activities would have minimal and insignificant effects on the animals. Turtles would be handled with care, kept moist, protected from temperature extremes, and returned to the sea.

Ultrasound is non-invasive with little to no effect to turtles (Owens 1999). Any stresses associated with this activity are likely to be related to the extra handling time and are expected to be minimal and short-term.

Response to flipper tagging and PIT tagging

Tagging activities are minimally invasive and all tag types have negatives associated with them, especially concerning tag retention. Plastic tags can become brittle, break and fall off underwater, and titanium tags can bend during implantation and thus not close properly, leading to tag loss. Tag malfunction can result from rusted or clogged applicators or applicators that are worn from heavy use (Balazs 1999). Turtles that have lost external tags would be re-tagged if captured again at a later date, which subjects them to additional effects of tagging.

Turtles would experience some discomfort during the tagging procedures and these procedures would produce some level of pain. The discomfort would usually be short and highly variable between individuals (Balazs 1999). Most barely seem to notice, while a few others exhibit a marked response. However, NMFS expects the stresses to be minimal and short-term and that the small wound-site resulting from a tag would heal completely in a short period of time. Similarly, turtles that must be re-tagged would also experience minimal short-term stress and heal completely in a short period of time. Re-tagging would not be expected to appreciably affect these turtles. The proposed tagging methods have been regularly employed in sea turtle research with little lasting impact on the individuals tagged and handled (Balazs 1999).

Given the precautions that would be taken by the researchers to ensure the safety of the turtles and the permit conditions relating to handling, NMFS expects that the activities would have minimal and insignificant effects on the animals. All animals would be handled with care, kept moist, protected from temperature extremes and later returned to the sea.

Response to blood sampling

Taking a blood sample from the sinuses in the dorsal side of the neck is now a routine procedure (Owens 1999). According to Owens (1999), with practice it is possible to obtain a blood sample 95% of the time and the sample collection time would be expected to be about 30 seconds in duration. Sample collection sites would be disinfected with alcohol or other antiseptic prior to sampling. Blood sampling volume would be conditioned to only allow a conservative amount of blood (conditioned in the permit) to be drawn. Blood hormones and heart rate have been measured in animals that have had this amount of blood drawn from them and no stress has been observed (E. Stabenau, pers. comm. to P. Opay, NMFS, 2005).

Response to barnacle removal, keratin biopsy, and cloacal swabbing

Removal of barnacles is not expected to significantly affect the animal as they can be removed in a relatively non-invasive manner. While the turtle may experience short-term stress, this stress would not be significant, either individually or cumulatively.

Keratin biopsies would be conducted on loggerheads using a sterile biopsy punch. This activity would allow researchers to collect splinters of scute material in a non-invasive manner with little effect on the turtles. NMFS does not expect that the collection of a keratin sample would cause any significant additional stress or discomfort to the turtle beyond what was experienced during other research activities.

Cloacal swabs would be collected from loggerheads. Although the swab would enter the cloaca and could be mildly uncomfortable to the turtle, the swab would be sterile and no tissue surface would be pierced. NMFS does not expect that the cloacal swab sampling would cause any significant additional stress or discomfort to the turtle beyond what was experienced during other research activities.

Response to satellite tagging

Transmitters attached to the carapace of turtles have the potential to increase hydrodynamic drag and affect lift and pitch (Watson and Granger 1998). It is possible that transmitter attachments would negatively affect the swimming energetics of the turtle. During a study of sonic-tracked turtles by Seminoff et al. (2002), green turtles returned to areas of initial capture, suggesting that the transmitters and the tagging experience left no lasting effect on habitat use patterns. In a study of video camera-equipped green turtles, telemetered turtles exhibit normal diving behavior, and sufficient swimming speeds (Seminoff et al. 2006). However, none of the instruments in the proposed research are as large as the video cameras, and so lesser potential impacts would be expected.

The short-term stresses resulting from transmitter attachment and tracking would be expected to be minimal and not add significantly to any stress that turtles have already experienced from capture or other the research activities. The permit would contain conditions to mitigate adverse impacts to turtles from the transmitters. Turtles would be satellite tagged as quickly as possible to minimize stresses resulting from the research.

Total weight of any transmitter or tag attachment for any one turtle must not exceed 5% of the body mass of the animal. The attachment must be made so that there is minimal risk to the turtle of entanglement and the attachment is as hydrodynamic as possible.

Based on past experience with these techniques used by turtle researchers and the documented effects of transmitter attachments, we expect that the turtles would experience some small additional stress from attaching transmitters during this research, but would not experience significant increases in stress or discomfort beyond what was experienced during capture and other research activities, and that the transmitters would not result in any serious injury. We expect that the transmitters would not significantly interfere with the turtles' normal activities after they are released.

Response to transport

Given the precautions that would be taken by the researchers and the permit conditions they would be required to follow to ensure the safety of the turtles, NMFS believes that the transport of any animals would have minimal, insignificant effects on the animals.

Atlantic sturgeon

Response to capture and release

As described in the *Exposure analysis*, all 5 of the Atlantic sturgeon captured in 2005 were active and released alive. The single sturgeon caught in 2006 was in a state of decay, and although it would still be considered a "take" under the ESA, we can assume that the trawl did not cause the mortality. Balazik *et al.* (2009; as cited in Kahn and Mohead 2010) report a disproportionately high level of mortality using 10" stretch mesh with Atlantic sturgeon. The nets used in the proposed action would have 8" stretch mesh (net body) and 4" stretch mesh (cod end).

Based on the past captures either being of living and apparently unharmed Atlantic sturgeon or of carcasses, and the net's mesh size being smaller than that which is most likely to cause mortality to the sturgeon, we believe that the capture of Atlantic sturgeon would not likely to cause mortality for the captured sturgeon. Trawling is recommended in Kahn and Mohead (2010) as a safe and efficient gear for capturing Atlantic sturgeon, and therefore we do not expect that their capture and release would significantly interfere with the sturgeon's normal activities after they are released.

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 include state legislature websites and Nexis. We reviewed bills passed from 2011-2012 and pending bills under consideration were included as further evidence that actions "are reasonably certain to occur."

Legislation from South Carolina, Georgia, and Florida address oil spill prevention and response, off-shore oil drilling and alternative energy development, wastewater treatment and controlling pollution discharges, water supply concerns, climate change, dredging of ports, regulation of commercial and recreational use of ocean waters, and ecosystem, natural resource, and endangered species recovery and protection.

After reviewing available information, NMFS is not aware of effects from any additional future non-federal activities in the action area that would not require federal authorization or funding and are reasonably certain to occur during the foreseeable future.

Integration and synthesis of the 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.

The *Status of listed resources* and *Environmental baseline* described the factors that have contributed to the reduction in population size for green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles and Atlantic sturgeon. Sea turtle populations have suffered drastic declines, likely due to overharvesting of eggs and mortality from fishing activities (bycatch). Other threats include predation, habitat degradation and climate change, contaminants, and marine debris. Atlantic stugeon have declined due to historic overfishing and habitat degradation. NMFS expects that the current natural anthropogenic threats described in the *Environmental baseline* will continue. The *Cumulative effects* section provided examples of state legislation that is likely to occur and could have an effect on the action area.

The NMFS Permits Division proposes to issue a permit amendment to the South Carolina Department of Natural Resources to increase the number of Kemp's ridley sea turtles that could be captured and handled under the current permit. We considered the effects of the proposed amendment, in conjunction with the currently permitted actions authorized for 445 loggerhead, 29 Kemp's ridley, 9 green, 1 leatherback, and 1 hawksbill sea turtles that could be captured annually. Although there is a chance of mortality due to capture, we expect there would be no more than short-term effects on individual animals from the other proposed actions would not lead to reduced opportunities for foraging or reproduction for targeted individuals, and we do not expect this risk of mortality to increase due to the amendment.

Given the past experience the applicant has had catching Atlantic sturgeon in its trawls, we believe that up to 3 sturgeon could be captured over the life of the permit. We do not anticipate that this will result in mortality for the Sturgeon, and we expect that any effects would be short-term and would not lead to reduced opportunities for foraging or reproduction for any affected sturgeon.

Conclusion

After reviewing the current *Status of listed resources*; the *Environmental baseline* for the *Action area*; the anticipated effects of the proposed activities; and the *Cumulative effects*, it is NMFS' Biological Opinion that the activities authorized by the issuance of scientific research permit 15566-01, as proposed, are not likely to jeopardize the continued existence of green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles, and Atlantic sturgeon, and we do not anticipated the destruction or adverse modification of designated critical habitat of within the action area.

Incidental take statement

Section 9 of the ESA and federal regulation pursuant to Section 4(d) of the ESA prohibit 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 the 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 Sections 7(b)(4) and 7(o)(2), taking that is incidental and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

As discussed in the accompanying Biological Opinion, the listed species targeted by the proposed research activities would be harassed as part of the intended purpose of the proposed action. Therefore, the NMFS does not expect the proposed action would incidentally take the targeted listed threatened or endangered species, and the take of green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles is not considered under the Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the NMFS' Permits Division so that they become binding conditions of any permit issued to the South Carolina Department of Natural Resources, as appropriate, for the exemption in section 7(o)(2) to apply. The Permits Division has a continuing duty to regulate the activity covered by this incidental take statement. If the Permits Division (1) fails to assume and implement the terms and conditions or (2) fails to require the permit holder to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Permits Division must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement. [50 CFR §402.14(i)(3)]

Amount or extent of take

NMFS anticipates that the proposed action is likely to result in incidental take of Atlantic sturgeon. Based on the past numbers of Atlantic sturgeon caught in the permit holder's trawls, we conducted a Poisson analysis and estimate that they could catch up to 3 Atlantic sturgeon over the course of the 5-year permit, if the proposed permit is issued.

Of the 3 that we expect could be captured in trawls, we do not anticipate any mortalities would occur, based on the previous experience of the permit holder and the mesh size of the trawls. It is possible that a dead Atlantic sturgeon could be caught in the trawl.

In the accompanying Biological Opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to Atlantic sturgeon.

Reasonable and prudent measures

NMFS believes the following reasonable and prudent measure(s) are necessary and appropriate to minimize take of Atlantic sturgeon:

- Ensure completion of a monitoring and reporting program to confirm this Opinion is meeting its objective of limiting the extent of take and minimizing take from permitted activities.
- Minimize the impact of incidental take resulting from capturing and handling Atlantic sturgeon.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Permits Division must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

- To implement RPM 1 (monitoring), the Permits Division shall:
    - Report any sturgeon interactions to the NMFS' Chief of the Endangered Species Act Interagency Cooperation Division, Office of Protected Resources.
    - Report total captures of Atlantic sturgeon in the annual reports that would be required under Permit 15566-01.
- To implement RPM 2 (minimize impact), the Permits Division shall:
    - Require the permit holder to handle fish with care, and return them to the water as quickly as possible. As described in the conditions in permit 15566-01, efforts must be made to return the fish to neutral buoyancy prior to and during release. Air must be released by gently applying ventral pressure in a posterior to anterior direction. The specimen must then be propelled rapidly downward during release.

The ESA IC Division believes that no more than 3 of Atlantic sturgeon will be incidentally taken as a result of the proposed action. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Permits Division must immediately provide an explanation of the causes of the taking and review with the ESA IC Division the need for possible modification of the reasonable and prudent measures.

Conservation recommendations

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of 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 following conservation recommendations would provide information that would improve the level of protections afforded in future consultations involving proposals to issue permits for research on the listed sea turtle species:

1. *Cumulative impact analysis.* The Permits Division should work with sea turtle recovery teams and the research community to develop protocols that would have sufficient power to determine the cumulative impacts (that is, includes the cumulative lethal, sub-lethal, and behavioral consequences) of existing levels of research on individuals populations of sea turtles.

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

Reinitiation notice

This concludes formal consultation on the proposal to amend scientific research permit No. 15566-01 to the South Carolina Department of Natural Resources for studies of green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles, and the the incidental take of Atlantic sturgeon, off the coast of the southeastern United States. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of authorized take is exceeded, the NMFS Permits Division must immediately request reinitiation of Section 7 consultation.

References

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.

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., I. Mahmoud, A. Elshafie, A. Al-Harthy, S. Al-Ghafri, I. Al-Amri, and A. Alkindi. 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., J. M. Keller, J. R. Kucklick, J. Wyneken, L. Crowder, and G. I. Scott. 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.

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.

Arendt, M., J. Byrd, A. Segars, P. Maier, J. Schwenter, D. Burgess, J. Boynton, J. D. Whitaker, L. Liguori, L. Parker, D. Owens, and G. Blanvillain. 2009. Examination of local movement and migratory behavior of sea turtles during spring and summer along the Atlantic coast off the southeastern United States. South Carolina Department of Natural Resources, University of Georgia, and College of Charleston, Final Report to NOAA Fisheries, Contract Number NA03NMF4720281, 177p.

Armstrong, J. L. and J. E. Hightower. 2002. Potential for restoration of the Roanoke River population of Atlantic sturgeon. . Journal of Applied Ichthyology. 18:475-480.

ASMFC. 1990. Interstate fishery management plan for Atlantic sturgeon. Fisheries Management Report No. 17. Atlantic States Marine Fisheries Commission, Washington, D.C. 73 pp.

ASMFC. 1998. Amendment 1 to the interstate fishery management plan for Atlantic sturgeon. Management Report No. 31, 43 pp.

Atlantic Sturgeon Status Review Team. 2007. Status Review of Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

Avens, L. and L. R. Goshe. 2007. Skeletochronological analysis of age and growth for leatherback sea turtles in the western North Atlantic. P.223 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.

Bain, M. B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and Divergent Life History Attributes. . Environmental Biology of Fishes 48:347-358.

Balazik, M., S. Cameron, D. Clarke, C. Frederickson, S. Giordano, C. Hager, J. Lazar, S. McIninch, K. Reine, C. Dickerson, W. Shuart, and A. Spells. 2009. Movements and habitat associations of Atlantic sturgeon in the James River estuary, Virginia. Oral Presentation Abstract, 139th Meeting of the American Fisheries Society, Nashville, Tennessee.

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.

Bjourndal, F. A. Abreu-Grobois and M. Donnelly (editors). IUCN/SSC Marine Turtle Specialist Group Publication No 4, 1999.
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.
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.
Beale, C. M. and P. Monaghan. 2004. Human disturbance: people as predation-free predators? Journal of Applied Ecology 41:335-343.
Beggs, J. A., J. A. Horrocks, and B. H. Krueger. 2007. Increase in hawksbill sea turtle Eretmochelys imbricata nesting in Barbados, West Indies. Endangered Species Research 3:159–168.
Bell, L. A. J., U. Fa'Anunu, and T. Koloa. 1994. Fisheries resources profiles: Kingdom of Tonga, Honiara, Solomon Islands.
Benson, S. R., P. H. Dutton, C. Hitipeuw, B. Samber, J. Bakarbessy, and D. Parker. 2007a. Post-nesting migrations of leatherback turtles (*Dermochelys coriacea*) from Jamursba-Medi, Bird's Head Peninsula, Indonesia. Chelonian Conservation and Biology 6(1):150-154.
Benson, S. R., K. M. Kisokau, L. Ambio, V. Rei, P. H. Dutton, and D. Parker. 2007b. Beach use, internesting movement, and migration of leatherback turtles, *Dermochelys coriacea*, nesting on the north coast of Papua New Guinea. Chelonian Conservation and Biology 6(1):7-14.
Berkson, H. 1967. Physiological adjustments to deep diving in the Pacific green turtle (Chelonia mydas 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.
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 Technical Memorandum NMFS-SEFSC-445.
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., T. J. Austin, C. D. L. Bell, J. B. Bothwell, A. C. Broderick, G. Ebanks-Petrie, J. A. Gibb, K. E. Luke, J. R. Olynik, M. F. Orr, J. L. Solomon, and B. J. Godley. 2009. Ecology of Hawksbill Turtles, Eretmochelys imbricata, on a Western Caribbean Foraging Ground. Chelonian Conservation and Biology 8(1):1-10.
Bolten, A. B. 1999. Techniques for measuring sea turtles. . Pages 110-114 *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. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.
Boreman, J. 1997. Sensitivity of North American sturgeons and paddlefish to fishing mortality. Environmental Biology of Fishes 48:399-405.
Boulon, R. H., Jr. 1983. Some notes on the population biology of green (*Chelonia mydas*), and hawksbill (*Eretmochelys imbricata*) turtles in the northern U.S. Virgin Islands; 1981-83.

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

Bowen, B. W., A. L. Bass, A. Garcia Rodriguez, C. E. Diez, R. Van Dam, A. B. Bolten, K. A. Bjorndal, M. M. Miyamoto, and R. J. Feri. 1996. Origin of hawksbill turtles in a Caribbean feeding area as indicated by genetic markers. Ecological Applications 6:566-572.

Bowen, B. W., W. S. Grant, Z. Hillis-Starr, D. J. Shaver, K. A. Bjorndal, A. B. Bolten, and A. L. Bass. 2007. Mixed stock analysis reveals the migrations of juvenile hawksbill turtles (Eretmochelys imbricata) in the Caribbean Sea. Molecular Ecology 16:49-60.

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

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

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., C. R. Frauenstein, F. Glen, G. C. Hays, A. L. Jackson, T. Pelembe, G. D. Ruxton, and B. J. Godley. 2006. Are green turtles globally endangered? Global Ecology and Biogeography 15:21-26.

Brongersma, L. 1972. European Atlantic Turtles. Zool. Verhand. Leiden, 121:318 pp., 12 pits., 8 maps.

Brooks, L. B., J. T. Harvey, and W. J. Nichols. 2009. Tidal movements of East Pacific green turtle Chelonia mydas at a foraging area in Baja California Sur, Mexico. Marine Ecology-Progress Series 386:263-274.

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.
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.
Caron, F., D. Hatin, and R. Fortin. 2002. Biological characteristics of adult Atlantic sturgeon (Acipenser oxyrinchus) in the Saint Lawrence River estuary and the effectiveness of management rules. Journal of Applied Ichthyology. 18:580-585.
Carr, A. 1987. New perspectives on the pelagic stage of sea turtle development. Conservation Biology 1.
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.
Carr, A. F. 1963. Panspecific reproductive convergence in Lepidochelys kempi. Ergebnisse der Biologie 26:298-303.
Carreras, C., S. Pont, F. Maffucci, M. Pascual, A. Barceló, F. Bentivegna, L. Cardona, F. Alegre, M. SanFélix, G. Fernández, and A. Aguilar. 2006. Genetic structuring of immature loggerhead sea turtles (Caretta caretta) in the Mediterranean Sea reflects water circulation patterns. Marine Biology 149(5):1269-1279.
Casale, P., A. D. Mazaris, D. Freggi, C. Vallini, and R. Argano. 2009. 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.
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. 2009. Effect of tidal overwash on the embryonic development of leatherback turtles in French Guiana. Marine Environmental Research in press(in press):in press.
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-CT558-548 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.
Chaloupka, M. 2001. Historical trends, seasonality, and spatial synchrony in green sea turtle egg production. Biological Conservation 101:263-279.
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.

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.
Chan, E. H. and H. C. Liew. 1999. Hawksbill turtles, Eretmochelys imbricata, nesting on Redang Island, Terengganu, Malaysia, from 1993 to 1997. Chelonian Conservation and Biology 3(2):326-329.
Cheng, I. J., C. T. Huang, P. Y. Hung, B. Z. Ke, C. W. Kuo, and C. L. Fong. 2009. Ten Years of Monitoring the Nesting Ecology of the Green Turtle, Chelonia mydas, on Lanyu (Orchid Island), Taiwan. Zoological Studies 48(1):83-94.
Clarke, J. T. and S. A. Norman. 2005. Results and evaluation of the US Navy shock trial environmental mitigation of marine mammals and sea turtles. Journal of Cetacean Research and Management 7(1):43-50.
Collins, M. R., T. I. J. Smith, W. C. Post, and O. Pashuk. 2000. Habitat utilization and biological characteristics of adult Atlantic sturgeon in two South Carolina rivers. Transactions of the American Fisheries Society 129:982-988.
Compagno, L. J. V. 1984. Sharks of the world. Food and Agriculture Organization of the United Nations Species Catalogue Volume 4. 655 pages.
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.
Cox, T. M., R. L. Lewison, R. Zydelis, L. B. Crowder, C. Safina, and A. J. Read. 2007. Comparing effectiveness of experimental and implemented bycatch reduction measures: the ideal and the real. Conservation Biology 21:1155-1164.
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.
Crouse, D. T., L. B. Crowder, and H. Caswell. 1987. A stage-based population model for loggerhead sea turtles and implications for conservation. Ecology 68(5):1412-1423.
Crowder, L. B., D. T. Crouse, S. S. Heppell, and T. H. Martin. 1994. Predicting the impact of turtle excluder devices on loggerhead sea turtle populations. Ecological Applications 4:437-445.
Dadswell, M. 2006. A review of the status of Atlantic sturgeon in Canada, with comparisons to populations in the United States and Europe. . Fisheries 31:218-229.
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.
Deem, S. L., T. M. Norton, M. Mitchell, A. Segars, A. R. Alleman, C. Cray, R. H. Poppenga, M. Dodd, and W. B. Karesh. 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.
Diaz-Fernandez, R., T. Okayama, T. Uchiyama, E. Carrillo, G. Espinosa, R. Marquez, C. E. Diez, and H. Koike. 1999. Genetic sourcing for the hawksbill turtle, Eretmochelys imbricata, in the Northern Caribbean Region. Chelonian Conservation and Biology 3:296-300.
Diez, C. E. and R. P. v. Dam. 2002. Habitat effect on hawksbill turtle growth rates on feeding grounds at Mona and Monito Islands, Puerto Rico. Marine Ecology Progress Series 234:301-309.
Diez, C. E. and R. P. van Dam. 2006. Hawksbill turtle nesting beach habitat restoration on Mona Island, Puerto Rico: Research report for 2005.

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.

Dovel, W. L. and T. J. Berggren. 1983. Atlantic sturgeon of the Hudson River estuary, New York. . New York Fish and Game Journal 30:140-172.

Dutton, D. L., P. H. Dutton, M. Chaloupka, and R. H. Boulon. 2005. Increase of a Caribbean leatherback turtle *Dermochelys coriacea* nesting population linked to long-term nest protection. Biological Conservation 126:186-194.

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

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

Eckert, K. L. and S. A. Eckert. 1988. Pre-reproductive movements of leatherback turtles (Dermochelys coriacea) nesting in the Caribbean. Copeia 1988(2):400-406.

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., J. E. Moore, D. C. Dunn, R. S. van Buiten, K. L. Eckert, and P. N. Halpin. 2008. Modeling loggerhead turtle movement in the Mediterranean: Importance of body size and oceanography. Ecological Applications 18(2):290-308.

Ehrhart, L., 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 Institution Press, Washington, D.C.
Ehrhart, L. M., W. E. Redfoot, and D. A. Bagley. 1996. A study of the population ecology of in-water marine turtle populations on the east-central Florida coast from 1982-96. 164 pp. Department of Biology, University of Central Florida, Orlando.
Ehrhart, L. M. and B. E. Witherington. 1987. Human and natural causes of marine turtle nest and hatchling mortality and their relationship to hatchling production on an important Florida nesting beach. Final Report, Project Number GFC-84-018. Florida Game and Fresh Water Fish Commission, Nongame Wildlife Program, Technical Report No. 1. Tallahassee, Florida. 141 pages. .
Eisenberg, J. F. and J. Frazier. 1983. A leatherback turtle (Dermochelys coriacea) feeding in the wild. Journal of Herpetology 17(1):81-82.
Epperly, S., L. Avens, L. Garrison, T. Henwood, W. Hoggard, J. Mitchell, J. Nance, J. Poffenberger, C. Sasso, E. Scott-Denton, and C. Yeung. 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, NOAA Technical Memorandum NMFS-SEFSC-490, 88 pp.
Fergusson, I. K., L. J. V. Compagno, and M. A. Marks. 2000. Predation by white sharks Carcharodon carcharias (Chondrichthyes: Lamnidae) upon chelonians, with new records from the Mediterranean Sea and a first record of the ocean sunfish Mola mola (Osteichthyes: Molidae) as stomach contents. . Environmental Biology of Fishes 58:447-453.
Ferraroli, S., J. Y. Georges, P. Gaspar, and Y. L. Maho. 2004. Where leatherback turtles meet fisheries. Nature 429:521-522.
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.
Flint, M., J. M. Morton, C. J. Limpus, J. C. Patterson-Kane, P. J. Murray, and P. C. Mills. 2009. Development and application of biochemical and haematological reference intervals to identify unhealthy green sea turtles (Chelonia mydas). The Veterinary Journal.
Foley, A., A. Schroeder, A. Redlow, K. Fick-Child, and W. 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.
Fossette, S., C. Girard, T. Bastian, B. Calmettes, S. Ferraroli, P. Vendeville, F. Blanchard, and J.-Y. Georges. 2009. Thermal and trophic habitats of the leatherback turtle during the nesting season in French Guiana. Journal of Experimental Marine Biology and Ecology.
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., R. Arauz, J. Chevalier, A. Formia, J. Fretey, M. H. Godfrey, R. M.-. M., B. Pandav, and K. Shanker. 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.
Fretey, J. 2001. 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.
Frid, A. 2003. Dall's sheep responses to overflights by helicopter and fixed-wing aircraft. Biological Conservation 110:387-399.
Frid, A. and L. Dill. 2002. Human-caused disturbance stimuli as a form of predation risk. Conservation Ecology 6:11.
Fritts, T. H., M. L. Stinson, and R. Márquez-M. 1982. Status of sea turtle nesting in southern Baja California, México. Bulletin of the Southern California Academy of Sciences 81(2):51-60.
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.
Garcia-Fernandez, A. J., P. Gomez-Ramirez, E. Martinez-Lopez, A. Hernandez-Garcia, P. Maria-Mojica, D. Romero, P. Jimenez, J. J. Castillo, and J. J. Bellido. 2009. Heavy metals in tissues from loggerhead turtles (Caretta caretta) from the southwestern Mediterranean (Spain). Ecotoxicology and Environmental Safety 72(2):557-563.
Gardner, S. C., S. L. Fitzgerald, B. A. Vargas, and L. M. Rodriguez. 2006. Heavy metal accumulation in four species of sea turtles from the Baja California peninsula, Mexico. Biometals 19:91-99.
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.
Garduño-Andrade, M. 1999. Nesting of the hawksbill turtle, Eretmochelys imbricata, in Río Lagartos, Yucatán, Mexico, 1990-1997. Chelonian Conservation and Biology 3(2):281-285.
George, P. H. 1997. Health problems and diseases in turtles. Pages 363-385 *in* P. L. Lutz, and J. A. Musick, editors. The Biology of Sea Turtles. CRC Press, Boca Raton, Florida.
Gilbert, C. R. 1989. Atlantic and shortnose sturgeons. United States Department of Interior Biological Report 82: 28 pp. .
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., D. Kobayashi, T. Swenarton, N. Brothers, P. Dalzell, and I. Kinan-Kelly. 2007. Reducing sea turtle interactions in the Hawaii-based longline swordfish fishery. Biological Conservation 139:19-28.
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.
Godley, B., J. S. Richardson, A. C. Broderick, M. S. Coyne, F. Glen, and G. C. Hays. 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., H. S. M. Lima, S. Akesson, A. C. Broderick, F. Glen, M. H. Godfrey, P. Luschi, and G. C. Hays. 2003. Movement patterns of green turtles in Brazilian coastal waters described by satellite tracking and flipper tagging. Marine Ecology Progress Series 253:279-288.

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.

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.

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

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.

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., 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., 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.

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(4).

Heppell, S. S., D. T. Crouse, L. B. Crowder, S. P. Epperly, W. Gabriel, T. Henwood, R. Márquez, and N. B. Thompson. 2005. A population model to estimate recovery time, population size, and management impacts on Kemp's ridley sea turtles. Chelonian Conservation and Biology 4(4):767-773.

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.

Herbst, L. H. and E. R. Jacobson. 1995. Diseases of marine turtles. Pages 593-596 *in* K. A. Bjorndal, editor. Biology and Conservation of Sea Turtles, Revised Edition. Smithsonian Institution Press, Washington, D.C.

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

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.

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.

Homer, B. L., A. Foley, K. J. Fick, M. C. Lores, A. E. Redlow, and E. R. Jacobson. 2000. Legions, pathogens and toxins identified in 13 stranded marine turtles in Florida. Pages 117-118 in Abreu-Grobois, F.A., R. Briseno-Duenas, R. Marquez, and L. Sarti (compilers). Proceedings of the Eighteenth International Sea Turtle Symposium. NOAA Technical Memorandum NMFS-SEFSC-436.

Hopkins-Murphy, S. R., D. W. Owens, and T. M. Murphy. 2003. Ecology of Immature Loggerheads on Foraging Grounds and Adults in Internesting Habitat in the Eastern United States. Pages 79-92 *in* A. B. Bolten, and B. E. Witherington, editors. Loggerhead Sea Turtles. Smithsonian Books, Washington, D.C.

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., L. A. Vermeer, B. Krueger, M. Coyne, B. A. Schroeder, and G. H. Balazs. 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.

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.

Innis, C., A. C. Nyaoke, C. R. Williams, B. Dunnigan, C. Merigo, D. L. Woodward, E. S. Weber, and S. Frasca. 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.

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.

Jacobson, E. R., B. L. Homer, B. A. Stacy, E. C. Greiner, N. J. Szabo, C. L. Chrisman, F. Origgi, S. Coberley, A. M. Foley, J. H. Landsberg, L. Flewelling, R. Y. Ewing, R. Moretti, S. Schaf, C. Rose, D. R. Mader, G. R. Harman, C. A. Manire, N. S. Mettee, A. P. Mizisin, and G. D. Shelton. 2006. Neurological disease in wild loggerhead sea turtles Caretta caretta. Diseases of Aquatic Organisms 70:139-154.

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.

Kahn, J. and M. Mohead. 2010. A protocol for use of shortnose, Atlantic, Gulf, and green sturgeons. U.S. Department of Commerce, NOAA Technical Memo NMFS-OPR-45, 62p.

Kahnle, A. W., K. A. Hattala, and K. McKown. 2007. Status of Atlantic sturgeon of the Hudson River estuary, New York, USA. J. Munro, D. Hatin, K. McKown, J. Hightower, K. Sulak, A. Kahnle, and F. Caron, editors. Proceedings of the symposium on anadromous sturgeon: Status and trend, anthropogenic impact, and essential habitat. American Fisheries Society, Bethesda, Maryland.

Kamel, S. J. and E. Delcroix. 2009. Nesting Ecology of the Hawksbill Turtle, Eretmochelys imbricata, in Guadeloupe, French West Indies from 2000-07. Journal of Herpetology 43(3):367-376.

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.

Keinath, J. A., J. A. Musick, and R. A. Byles. 1987. Aspects of the biology of Virginia's sea turtles: 1979-1986. Virginia Journal of Science 38(4):329-336.

Keller, J. M., K. Kannan, S. Taniyasu, R. D. Day, M. D. Arendt, A. L. Segars, and J. R. Kucklick. 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., 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.

Kynard, B. and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic sturgeon, Acipenser oxyrinchus oxyrinchus, and shortnose sturgeon, A. brevirostrum, with notes on social behavior. . Environmental Behavior of Fishes 63:137-150.

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.

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., D. T. Costa, F. L. Kenyon, M. C. Hadler, M. S. Coyne, L. A. Hoopes, L. M. Orvik, K. E. St.John, and K. J. VanDenburg. 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.

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.

León, Y. M. and K. A. Bjorndal. 2002. Selective feeding in the hawksbill turtle, an important predator in coral reef ecosystems. Marine Ecology Progress Series 245:249-258.

León, Y. M. and C. E. Diez. 1999. Population structure of hawksbill turtles on a foraging ground in the Dominican Republic. Chelonian Conservation and Biology 3(2):230-236.

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.

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. 2004. A biological review of Australian marine turtles. III. Hawksbill turtle, Eretmochelys imbricata (Linnaeus). Department of Environment and Heritage and Queensland Environmental Protection Agency.

Limpus, C. J. and J. D. Miller. 2000. Final report for Australian hawksbill turtle population dynamics project.

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.

Lutcavage, M. E. and P. L. Lutz. 1997. Diving physiology. P. L. Lutz, and J. A. Musick, editors. The biology of sea turtles. CRC Press, Boca Raton, Florida.

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

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.

Mangin, E. 1964. Croissance en Longueur de Trois Esturgeons d'Amerique du Nord: Acipenser oxyrhynchus, Mitchill, Acipenser fulvescens, Rafinesque, et Acipenser brevirostris LeSueur. Verh. Int. Ver. Limnology 15:968-974.

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.

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.

Martin, R. E. and R. G. Ernst. 2000. Physical and ecological factors influencing sea turtle entrainmenlevels at the St. Lucie Nuclear Plant. 62 pp.

Matos, R. 1987. Sea turtle hatchery project with specific reference to the leatherback Dermochelys coriacea and hawksbill Eretmochelys imbricata sea turtle, Humacao, Puerto Rico, 1987. Annual Report, Puerto Rico Department of Natural Resources. 36 pp.

Mazaris, A. D., A. S. Kallimanis, J. Tzanopoulos, S. P. Sgardelis, and J. D. Pantis. 2009. 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.

McClellan, C. M., T. Tucker, and L. Avens. 2010. Satellite tracking workshop, 30th International Sea Turtle Symposium, Goa, India, 30 April 2010. Presentations available online at: http://www.seaturtle.org/tagging/workshop2010.shtml.
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. 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.
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. 1988. Spongivory in hawksbill turtles: A diet of glass. Science 239:393-395.
Meylan, A. and M. Donnelly. 1999. Status Justification for Listing the Hawksbill Turtle (Eretmochelys imbricata) as Critically Endangered on the 1996 IUCN Red List of Threatened Animals. Chelonian Conservation and Biology 3:200-224.
Meylan, A. B. 1999. The status of the hawksbill turtle (Eretmochelys imbricata) in the Caribbean Region. Chelonian Conservation and Biology 3:177-184.
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.
Mills, S. K. and J. H. Beatty. 1979. The propensity interpretation of fitness. Philosophy of Science 46:263-286.
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.
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 R. Bresson. 1999. Temporal distribution and periodicity in hawksbill turtles (Eretmochelys imbricata) nesting at Cousin Island, Republic of Seychelles, 1971-1997. Chelonian Conservation and Biology 3(2):318-325.

Mortimer, J. A., J. Collie, T. Jupiter, R. Chapman, A. Liljevik, and B. Betsy. 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. 2007. Marine Turtle Specialist Group 2007 IUCN Red List status assessment, hawksbill turtle (*Eretmochelys imbricata*). Internationa Union for the conservation of Nature.

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.

Murawski, S. A. and A. L. Pacheco. 1977. Biological and fisheries data on Atlantic Sturgeon, Acipenser oxyrhynchus (Mitchill). National Marine Fisheries Service Technical Series Report 10:1-69.

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

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

NMFS. 1997. Biological opinion on U.S. Navy activities off the southeastern United States along the Atlantic coast. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Regional Office; St. Petersburg, Florida.

NMFS. 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. NOAA Technical Memorandum NMFS-SEFSC-455.

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

NMFS and USFWS. 1995. Status reviews for sea turtles listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland.

NMFS and USFWS. 1998a. Recovery Plan for the U.S. Pacific Populations of the Leatherback Turtles (*Dermochelys coriacea*). Silver Spring, Maryland.

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

NMFS and USFWS. 1998c. Recovery Plan for U.S. Pacific Populations of the Loggerhead Turtle (*Caretta caretta*), Silver Spring, Maryland.

NMFS and USFWS. 2007. Hawksbill Sea Turtle (*Eretmochelys imbricata*) 5-Year Review: Summary and Evaluation National Marine Fisheries Service and U.S. Fish and Wildlife Service.

NMFS and USFWS. 2008. DRAFT Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (*Caretta caretta*): Second Revision. National Marine fisheries Service, U.S. Fish and Wildlife Service, Silver Spring, MD.

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.

Okuyama, J., O. Abe, H. Nishizawa, M. Kobayashi, K. Yoseda, and N. Arai. 2009. Ontogeny of the dispersal migration of green turtle (Chelonia mydas) hatchlings. Journal of Experimental Marine Biology and Ecology.

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.

Owens, D. W. 1999. Reproductive Cycles and Endocrinology in Research and Management Techniques for the Conservation of Sea Turtles. K. L. Eckert, K. A. Bjourndal, F. A. Abreu-Grobois and M. Donnelly (editors). IUCN/SSC Marine Turtle Specialist Group Publication No 4, 1999. .

Owens, D. W. and G. J. Ruiz. 1980. New methods of obtaining blood and cerebrospinal fluid from marine turtles. Herpetologica 36:17-20.

Parker, D. M. and G. H. Balazs. 2008. Diet of the oceanic green turtle, *Chelonia mydas,* in the North Pacific. Preceedings of the twenty-fifth annual symposium on sea turtle biology and conservation. NOAA Technical Memorandum NMFS-SEFSC-582.

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.

Parrish, A. and K. Goodman. 2006. Tagging and nesting research on hawksbill turtles (Eretmochelys imbricata) at Jumby Bay, Long Island, Antigua, West Indies: 2002 annual report. Prepared for the Jumby Bay Island Company, Limited.

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., A. Giammarino, V. Olivieri, S. Guccione, O. R. Lai, and M. Amorena. 2006. Polychlorinated biphenyls and organochlorine pesticide levels in tissues of Caretta caretta from the Adriatic Sea. Diseases of Aquatic Organisms 71(2):155-161.

Pilcher, N. J. and L. Ali. 1999. Reproductive biology of the hawksbill turtle, Eretmochelys imbricata, in Sabah, Malaysia. Chelonian Conservation and Biology 3(2):330-336.

Pita, J. and D. Broderick. 2005. Hawksbill turtles in the Solomon Islands. Pages 101-102 in: Kinan, I., editor. Proceedings of the Second Western Pacific Sea Turtle Cooperative Research and Management Workshop. Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

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: Lutz, P.L., J.A. Musick, and J. Wyneken, editors. Biology of sea turtles, volume II. CRC Press, Boca Raton, Florida.

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.

Prieto, A., A. Prietol, F. Moncadal, G. Nodarse, R. Pugal, M. E. d. Leon, R. Diaz-Fernandez, G. Espinoru, D. Castillo, M. Hernandez, E. Peregrin, M. d. Arazoza, D. Salabarria, E. Morales, G. Webbs, C. Manolis, and R. Gomez. 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, May l5 - 17, 2001.

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. and R. Mtirquez. 1973. Kemp's ridley or Atlantic ridley, Lepidochelys kempii. IUCN Monograph No. 2. (Marine Turtle Ser.). 30 pp.
Pritchard, P. C. H. and P. Trebbau. 1984. The turtles of Venezuela. SSAR Contribution to Herpetology No. 2.
Read, A. J. 2007. Do circle hooks reduce the mortality of sea turtles in pelagic longlines? A review of recent experiments. . Biological Conservation 135:155-169.
Reid, K. A., D. Margaritoulis, and J. R. Speakman. 2009. Incubation temperature and energy expenditure during development in loggerhead sea turtle embryos. Journal of Experimental Marine Biology and Ecology 378:62-68.
Renaud, M. L. 1995. Movements and submergence patterns of Kemp's ridley turtles (*Lepidochelys kempii*). Journal of Herpetology 29(3):370-374.
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.
Rhodin, A. G. J. 1985. Comparative chondro-osseous development and growth in marine turtles. Copeia 1985:752-771.
Richardson, J. I., R. Bell, and T. H. Richardson. 1999. Population ecology and demographic implications drawn from an 11-year study of nesting hawksbill turtles, Eretmochelys imbricata, at Jumby Bay, Long Island, Antigua, West Indies. Chelonian Conservation and Biology 3(2):244-250.
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.
Romero, L. M. 2004. Physiological stress in ecology: lessons from biomedical research. Trends in Ecology and Evolution 19(5):249-255.
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.
Rybitski, M. J., R. C. Hale, and J. A. Musick. 1995. Distribution of organochlorine pollutants in Atlantic sea turtles. Copeia 1995 (2):379-390.
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.
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., P. Luschi, R. Mencacci, P. Lambardi, G. R. Hughes, G. C. Hays, S. Benvenuti, and F. Papi. 2006. Long-term monitoring of leatherback turtle diving behaviour during oceanic movements. Journal of Experimental Marine Biology and Ecology 328:197-210.

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.

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.

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

Schuller, P. and D. L. Peterson. 2006. Population status and spawning movements of Atlantic sturgeon in the Altamaha River, Georgia. Presentation to the 14th American Fisheries Society Southern Division Meeting, San Antonio, February 8-12th, 2006.

Secor, D. H. and J. R. Waldman. 1999. Historical abundance of Delaware Bay Atlantic sturgeon and potential rate of recovery. . American Fisheries Society Symposium 23:203-216.

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, and G. J. Marshall. 2006. Underwater behaviour of green turtles monitored with video-time-depth recorders: what's missing from dive profiles? Marine Ecology Progress Series 322:269-280.

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. 2002. Diet of East Pacific green turtles (Chelonia mydas) in the central Gulf of California, Mexico. Journal of Herpetology 36(3):447-453.

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. 2007. 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.

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

Simpfendorfer, C. A., A. B. Goodreid, and R. B. McAuley. 2001. Size, sex and geographic variation in the diet of the tiger shark, Galeocerdo cuvier, from Western Australia waters.
. Environmental Biology of Fishes 61:37-46.

Smith, T. I. J. 1985. The fishery, biology, and management of Atlantic sturgeon, Acipenser oxyrhynchus, in North America. . Environmental Biology of Fishes 14(1):61-72.
Smith, T. I. J. 1990. Culture of North American sturgeons for fishery enhancement. In Sparks, A.K. (ed.), Marine Farming and Enhancement: Proceedings of the 15th US Japan Meeting of Aquaculture, Kyoto, Japan. October 22-23, 1986. NOAA Tech Rep. NMFS 85: 19-27.
Smith, T. I. J. and J. P. Clugston. 1997. Status and management of Atlantic sturgeon, Acipenser oxyrinchus, in North America. . Environmental Biology of Fishes 48:335-346.
Smith, T. I. J., E. K. Dingley, and E. E. Marchette. 1980. Induced spawning and culture of Atlantic sturgeon. . Progressive Fish Culturist 42:147-151.
Smith, T. I. J., D. E. Marchette, and R. A. Smiley. 1982. Life history, ecology, culture and management of Atlantic sturgeon, Acipenser oxyrhynchus oxyrhynchus, Mitchill, in South Carolina. South Carolina Wildlife Marine Resources. Resources Department, Final Report to U.S. Fish and Wildlife Service Project AFS-9. 75 pp.
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.
Spotila, J. R. 2004. Sea turtles: A complete guide to their biology, behavior, and conservation. John Hopkins University Press, Baltimore. 227p.
Spotila, J. R., A. E. Dunham, A. J. Leslie, A. C. Steyermark, P. T. Plotkin, and F. V. Paladino. 1996. Worldwide population decline of *Dermochelys coriacea*: Are leatherback turtles going extinct? Chelonian Conservation and Biology 2(2):209-222.
Spotila, J. R., M. P. O'Connor, and F. V. Paladino. 1997. Thermal biology. Pages 297-314 *in* P. L. Lutz, and J. A. Musick, editors. The Biology of Sea Turtles, volume CRC Marine Science Series. CRC Press, Inc., Boca Raton, Florida.
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.
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. . Comp. Biochem. Physiol 99A:107-111.
Stearns, S. C. 1992. The evolution of life histories.Oxford University Press, 249p.
Stein, A. B., K. D. Friedland, and M. Sutherland. 2004. Atlantic sturgeon marine distribution and habitat use along the northeastern coast of the United States. . Transactions of the American Fisheries Society 133:527-537.
Stevenson, J. T. 1997. Life history characteristics of Atlantic Sturgeon (Acipenser oxyrinchus) in the Hudson River and a model for fishery management. M.S. thesis, Marine Environmental and Estuarine Studies Program, University of MD, College Park, MD. 222 pp.
Stevenson, J. T. and D. H. Secor. 1999. Age determination and growth of Hudson River Atlantic sturgeon, Acipenser oxyrinchus. Fishery Bulletin 97:153-166.
Stinson, M. L. 1984. Biology of sea turtles in San Diego Bay, California, and in northeastern Pacific Ocean. Master's thesis. San Diego State University, San Diego, California.
Storelli, M., M. G. Barone, and G. O. Marcotrigiano. 2007. 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.

Taquet, C., M. Taquet, T. Dempster, M. Soria, S. Ciccione, D. Roos, and L. Dagorn. 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. 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. 2009. An assessment of the loggerhead turtle population in the western North Atlantic ocean. Turtle Expert Working Group (TEWG), NMFS-SEFSC-575.

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.

Tomillo, P. S., J. S. Suss, B. P. Wallace, K. D. Magrini, G. Blanco, F. V. Paladino, and J. R. Spotila. 2009. Influence of emergence success on the annual reproductive output of leatherback turtles. Marine Biology 156(10):2021-2031.

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

Turtle Expert Working Group. 2000. Assessment update for the Kemp’s ridley and loggerhead sea turtle populations in the Western North Atlantic. U.S. Department of Commerce, NOAA Technical Memo NMFS-SEFSC-444, 115 pp.

U.S. Navy. 2008. USS Nassau Expeditionary Strike Group Composite Training Unit Exercise 08-01 (ESG COMPTUEX 08-01): after action report for the exercise occurring 28 November to 14 December 2007. U.S. Department of the Navy, Fleet Forces Command, Norfolk, Virginia.

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.

Valentine, K. H., C. A. Harms, M. B. Cadenas, A. J. Birkenheuer, H. S. Marr, J. Braun-McNeill, R. G. Maggi, and E. B. Breitschwerdt. 2007. Bartonella DNA in loggerhead sea turtles. Emerging Infectious Diseases 13(6):949-950.

Van Dam, R. P. and C. E. Diez. 1997. Predation by hawksbill turtles on sponges at Mona Island, Puerto Rico. Proceedings of the Eighth International Coral Reef Symposium 2:1421-1426.

van de Merwe, J. P. V., M. Hodge, H. A. Olszowy, J. M. Whittier, K. Ibrahim, and S. Y. Lee. 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.

Van Eenennaam, J. P. and S. I. Doroshov. 1998. Effects of age and body size on gonadal development of Atlantic sturgeon. Journal of Fish Biology 53:624-637.

Velez-Zuazo, X., W. D. Ramos, R. Van Dam, C. E. Diez, A. Arreu-Grobois, and O. McMillan. 2008. Dispersal, recruitment and migratory behavior in a hawksbill sea turtle aggregation. Molecular Ecology 17:839-853.

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.

Vladykov, V. D. and J. R. Greely. 1963. Order Acipenseroidei. In: Fishes of Western North Atlantic. Sears Foundation. Marine Research, Yale Univ. 1 630 pp. .

Walker, B. G., P. D. 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., R. L. Lewison, S. L. McDonald, R. K. McDonald, C. Y. Kot, S. Kelez, R. K. Bjorkland, E. M. Finkbeiner, S. r. Helmbrecht, and L. B. Crowder. 2010. Global patterns of marine turtle bycatch. Convervation Letters in press(in press):in press.

Watson, K. P. and R. A. Granger. 1998. Hydrodynamic effect of a satellite transmitter on a juvenile green turtle (Chelonia mydas). Journal of Experimental Biology 201(17):2497-2505.

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.

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.

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

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.

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

Witzell, W. N. 1987. Selective predation on large cheloniid sea turtles by tiger sharks (Galeocerdo cuvier). . Japanese Journal of Herpetology 12(1):22-29.

Witzell, W. N., A. A. Geis, J. R. Schmid, and T. Wibbels. 2005. 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.

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.

Zug, G. R. and J. F. Parham. 1996. Age and growth in leatherback turtles, Dermochelys coriacea (Testudines: Dermochelyidae): A skeletochronological analysis. Chelonian Conservation and Biology 2(2):244-249.