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, National Marine Fisheries Service

Proposed Action: Biological Opinion on the proposal to issue permit amendment 13543-01 to the South Carolina Department of Natural Resources to authorize additional annual takes on Kemp's ridley, and loggerhead sea turtles in the southeastern United States, pursuant to Section 10(a)(1)(A) of the Endangered Species Act of 1973.

Prepared by: ESA Interagency Cooperation Division of the Office of Protected Resources, National Marine Fisheries Service

Approved by: Helen M. Golde
Acting Director, Office of Protected Resources

Date: MAY 15 2013

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 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 – ESA Interagency Cooperation Division.

This document represents the NMFS' biological opinion (Opinion) of the effects of the proposed amendment to a scientific research permit on the endangered Kemp's ridley sea turtles, and threatened loggerhead sea turtles (Northwest Atlantic Ocean DPS), 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 Division's draft Environmental Assessment, draft permit 13545-01, the amendment application from the South Carolina Department of Natural Resources, the EA and biological opinion for the original permit 13543, 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.

BIOLOGICAL OPINION

Consultation History

The NMFS' Permits and Conservation Division (Permits Division) requested consultation with the NMFS' Endangered Species Act Interagency Coordination Division on the proposal to issue an amendment to a scientific research permit authorizing studies on green, hawksbill, Kemp's ridley, olive 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 September 9, 2008, 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 24, 2009, and NMFS concluded that issuance of the permit was not likely to jeopardize listed species or destroy or modify critical habitat.

- In 2012, 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 came close to approaching the limit for loggerhead sea turtles, and submitted an application to amend their permit.

- On March 1, 2013 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 and loggerhead sea turtles that could be captured by the permit holder.

- On March 4, 2013 the ESA Interagency Cooperation Division formally initiated consultation with the Permits Division.

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 13543-01 to the South Carolina Department of Natural Resources would increase the number of Kemp's ridley and loggerhead sea turtles that could be captured by the permit holder in the Atlantic Ocean, off the coast of the southeastern United States, bounded to the north by Cape Hatteras, NC and to the south by Cape Canaveral, FL.

Proposed permit amendment 13543-01:

The Permits Division proposes to authorize the South Carolina Department of Natural Resources to capture and handle 32 Kemp's ridley sea turtles, increased from the previously authorized 15 and 50 loggerhead sea turtles, increased from the previously authorized 45. The suite of actions that would be included in handling are: photograph/video, weigh and measure, flipper and PIT tag. These actions are the same as were previously authorized in permit 13543, 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.

The modified annual takes are summarized in take Table 1 that follows.

Table1: Maximum Annual Take Under Modified Permit No. 13543-01 through April 30, 2014.			
Species	Authorized take	Requested take	In-water Take Activities*
Loggerhead	45	**50**	Measure, weigh, PIT tag, flipper tag, photograph
Green*	6	6	Measure, weigh, PIT tag, flipper tag, photograph
Kemp's ridley	15	**32**	Measure, weigh, PIT tag, flipper tag, photograph
Leatherback	6	6	Measure, weigh, PIT tag, flipper tag, photograph
Hawksbill	2	2	Measure, weigh, PIT tag, flipper tag, photograph
Olive ridley	2	2	Measure, weigh, PIT tag, flipper tag, photograph

* Green sea turtles in U.S. waters are listed as threatened except for the Florida breeding population, which is listed as endangered. Because we are unable to distinguish between the populations away from the nesting beaches, green sea turtles are considered endangered wherever they occur in U.S. waters.

The following provides additional detail on the methodologies that would be used under the proposed action:

Turtle Capture, Experimental Procedures and Minimization of Impacts

The following sections will describe how turtles will be captured and handled as well as the experimental procedures that will be carried out under the proposed action. This section will also note actions that will be taken to minimize the impact of these activities.

Researchers would not capture turtles. Turtles would be captured via 20 minute bottom time trawl authorized by the NMFS Southeast Regional Office (SERO). The trawls are part of the Southeast Monitoring and Assessment Program (SEAMAP) Coastal Survey to monitor abundance and distribution of marine species. Incidental capture of sea turtles during the survey is authorized by the SER based on tow time restrictions. The research that would be authorized by the proposed action would be conducted on animals captured during these surveys and would collect biological and ecological information on these species. No work would occur in protected areas, including National Marine Sanctuaries.

Sea turtles would be handled and resuscitated according to procedures specified in 50 CFR 223.206(d)(1)(i). Researchers would sample and tag in accordance with NOAA Technical Memorandum NMFS-SEFSC-579, the Sea Turtle Research Techniques Manual (NMFS SEFSC 2008)

Live, healthy sea turtles would be held for no more than 30 minutes, and would be released close to the original capture site after all sampling is complete. During release, engines would be in neutral and turtles released away from trawling gear and as close to the surface of the water as possible. When possible, salvage of dead sea turtles taken incidentally to commercial fishing operations would be transferred to the STSSN.

Handling/Restraint: Once released from the trawl tail bag onto the deck, turtles would be wet down with a saltwater deck hose as necessary to keep them cool. Individuals would be placed on a tire or simply held in place by one crew member while a second takes measurements and places tags. The turtle would be lifted by hand and placed on a platform scale for weighing. Processing time would rarely exceed one half hour; even then only if multiple turtles are landed from a single tow.

Marking: Captured turtles larger than 25 cm SCL would be externally tagged using oxidation and corrosion resistant metal tags (Inconel) to the trailing edge of each front flipper, using an applicator, which will be cleaned with a mild disinfectant solution prior to use. All sites for flipper and PIT tag insertion would be scrubbed with disinfectant (e.g., Betadine solution) prior to tagging. The applicant will make certain that the locking mechanisms are correctly aligned and that the tag locks in place. Care is needed to ensure that the tag is not applied too far into the edge of the flipper. Ideally, 25-33% of the tag should extend beyond the edge of the flipper after application. This is especially important when applying tags to immature turtles that are still growing. Captured turtles larger than 20 cm SCL will be tagged with PIT tags inserted into one of the triceps superficialis muscle complex locations. Before insertion of any tags all flippers will be scanned for the presence of any pre-existing PIT tags and the tagging area would be disinfected.

Photographing: Animals would be restrained and protected from harsh environmental conditions while photographed.

Permit Conditions

The following information outlines the main mitigation measures researchers would employ to minimize the potential for any adverse impacts to the target species (sea turtles) as well as any additional ESA-listed species in the action area. The research project is designed to minimize the potential of any stress, pain or suffering. All the investigators and personnel involved are experienced in capturing sea turtles and will undertake the following precautions. Turtles will be handled carefully so they do not incur additional injury during or after research procedures. Antiseptic methods such as sterilizing equipment with bleach solution and the use of Betadine and or Chlorox solution at tag sites will be standard protocol to prevent the transmittal of disease and prevent infection. Turtles found to have serious injuries will be evaluated for possible transport to a rehabilitation facility. In such cases, the Marine Turtle Stranding Team of the Virginia Aquarium will be consulted and will conduct any necessary transfer.

The following specific research conditions will be placed on the research should permit amendment (No. 13543-01) be issued to ensure compliance with appropriate research protocols:

1. The Permit Holder would be responsible for all activities of any individual who is operating under the authority of the proposed permit. The Principal Investigator (PI) would share this responsibility. Individuals operating under the specified Permit and conducting the activities authorized herein, must be approved by NMFS. Alternatively, there must be a NMFS-approved individual present to supervise these activities until such time that the other individuals have been approved by NMFS.

2. Accidental Mortality of Authorized Sea Turtles: If a turtle is seriously injured or dies during sampling, the Permit Holder must cease research immediately and notify the

Chief, Permits and Conservation Division by phone (301-427-8401) as soon as possible, but no later than two days following the event. The Permit Holder must re-evaluate the techniques that were used and those techniques must be revised accordingly to prevent further injury or death. The Permit Holder must submit a written report describing the circumstances surrounding the event. The Permit Holder must send this report to the Chief, Permits and Conservation Division, F/PR1, 1315 East-West Highway, Silver Spring, MD 20910. Pending review of these circumstances, NMFS may suspend authorization of research activities or amend the Permit in order to allow research activities to continue.

3. An annual report would be submitted and reviewed by NMFS for each year the permit is valid. In addition to an account of actual 'take' that occurred, the reports would include detailed descriptions of the animals' reactions, measures taken to minimize disturbance, research plans for the forthcoming year, and an indication as to when or if any results have been published or otherwise disseminated during the year. At the end of the proposed permit, the Permit Holder would submit a final report that includes: (1) a reiteration of the objectives and summary of results of the research and how they pertain to or further the research goals stated in the Permit application and NMFS conservation plan; and (2) an indication of where and when the research results would be published.

4. Instruments and equipment that are used for invasive procedures must be sterilized or disinfected with an appropriate disinfectant (e.g., mild bleach solution or 10% povidone-iodine) between animals, and shall be the appropriate weight/size ratio to the receiving animal.

5. When handling and/or tagging turtles displaying fibropapilloma tumors and/or lesions, researchers would use the following procedures:

    - Clean all equipment that comes into contact with the turtle (tagging equipment, tape measures, etc.) with a mild bleach solution, between the processing of each turtle, and

    - Maintain a separate set of sampling equipment for handling animals displaying fibropapilloma tumors and/or lesions.

    - Limit procedures conducted on compromised turtles.

6. All turtles shall be examined for existing tags, including PIT tags, before attaching or inserting new ones.

7. Flipper Tagging with Metal Tags – All tags shall be cleaned (e.g., oil residue) and disinfected before being used.

8. Netting Special Conditions

    - Nets used to catch turtles must be of large enough to diminish bycatch of other species.

- Trawl times must not exceed the 2 minute bottom time trawl authorized by the NMFS Southeast Regional Office.

- Nets must not be put in the water when marine mammals 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 net setting is initiated. Should any marine mammals enter the research area after the nets have been set, the lead line must be raised and dropped in an attempt to make marine mammals in the vicinity aware of the net. If marine mammals remain within the vicinity of the research area, nets must be removed.

- If a marine mammal is entangled, researchers must stop netting activities and immediately free the animal; notify the appropriate NMFS Regional Stranding Coordinator as soon as possible; and report the incident as specified.

9. General Handling and Releasing of Turtles: The Principal Investigator, Co-investigator(s), or Research Assistant(s) acting on the Permit Holder's behalf 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, stressed or 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. All turtles must be handled according to procedures specified in 50 CFR 223.206(d)(1)(i).

10. Turtles are to be protected from temperature extremes of heat and cold, and kept moist during sampling. The turtle would be placed on pads for cushioning and this surface would be disinfected between turtles. The area surrounding the turtle may not contain any materials that could be accidentally ingested.

11. During release, turtles shall be lowered as close to the water's surface as possible, to prevent potential injuries.

12. Transport and Holding:

    - Turtles are to be transported via a climate-controlled environment, protected from temperature extremes of heat and cold, and kept moist. The turtle would be placed on pads for cushioning. The area surrounding the turtle may not contain any material that could be accidentally ingested.

    - Turtles transported to a facility and held (e.g. for rehabilitation) must be maintained and cared for under the "Care and Maintenance Guidelines for Sea Turtles Held in Captivity" issued by the U.S. Fish and Wildlife Service.

13. Bycatch: All incidentally captured species (e.g. fishes) must be released alive as soon as possible.

14. For any listed sturgeon species encountered:

    - Should a sturgeon be taken incidentally during the course of netting, if possible and if it can be done rapidly, the animal must be scanned for PIT tags and measured before release. Researchers shall ensure animals are not out of the water for any period greater than is absolutely necessary. Animals shall be released as soon as possible, near the capture area but in a manner that minimizes recapture in net gear if researchers continue netting activities.
    - 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. For help with any questions relating to sturgeon researchers should contact Shelley Norton, of NMFS' Southeast Regional Office. The Permit Holder must report any sturgeon interactions to NMFS' Assistant Regional Administrator for Protected Resources, Southeast Regional Office, within 14 days of the incident. This report must contain: the description of the take (including length and weight if possible), the PIT tag number, latitude and longitude of capture, water depth the animal was taken in, substrate type animal was in when captured, any other environmental conditions that are already being recorded (e.g., water salinity, temperature), and final disposition of the sturgeon (Le., released in good health, etc.). This same information must be reported within 14 days of the incident to the Chief, Permits, Conservation and Education Division, PR1 (National Marine Fisheries Service, Office of Protected Resources, 1315 East West Highway, Silver Spring, MD 20910).

15. Researchers must take all practicable steps to identify submerged aquatic vegetation (SAV), coral communities, and live/hard bottom habitats and avoid setting gear in such areas. Researchers must use strategies to identify SAV, coral and live or hard bottom types and avoid adverse impacts to Essential Fish Habitat (EFH), including the use of tools such as charts, GIS, sonar, fish finders, or other electronic devices to help determine characteristics and suitability of bottom habitat prior to using gear. If research gear is lost, diligent efforts must be made to recover the lost gear to avoid further damage to benthic habitat and impacts related to “ghost fishing”.

16. Coral and hard/live bottom. No gear may be set, anchored on, or pulled across coral or hard/live bottom habitats.

17. Sea grass species. Researchers would avoid conducting research over or immediately adjacent to any non-listed sea grass species. If these non-listed species cannot be avoided, then the following avoidance/minimization measures shall be implemented:

    - In order to reduce the potential for sea grass damage, anchors would be set by hand when water visibility is acceptable. Anchors must be placed in unvegetated areas within seagrass meadows or areas having relatively sparse vegetation

coverage. Anchor removal must be conducted in a manner that would avoid the dragging of anchors and anchor chains.

- Researchers would take great care to avoid damaging any sea grass species and if the potential for anchor or net drag is evident researchers would suspend research activities immediately.
- Researchers must be careful not to tread or trample on seagrass and coral reef habitat.

18. For any manatees encountered- The following conditions to the permit are provided by the USFWS to prevent adverse interactions with endangered Florida manatees:

- Vessel personnel must be informed that it is illegal to intentionally or unintentionally harm, harass, or otherwise "take" manatees, and to obey all posted manatee protection speed zones, Federal manatee sanctuary and refuge restrictions, and other similar state and local regulations while conducting in-water activities. Such information shall be provided in writing to all vessel personnel prior to beginning the permitted research.

- Crew involved in research activities must wear polarized sunglasses to reduce glare while on the water and keep a look out for manatee. The crew shall include at least one member experienced in and dedicated to watching for manatee during all in-water activities.

- All vessels engaged in netting and trapping shall operate at the slowest speed consistent with those activities. All netting and trapping shall be restricted to the hours between one-half hour after sunrise to one-half hour before sunset.

- Rope attaching floats to nets or traps shall not have kinks or contain slack that could present an entanglement hazard to manatee.

- All nets and traps must be continuously monitored. Netting activities must cease if a manatee is sighted within a 100-foot radius of the research vessel or the net, and may resume only when the animal is no longer within this safety zone, or 30 min has elapsed since the manatee was last observed within the safety zone.

- If a manatee is accidentally captured:

    1. Devote all research staff efforts to freeing the animal. Remember that a manatee must breathe and surface approximately every four min. The Permit Holder or PI must brief all research participants to ensure that they understand that freeing a manatee can dangerous. This briefing will caution people to keep fingers out of the nets, that no jewelry should be worn, that they be careful to stay away from the manatee's paddle, and that they give the animal adequate time and room to breathe as they are freeing it.

2. As appropriate, turn off the vessel motors or put the engine in neutral. Propellers can seriously injure or kill manatees.

3. Release tension on the net to allow the animal the opportunity to free itself. Exercise caution when attempting to assist the animal in freeing itself. Manatee are docile animals but can thrash violently if captured or become entangled in a net. A 1,200 to 3,500 pound (lb) manatee can cause extensive damage to nets while trying to escape or breathe, so quick action is essential to protect both the manatee and the net. Ensure that the animal does not escape with net still attached to it.

4. Contact the Florida Fish and Wildlife Conservation Commission, Division of Law Enforcement immediately to report any incidents. If a manatee is injured, the sooner the animal receives treatment, the better its chance of recovery. Immediately contact Nicole Adimey of the USFWS to report any gear or vessel interactions with manatees. Also contact NMFS (Chief of the Permits Division) as soon as possible.

Approach to the Assessment

NMFS approaches its section 7 analyses of research permits 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 results of this step define 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 populations of vertebrate species. Because the continued existence of species depends on the fate of the populations that comprise them, the continued existence of these "species" depends on the fate of the populations that comprise them. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them; populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

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

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

When individual, listed plants or animals are expected to experience reductions in fitness in response to an action, those fitness reductions are likely to reduce the abundance, reproduction, or growth rates (or increase the variance in these measures) of the populations those individuals represent (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; Mills and Beatty 1979; Stearns 1992; Anderson 2000). 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 are a necessary condition for reductions in a population's viability, reducing the fitness of individuals in a population is not always sufficient to reduce the viability of the population(s) those individuals represent. Therefore, if we conclude that listed plants or animals are likely to experience reductions in their fitness, we determine whether those fitness reductions are likely to reduce the viability of the populations the individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, variance in these measures, or measures of extinction risk). In this step of our analyses, we use the population's base condition (established in the *Environmental Baseline* and *Status of the Species* 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 the Species* 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 might consist of monitoring reports submitted by past and present permit holders; reports from NMFS Science Centers; reports prepared by natural resource agencies in states, and other countries; reports from domestic and foreign non-governmental organizations involved in marine conservation issues, the information provided by the Permits, Conservation and Education Division when it initiates formal consultation, and the general scientific literature.

During each consultation, we conduct electronic searches of the general scientific literature using *American Fisheries Society*, *Google Scholar*, *ScienceDirect*, *BioOne*, *Conference Papers Index*, *JSTOR*, and *Aquatic Sciences and Fisheries Abstracts* search engines. We supplement these searches with electronic searches of doctoral dissertations and master's theses. These searches specifically try to identify data or other information that supports a particular conclusion (for example, a study that suggests sea turtles will exhibit a particular response to tagging) as well as data that does not support that conclusion. When data are equivocal, or in the face of 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.

We rank the results of these searches based on the quality of their study design, sample sizes, level of scrutiny prior to and during publication, and study results. Carefully designed field experiments (for example, experiments that control potentially confounding variables) are rated higher than field experiments that are not designed to control those variables. Carefully designed field experiments are generally ranked higher than computer simulations. Studies that produce large sample sizes with small variances are generally ranked higher than studies with small sample sizes or large variances.

Action Area

The action area is defined in 50 CFR 402.2 as "all areas to be affected directly or indirectly by the Federal Action and not merely the immediate area involved in the action." The action area under these proposed activities would be as follows until April 30, 2014:

Permit No. 13543-01: The research would take place in the Atlantic waters bounded to the north by Cape Hatteras, NC and to the south by Cape Canaveral, FL (Figure 1). It is further defined as falling in near-shore waters between the fifteen foot and thirty foot contours on NOS navigation charts.

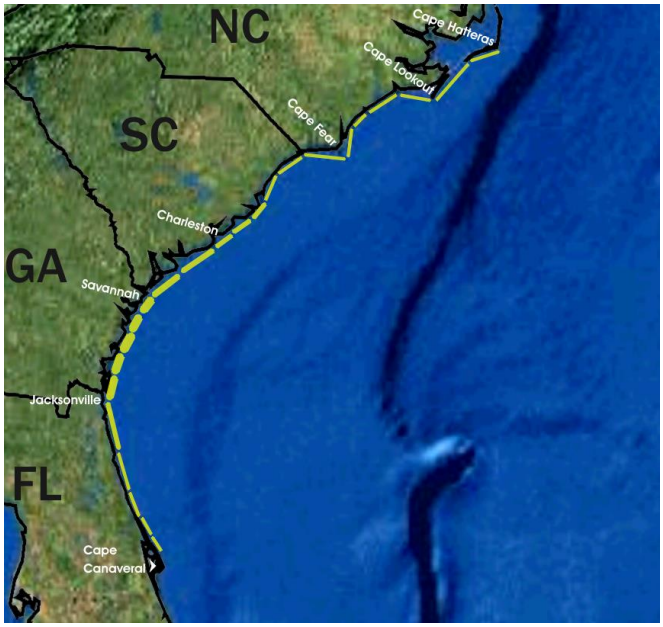

Figure 1. Study area for proposed research.

Status of the Species

The following listed species under the jurisdiction of NMFS may occur in the action area that would be covered under the proposed issuance of Section 10 modified research permit 13543-01 to the applicant and may be affected:

Common Name	Scientific Name	Listing Status
Sea Turtles		
Green sea turtle[1]	*Chelonia mydas*	Endangered/Threatened
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Olive ridley sea turtle	*Lepidochelys olivacea*	Threatened
Cetaceans		
Humpback whale	*Megaptera novaeangliae*	Endangered
N. Atlantic right whale	*Eubalaena glacialis*	Endangered
Fish		
Atlantic sturgeon Carolina and South	*Acipenser oxyrinchus*	Endangered

[1] Green sea turtles in U.S. waters are listed as threatened except for the Florida breeding population, which is listed as endangered. Because we are unable to distinguish between the populations away from the nesting beaches, green sea turtles are considered endangered wherever they occur in U.S. waters.

Atlantic DPS		
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered

Critical Habitat
North Atlantic Right Whale

No critical habitat has been designated in the action areas for any listed sea turtles species under NMFS jurisdiction; therefore, no sea turtle critical habitat will be affected.

Species Not Affected or Not Likely to be Adversely Affected

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 suite of research activities would remain the same as were previously authorized in permit 13543, and no other changes would be authorized, other than the amendment to increase the annual takes of loggerhead and Kemp's ridley sea turtles only. Therefore the take of green, hawksbill, olive ridley and leatherback sea turtles would continue to be authorized under the original permit 13543, and they will not be considered further in this Opinion.

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.

Atlantic sturgeon juveniles can remain in riverine and estuarine systems for periods of 1 to 6 years before migrating to the coast and onto the continental shelf where they grow to maturity, and typically forage on "benthic" invertebrates (e.g. crustaceans, worms, mollusks). They could be present in the research area, but should generally be able to avoid the trawl, and would only be temporarily displaced.

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, or are covered under another authority during trawl surveys. Therefore, they will not be considered further in this Opinion.

Species Likely to be Adversely Affected

The loggerhead and Kemp's ridley sea turtles are likely to be adversely affected.

Background information on the range-wide status of these species can be found in a number of published documents including status reviews and recovery plans; Kemp's ridley (NMFS and USFWS 2011), and loggerhead (NMFS and USFWS 2011). Most of these species have circumgobal ranges and are highly migratory, however since the action areas would only affect species that live within the Atlantic Ocean basin, the other oceanic basins, which would not be impacted by the action, have been excluded from further analyses. Summary information on the biology and status of these species is provided below.

Loggerhead Sea Turtle Northwest Atlantic Ocean DPS

Species Description, Distribution, and Population Structure
Adult and subadult loggerhead sea turtles are characterized as having a light yellow plastron and a reddish brown carapace covered by non-overlapping scutes that meet along seam lines. They typically have 11 or 12 pairs of marginal scutes, five pairs of costals, five vertebrals, and a nuchal (pre-central) scute that is in contact with the first pair of costal scutes. Hatchlings lack the reddish tinge and vary from light to dark brown dorsally. Both pairs of appendages are dark brown and have distinct white margins. Hatchling mean body mass is about 20 grams and mean SCL is about 45 mm (Dodd, 1988).

In the most recent status review conducted for the species, the loggerhead biological review team identified 60°N latitude and the equator as the north-south boundaries and 40°W longitude as the east boundary of the Northwest Atlantic Ocean population segment based on oceanographic features, loggerhead sightings, thermal tolerance, fishery bycatch data, and information on loggerhead distribution from satellite telemetry and flipper tagging studies (Conant et al., 2009). The majority of loggerhead nesting in the Northwest Atlantic is concentrated along the U.S. coast from southern Virginia to Alabama. Additional nesting beaches are found along the

northern and western Gulf of Mexico, eastern Yucatán Peninsula, at Cay Sal Bank in the eastern Bahamas, off the southwestern coast of Cuba, and along the coasts of Central America, Colombia, Venezuela, and the eastern Caribbean Islands (Addison and Morford, 1996; Addison, 1997; Gavilan, 2001). From a global perspective, the loggerhead nesting aggregation in the southeastern U.S. is second in size only to the nesting aggregations in the Arabian Sea off Oman, making it one of the most important nesting areas for the species.

Non-nesting, adult female loggerheads are reported in nearshore and offshore waters throughout the U.S. and Caribbean Sea (Foley et al., 2008) and recent tagging studies conducted in the Gulf of Mexico suggest that sea turtles nesting along the Gulf coast of Florida and the Florida Panhandle generally do not leave the region for extended periods throughout the year [Turtle Expert Working Group (TEWG, 2009)]. Significant numbers of male and female loggerheads forage in shallow water habitats with large expanses of open ocean access (such as Florida Bay) year-round while juveniles are also found in enclosed, shallow water estuarine environments (Epperly et al., 1995a).

In terms of population structure for the Northwest Atlantic Ocean DPS, NMFS and USFWS (2008) identified and evaluated five separate recovery units (i.e., nesting subpopulations): the Northern U.S. (Florida/Georgia border to southern Virginia); Peninsular Florida (Florida/Georgia border south through Pinellas County, excluding the islands west of Key West, Florida); Dry Tortugas (islands west of Key West, Florida); Northern Gulf of Mexico (Franklin County, Florida, west through Texas); and Greater Caribbean (Mexico through French Guiana, The Bahamas, Lesser and Greater Antilles). All Northwest Atlantic recovery units are reproductively isolated from populations occurring within the Northeast Atlantic, South Atlantic, and Mediterranean Sea. For the purposes of this consultation, we assume that all sea turtles targeted by the researchers would be members of the Northern Gulf of Mexico and/or Peninsular Florida nesting subpopulations based on the study areas.

Life History Information

Loggerhead sea turtles reach sexual maturity between 20 and 38 years of age, although this varies widely among populations (Frazer and Ehrhart, 1985; NMFS, 2001). The annual mating season for loggerhead sea turtles occurs from late March to early June, and eggs are laid throughout the summer months. Female loggerheads deposit an average of 4.1 nests within a nesting season (Murphy and Hopkins, 1984) and have an average remigration interval of 3.7 years (Tucker, 2010). Mean clutch size varies from 100 to 126 eggs for nests occurring along the southeastern U.S. coast (Dodd, 1988). Sand temperatures prevailing during the middle third of the incubation period often determine the sex of hatchlings (Mrosovsky and Yntema, 1980). Incubation temperatures near the upper end of the tolerable range produce only female hatchlings while incubation temperatures near the lower end of the tolerable range produce only male hatchlings. The pivotal temperature (i.e., the incubation temperature that produces equal numbers of males and females) in loggerheads is approximately 29°C (Limpus et al., 1983; Mrosovsky, 1988; Marcovaldi et al., 1997).

As post-hatchlings, loggerheads hatched on U.S. beaches migrate offshore and become associated with *Sargassum spp.* habitats, driftlines, and other convergence zones (Carr, 1986; Witherington, 2002). They are believed to lead a pelagic existence in the North Atlantic Gyre

for a period as long as 7-12 years (Bolten et al., 1998) although Snover (2002) suggests a much longer oceanic juvenile stage duration with a range of 9-24 years and a mean of 14.8 years. Stranding records indicate that when immature loggerheads reach 40-60 centimeters SCL, they then travel to coastal inshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico (Witzell et al., 2002). Other studies, however, have suggested that not all loggerhead sea turtles follow the model of circumnavigating the North Atlantic Gyre as pelagic juveniles, followed by permanent settlement into benthic environments (Laurent et al., 1998; Bolten, 2003). These studies suggest some turtles may either remain in the pelagic habitat in the North Atlantic longer than hypothesized or move back and forth between pelagic and coastal habitats interchangeably (Witzell et al., 2002).

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 (neritic refers to the inshore marine environment from the surface to the sea floor where water depths do not exceed 200 meters). Benthic, immature loggerheads foraging in northeastern U.S. waters are also known to migrate southward in the fall as water temperatures cool and then migrate back northward in spring (Epperly et al., 1995a; Keinath, 1993; Morreale and Sandora, 1998; Shoop and Kenney, 1992). Juveniles are omnivorous and forage on crabs, mollusks, jellyfish and vegetation at or near the surface (Dodd, 1988). Sub-adult and adult loggerheads are primarily found in coastal waters and prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats.

Listing Status

The loggerhead sea turtle was originally listed as threatened throughout its range on July 28, 1978. Loggerhead sea turtles were effectively listed as nine DPSs on October 24, 2011 (76 FR 58868, September 22, 2011) four listed as threatened (i.e., Northwest Atlantic Ocean, South Atlantic Ocean, Southeast Indo-Pacific Ocean, and Southwest Indian Ocean DPSs) and five listed as endangered (i.e., Mediterraenean Sea, North Indian Ocean, North Pacific Ocean, South Pacific Ocean, and Northeast Atlantic Ocean DPSs). All sea turtles affected by this proposed action are expected to be members of the threatened Northwest Atlantic Ocean DPS. Critical habitat has not been designated for loggerhead sea turtles at the time of this consultation.

Abundance and Trends

For nesting subpopulations occurring in the Northwest Atlantic, the Peninsular Florida and Northern U.S. units support the greatest numbers of nesting females (i.e. over 10,000 for the Peninsular Florida unit and over 1,000 for the Northern U.S. unit) while the other three nesting subpopulations (i.e. Northern Gulf of Mexico, Dry Tortugas, and Greater Caribbean units) contain fewer than 1,000 nesting females based on count data (Baldwin et al., 2003; Ehrhart et al., 2003; Kamezaki et al., 2003, Limpus and Limpus, 2003; Margaritoulis et al., 2003; TEWG, 2009).

According to the most recent status reviews for the species, all nesting subpopulations occurring in the Northwest Atlantic Ocean show declining trends in the annual number of nests for which they were adequate data (NMFS and USFWS, 2008; Conant et al, 2009; TEWG, 2009). The Peninsular Florida nesting subpopulation, which represents approximately 87 percent of all nesting effort in the Northwest Atlantic Ocean DPS has declined 26 percent over a recent 20 year

study period (1989–2008) with a greater decline (41 percent) occurring in the latter 10 years of the study (NMFS and USFWS, 2008; Witherington et al., 2009). The second largest nesting subpopulation (i.e. Northern U.S.) also saw annual declines of 1.3 percent since 1983 (NMFS and USFWS, 2008) while the third largest recovery unit (i.e. Greater Caribbean) saw annual declines of over 5 percent occurring over the period 1995-2006 (TEWG, 2009). The two smallest nesting subpopulations (i.e., Northern Gulf of Mexico and Dry Tortugas) have also seen declines in nest counts since the mid 1990's; however, these units represent only a small fraction in loggerhead nesting and are not considered to be good indicators of the overall trend. In addition, a detailed analysis of Florida's long-term loggerhead nesting data (1989-2011) revealed that following a 24 percent increase between 1989 and 1998, nest counts for Florida beaches declined 16 percent between 1998 and 2011. The most recent nest counts in 2011 were close to the average for the preceding five-year period suggesting the recent trend may be stabilizing [Florida Fish and Wildlife Conservation Commission (FWC), 2011].

At present, there are no reliable estimates of population size of loggerheads occurring in the pelagic and oceanic environments (Bjorndal and Bolten, 2000); however, recent data collected from in-water studies reveal some patterns of abundance and/or size composition of loggerheads occurring in the Northwest Atlantic. The 2009 TEWG report summarized in-water capture and strandings data[2] spanning over four decades from the late 1970's through the late 2000's. Data from the southeastern U.S. (from central North Carolina through central Florida) indicated a possible increase in the abundance of neritic loggerheads captured over the past one to two decades while aerial surveys and one other in-water study conducted in the northeastern U.S. (north of Cape Hatteras, N.C.) indicate a decrease in abundance over similar periods (TEWG, 2009). This increase in catch rates for the southeastern U.S. was not consistent with the declines in nesting seen over the same time period. The authors suggested that the apparent increase in in-water catch rates in the southeastern U.S. coupled with a shift in median size of captured juveniles may indicate there is a relatively large cohort that will be reaching sexual maturity in the near future. However, additional data from the review suggests that any increase in adults may be temporary because in-water studies throughout the entire eastern U.S. also indicated a substantial decrease in the abundance of smaller sized juveniles which would, in turn, indicate possible recruitment failure. The authors stated these trends should be viewed with caution given the limited number and size of studies dedicated to assessing in-water abundance of loggerheads and that more research conducted over a longer time series needs to be completed to determine what impact, if any, these trends have on recruitment and/or survival rates.

Also, the loggerhead sea turtle biological review team recently conducted two independent analyses using nesting data (including counts of nesting females or nests) to assess extinction risks for the identified DPS using methods developed by Snover and Heppell (2009). The analysis performed for the status review indicated that the Northwest Atlantic Ocean DPS had a high likelihood of quasi-extinction over a wide range of quasi-extinction threshold values, suggesting that the DPS is likely to continue to decline in future years (Conant et al., 2009).

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2 Data was compiled from turtle captures recorded for the St. Lucie Power Plan in Florida since 1976 (see Bresette et al., 2003), entanglement surveys conducted in the Indian River in Florida since 1982 (see Ehrhart et al., 2007), fishery-independent trawl surveys off the southeastern U.S. (see SCMRI, 2000), pound-net captures off North Carolina (see Epperly et al., 2007) and off New York (see Morreale and Standora, 1998; Morreale et al., 2005), and strandings data maintained by the Sea Turtle Stranding and Salvage Network.

Current Threats

Loggerhead sea turtles face numerous natural and anthropogenic threats that help shape its status and affect the ability of the species to recover. As many of the threats affecting loggerheads are either the same or similar in nature to threats affecting other listed sea turtle species, many of the threats identified in this section below are discussed in a general sense for all listed sea turtles rather than solely for loggerheads. Threats specific to a particular species are then discussed in the corresponding status sections where appropriate.

Sea turtles have been impacted historically by domestic fishery operations that often capture, injure, and even kill sea turtles at various life stages. In the U.S., the bottom trawl, sink gillnets, hook and line gear, and bottom longline managed in the Northeast Multispecies Fishery are known to capture sea turtles during normal fishery operations (Watson et al., 2004; Epperly et al., 1995a; Lewison et al., 2003, Lewison et al., 2004; Richards, 2007) while the lines used for pot gear for the U.S. Lobster and Red Crab fisheries cause entanglement resulting in injury to flippers, drowning, and increased vulnerability to boat collisions (Lutcavage et al., 1997). In addition, various trawl, gillnet, longline, and hook gears used for the Monkfish, Spiny Dogfish, Summer Flounder, Scup, Black Sea Bass, and Atlantic Highly Migratory Species fisheries managed in the U.S. impact sea turtles at various degrees. The Southeast U.S. Shrimp Fishery (which uses otter trawl gear) has historically been one of the largest threats to sea turtles in the southeastern U.S. (Murray, 2006), and continues to interact with (and kill) large numbers of sea turtles each year. Although loggerhead sea turtles are most vulnerable to pelagic longlines during their immature life history stage, there is some evidence that benthic juveniles may also be captured, injured, or killed by pelagic fisheries as well (Lewison et al., 2004) (refer to the *Environmental Baseline* section of this Opinion for more specific information regarding federal and state managed fisheries affecting sea turtles operating in and around the action area).

In addition to domestic fisheries, sea turtles are subject to direct as well as incidental capture in numerous foreign fisheries, further exacerbating the ability of sea turtles to survive and recover on a more global scale. For example, pelagic, immature loggerhead sea turtles circumnavigating the Atlantic are exposed to international longline fisheries including the Azorean, Spanish, and various other fleets (Aguilar et al., 1995; Bolten et al., 1994; Crouse, 1999). Bottom set lines in the coastal waters of Madeira, Portugal, are reported to take an estimated 500 pelagic immature loggerheads each year (Dellinger and Encamacao, 2000) and gillnet fishing is known to occur in many foreign waters, including (but not limited to) the northwest Atlantic, western Mediterranean, South America, West Africa, Central America, and the Caribbean. In addition to the reported takes, there are many unreported takes or incomplete records by foreign fleets, making it difficult to characterize the total impact that international fishing pressure is having on listed sea turtles. Nevertheless, international fisheries represent a continuing threat to listed sea turtles' survival and recovery throughout their respective ranges.

There are also many non-fishery impacts affecting the status of sea turtle species, both in the marine and terrestrial environment. In nearshore waters of the U.S., the construction and maintenance of Federal navigation channels has been identified as a source of sea turtle mortality. Hopper dredges, which are frequently used in ocean bar channels and sometimes in harbor channels and offshore borrow areas, move relatively rapidly and can entrain and kill sea

turtles (NMFS, 1997a). Sea turtles entering coastal or inshore areas have been affected by entrainment in the cooling-water systems of electrical generating plants. Other neashore threats include harassment and/or injury resulting from private and commercial vessel operations, military detonations and training exercises, and scientific research activities.

Coastal development can deter or interfere with nesting, affect nesting success, and degrade nesting habitats for sea turtles. Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Lutcavage et al., 1997; Bouchard et al., 1998). These factors may directly, through loss of beach habitat, or indirectly, through changing thermal profiles and increasing erosion, serve to decrease the amount of nesting area available to females and may evoke a change in the natural behaviors of both adults and hatchlings (Ackerman, 1997; Witherington et al., 2003; Witherington et al., 2007). In addition, coastal development is usually accompanied by artificial lighting which has been known to alter the behavior of nesting adults (Witherington, 1992) and is often fatal to emerging hatchlings that are drawn away from the water (Witherington and Bjorndal, 1991). Predation by various land predators is a threat to developing nests and emerging hatchlings. Additionally, direct harvest of eggs and adults from beaches in foreign countries continues to be a problem for various sea turtle species throughout their ranges.

Multiple municipal, industrial and household sources as well as atmospheric transport introduce various pollutants such as pesticides, hydrocarbons, organochlorides (e.g. DDT and PCBs), and other pollutants that may cause adverse health effects to listed species including sea turtles (Iwata et al., 1993; Grant and Ross, 2002; Garrett, 2004; Hartwell, 2004). Loggerheads may be particularly affected by organochlorine contaminants as they were observed to have the highest organochlorine contaminant concentrations in sampled tissues (Storelli et al., 2008). It is thought that dietary preferences were likely to be the main differentiating factor among species. Storelli et al. (1998) analyzed tissues from twelve loggerhead sea turtles stranded along the Adriatic Sea (Italy) and found that mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals and porpoises (Law et al., 1991). Recent efforts have led to improvements in regional water quality, although the more persistent chemicals are still detected and are expected to endure for years (Mearns, 2001; Grant and Ross, 2002). Acute exposure to hydrocarbons from petroleum products released into the environment via oil spills and other discharges may directly injure individuals through skin contact with oils (Geraci, 1990), inhalation at the water's surface and ingesting compounds while feeding (Matkin and Saulitis, 1997). Hydrocarbons also have the potential to impact prey populations, and therefore may affect listed species indirectly by reducing food availability in the action area (for more information on the effects of present and past oil spills affecting populations in the Gulf of Mexico region, refer to the *Environmental Baseline* section of this Opinion).

Climate change and variability are identified as major causes of changing marine productivity and may therefore influence sea turtle prey abundance in foraging areas throughout the globe (Mantua et al., 1997; Francis et al., 1998; Beamish et al., 1999; Hare et al., 1999; Benson and Trites, 2002). For example, decade-scale climatic regime shifts have been related to changes in zooplankton in the North Atlantic (Fromentin and Planque, 1996) and decadal trends in the North Atlantic Oscillation (NAO) (Hurrell, 1995) can affect the position of the Gulf Stream

(Taylor et al., 1998) and other circulation patterns in the North Atlantic that act as important migratory pathways for various life stages of sea turtles. All reptiles including sea turtles have a tremendous dependence on their thermal environment for regulating physiological processes and for driving behavioral adaptations (Spotila et al., 1997). Atmospheric warming creates habitat alteration which in turn may change sex ratios and affect reproductive periodicity for nesting sea turtles. Climate variability may also increase hurricane activity leading to an increase in debris in nearshore and offshore waters, thereby resulting in increased entanglement, ingestion, or drowning as well as increased physical destruction of sea turtle nests. However, gaps in information and the complexity of climatic interactions complicate the ability to predict the effects that climate variability may have to these species from year to year.

The demand for both nourishment and the placement of hardened structures on the beach as management options for beach erosion are likely to increase in the future in the face of projected sea level rise and more intense storm activity associated with global climate change. The construction of beachfront armoring (i.e., rigid structures placed parallel to the shoreline on the upper beach to prevent both landward retreat of the shoreline and inundation or loss of upland property by flooding and wave action) includes bulkheads, seawalls, soil retaining walls, rock revetments, sandbags, and geotextile tubes. These structures can greatly impact nesting opportunities and hatching success of loggerhead turtles as well as other species. Mosier (1998) reported that fewer loggerheads made nesting attempts on beaches fronted by seawalls and found that when turtles did emerge in the presence of armoring structures, more returned to the water without nesting than those on non-armored beaches. Armoring structures can also eliminate a turtle's access to upper regions of the beach/dune system and subsequently cause turtles to nest at lower elevations which increases the risk of repeated tidal inundation and impact thermal regimes that can influence sex ratios.

Although numerous efforts are underway to reduce loggerhead bycatch in fisheries, and many positive actions have been implemented, it is unlikely that this source of mortality can be sufficiently reduced across the range of the DPS to positively benefit recovery potential in the near future because of the diversity and magnitude of the fisheries operating in the North Atlantic, the lack of comprehensive information on fishing distribution and effort, limitations on implementing demonstrated effective conservation measures, geopolitical complexities, limitations on enforcement capacity, and lack of availability of comprehensive bycatch reduction technologies (75 FR 12598). In addition, Heppell et al. (2003) showed that the growth of loggerhead sea turtle populations were particularly sensitive to changes in annual survival of both juvenile and adult sea turtles, and Crouse (1999) concluded that relatively small changes in annual survival rates of both juvenile and adult loggerhead sea turtles may adversely affect large segments of the total loggerhead sea turtle population. These studies suggest the species is particularly vulnerable to new sources of mortality as well as demographic and environmental stochasticity all of which are often difficult to predict with any certainty.

Kemp's Ridley Sea Turtle

Species Description, Distribution, and Population Structure

The Kemp's ridley sea turtle is among the smallest of all extant sea turtles with adults generally weighing less than 45 kilograms and having a SCL of around 60-65 centimeters (Heppell et al, 2005). Adults have an almost circular carapace with a grayish green color while the plastron is often pale yellow. There are two pairs of prefrontal scales on the head, five vertebral scutes, and five pairs of costal scutes. In the bridge adjoining the plastron to the carapace, there are four scutes, each of which is perforated by a pore. Hatchlings are usually grayish-black in color, range from 42-48 mm SCL, and weigh between 15-20 grams (Chavez et al., 1967; Marquez, 1972; Pritchard and Marquez, 1973; Marquez, 1990).

This species has a very restricted range relative to other sea turtle species with most adults occurring in shallow, nearshore waters from the Gulf of Mexico in the U.S. north to the Grand Banks and Nova Scotia (Bleakney, 1955; Watson et al., 2004; NMFS et al., 2011). Some individuals have also been identified to a lesser degree near the Azores and eastern north Atlantic (Deraniyagala, 1938; Brongersma, 1972; Fontaine et al., 1989; Bolten and Martins, 1990) as well as the Mediterranean region (Pritchard and Marquez, 1973, Brongersma and Carr 1983, Tomas and Raga 2007, Insacco and Spadola, 2010).

Nesting is essentially limited to the beaches of the western Gulf of Mexico, primarily in the Mexican state of Tamaulipas at a stretch of beach known as Rancho Nuevo (Hildebrand, 1963; Carr, 1963; Heppell et al., 2005) as well as south shores of Texas (especially South Padre Island) (Shaver and Plotkin, 1998; Shaver, 2002; Shaver, 2005). Nests have also been recorded in Veracruz and Campeche in Mexico and other east coast states in the U.S. (i.e., Florida, Alabama, Georgia, South Carolina, and North Carolina) although nesting is much less frequent in these areas. Kemp's ridley sea turtles display a unique mass nesting behavior where females emerge together onto the beach, usually during daylight hours. These synchronized emergences are known as arribadas and are frequently seen at Rancho Nuevo each year from April to July (Hildebrand, 1963; Carr, 1963; Marquez, 1994; Jimenez et al., 2005).

Dutton et al. (2006) examined mitochondrial DNA collected from Kemp's ridley females nesting at Padres Island between 2002 and 2004 and compared haloptype frequencies to those from the Rancho Nuevo population. The researchers found no significant differences suggesting genetic homogeneity between both populations.

Life History Information

The mean growth rate for Kemp's ridley sea turtles is between 5.5-7.5 cm per year (± 6.2 cm per year) with turtles tagged in the Gulf of Mexico exhibiting faster growth than those tagged in the Atlantic (Schmid and Woodhead, 2000). Sexual maturity is reached at approximately 10-16 years of age (Chaloupka and Zug, 1997; Schmid and Witzell, 1997; Zug et al., 1997; Schmid and Woodhead, 2000). The mean remigration interval for females is 2 years although intervals or 1 and 3 years have also been measured and are not uncommon (Marquez et al., 1982; TEWG, 1998; TEWG, 2000). Nesting generally occurs from April to July and females lay approximately 2.5 nests per season (TEWG, 1998) with each nest containing approximately 100 eggs (Marquez, 1994)

Studies have shown that the time spent in the post-hatchling pelagic stage can vary from 1-4 years time, while the benthic immature stage typically lasts approximately 7-9 years (Schmid and Witzell, 1997). Little is known of the movements of the post-hatching, planktonic stage within the Gulf of Mexico although the turtles during this stage are assumed to associate with floating seaweed (e.g. *Sargassum spp.*) similar to loggerhead and green sea turtles. During this stage, they presumably feed on the available seaweed and associated infauna or other epipelagic species found in the Gulf of Mexico. While many post-hatchlings remain in the Gulf of Mexico, some are transported eastward on the Florida Current into the Gulf Stream transporting them up the east coast of the U.S. (Collard and Ogren, 1990; Putman et al., 2010).

Atlantic juveniles/subadults travel northward with vernal warming to feed in the productive, coastal waters of Georgia through New England, returning southward with the onset of winter to escape the colder conditions (Lutcavage and Musick, 1985; Henwood and Ogren, 1987; Ogren, 1989). Upon leaving Chesapeake Bay in autumn, juvenile ridleys migrate down the coast, passing Cape Hatteras in December and January (Musick and Limpus, 1997). These larger juveniles are joined there by juveniles of the same size from North Carolina and smaller juveniles from New York and New England to form one of the densest concentrations of Kemp's ridleys outside of the Gulf of Mexico (Musick and Limpus, 1997; Epperly et al., 1995b; Epperly et al., 1995c).

Those that remained in the Gulf of Mexico during their early oceanic stage apparently move into coastal waters, mainly along the northern and eastern shorelines of the Gulf (Landry and Seney, 2008). Date obtained through satellite telemetry reveal a south to southwestern winter migration by Kemp's ridleys in the northwestern Gulf of Mexico, a west to east migration in the northern Gulf, and a southern winter migration in the eastern Gulf (Renaud and Williams, 2005). Schmid (1998) reported that neritic juveniles may continue this pattern of seasonal migrations and foraging site fidelity for a number of years until maturing into the adult stage.

Adult Kemp's ridleys primarily occupy nearshore neritic habitats, typically containing muddy or sandy bottoms where their preferred prey can be found. In the post-pelagic stages, Kemp's ridley sea turtles are largely cancrivorous (crab eating), with a preference for portunid crabs (Bjorndal, 1997). Stomach contents of Kemp's ridleys along the lower Texas coast consisted of a predominance of nearshore crabs and mollusks, as well as fish, shrimp and other foods considered to be bycatch discards from the shrimping industry (Shaver, 1991).

Listing Status

Kemp's ridley sea turtles were listed as endangered on December 2, 1970 (35 FR 18320). Internationally, the Kemp's ridley is considered the most endangered sea turtle (NRC 1990b; USFWS 1999). There is no designated critical habitat for the Kemp's ridley sea turtle.

Abundance and Trends

The global population of Kemp's ridley sea turtles is the lowest of all the extant sea turtle species and a review of nesting data collected since the late 1940's suggest that species has drastically declined in abundance over the past 50 years. When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand, 1963; Carr, 1963). By the early 1970s, the world population estimate of

mature female Kemp's ridleys had reduced to 2,500-5,000 individuals (i.e., 88-94 percent decline from 1940's levels) and this trend continued through the mid-1980s with the lowest nest count of 702 recorded for Rancho Nuevo in the year 1985. The severe decline in the Kemp's ridley population was likely caused by a combination of factors including direct egg removal, direct harvest of females on beaches, and impacts from Gulf of Mexico fishery operations during that time (notaby shrimp trawling) (NMFS et al., 2011).

Despite these drastic declines in abundance, recent nesting data collected from the National Institute of Fisheries in Mexico as well as data from the USFWS has suggested the population may be showing signs of recovery. For instance, the number of nests at Rancho Nuevo grew from a low of 702 nests in 1985, to 1,940 nests in 1995, to over 20,000 nests in 2009 which was the highest nest counts seen in over 55 years. Similar increases were documented for Texas beaches as the 911 nests documented from 2002-2010 represented an eleven-fold increase from the 81 nests counted over the period 1948-2001 (Shaver and Caillouet, 1998; Shaver, 2005). Results for the 2010 nesting season were not as encouraging as nest counts were recorded at levels lower than the previous three years for Rancho Nuevo and the previous two years for Texas beaches (Conant, personal communication, 2010) although they remain at levels significantly higher than those recorded over the previous five decades.

The TEWG (2000) developed a population model to evaluate trends in the Kemp's ridley population through the application of empirical data and life history parameter estimates chosen by the investigators. Model results identified three trends over time in benthic immature Kemp's ridley sea turtles. Increased production of hatchlings from the nesting beach beginning in 1966 resulted in an increase in the population of benthic Kemp's ridleys (defined as 20-60 cm in length and approximately 2-9 years of age) that leveled off in the late 1970s. A second period of increase followed by leveling occurred between 1978 and 1989 as hatchling production was further enhanced by the cooperative program between the U.S. Fish and Wildlife Service and Mexico's Instituto Nacional de Pesca to increase nest protection and relocation. A third period of steady increase has occurred since 1990 likely due to increased hatchling production and survival of immature turtles. The original model projected that population levels could theoretically reach the Recovery Plan's intermediate recovery goal of 10,000 nesters by the year 2015 if the assumptions of age to sexual maturity and age specific survivorship rates used are correct.

More recent models developed by Heppell et al. (2005) predict that the population is expected to increase at least 12-16 percent per year [19 percent using updated models utilized for the 2011 five year status review for the species (NMFS et al., 2011)] and that the population could attain at least 10,000 females nesting on Mexico beaches in this decade [by 2015 for (Heppel et al., 2005) and by 2011 for updates to the model developed for the 2011 five year status review (NMFS et al., 2011)]. Of course, this updated model assumes that current survival rates within each life stage remain constant. The recent increases in Kemp's ridley sea turtle nesting seen in the last two decades is likely due to a combination of management measures including elimination of direct harvest, nest protection, the use of TEDs, reduced trawling effort in Mexico and the U.S., and possibly other changes in vital rates (TEWG, 1998; TEWG, 2000). While these results are encouraging, the species limited range as well as low global abundance makes it

particularly vulnerable to new sources of mortality as well as demographic and environmental stochasticity all of which are often difficult to predict with any certainty.

Current Threats

Kemp's ridleys are currently subject to the same suite of threats on both nesting beaches and in the marine environment that affect other sea turtles (e.g. interaction with fishing gear, coastal construction, oil spills, climate change affecting sex ratios, etc.) although they are particularly affected by actions occurring in the Gulf of Mexico where essentially all nesting occurs and where the majority of offshore juveniles and adults reside throughout the year.

Direct harvest of eggs and nesting adults was common in Mexico before 1967 and represented a major threat to the species causing declines in both adult survival and reproductive success. The fact that the species nests in only a few key areas as well as the mass arribadas formed during the nesting season made them particularly vulnerable to capture based on their predictability. While direct harvest no longer occurs, illegal poaching continues to be an issue affecting Kemp's ridleys nesting in Mexico and Texas although the presence of field biologists and enforcement personnel on nesting beaches has minimized the threat in recent decades.

Of all commercial fisheries operating in the Gulf of Mexico and along the east coast of the U.S., shrimp trawling has had the greatest impact on sea turtle populations, including Kemp's ridleys. The National Academy of Sciences estimated that between 500 and 5,000 Kemp's ridley sea turtles were killed annually by the offshore shrimping fleet in the southeastern U.S. and Gulf of Mexico (Magnuson et al., 1990). While direct harvest on beaches affected eggs and adults, incidental mortalities in trawls and other commercial fisheries impacted offshore and neritic juveniles as well as adults. Before the use of TEDs, shrimp trawling was estimated to cause 10 times the mortality of any other antropogenic factors combined. Under current TED requirements, the estimated annual mortality of Kemp's ridleys in U.S. waters was estimated to be up to 4,208 individuals based on shrimping effort for the year 2001 (NMFS, 2002). However, by 2009, shrimp trawl effort had declined by 61 percent and 38 percent in the Gulf of Mexico and U.S. Atlantic, respectively, meaning that the adjusted mortality of Kemp's ridley mortalities was significantly lower in 2009 (1,717 Kemp's ridleys) than what was in the early part of the decade (NMFS-SEFSC, 2011). NMFS believes that the increase in neritic juveniles as a result of increased nesting seen over the last 10 years will expose more neritic juveniles to shrimp trawling in future years meaning that estimates for 2009 may be on the low side (NMFS et al., 2011). Shrimp trawls in addition to other fisheries operating in the Gulf of Mexico remains a major source of mortality that will affect the ability of the species to survive and recover in the wild.

Due to their limited range, Kemp's ridleys are also severely impacted by hurricanes and other major events such as pollution (e.g. oil spills) occurring in the Gulf of Mexico. Hurricanes and strong storm events are more frequent along the east coast of Mexico and Gulf of Mexico during August and September when hatchlings and eggs are particularly vulnerable. These storms can uncover eggs and manipulate dunes or create wash over channels that reduce suitable habitat for egg deposition and incubation (NMFS et al., 2011). The Gulf of Mexico is also an area of high-density offshore oil exploration and extraction with chronic, low-level spills as well as

occasional massive spills that affect nesting and foraging habitat for all life stages of Kemp's ridleys.

In the spring of 2010, The *Deepwater Horizon* offshore deepwater rig sank in the Gulf as a result of an explosion that lead to an uncontrolled and continuous release of oil from the well. The explosion occurred at the beginning of the nesting season for Kemp's ridley sea tutles and lasted for approximately three months before the well was capped. While the oil did not reach the nesting beaches in Mexico and Texas, the oil did affect nesting beaches in Alabama as well as the Florida Panhandle (including the action area for this proposed action). As a result, five Kemp's ridley nests were relocated to unaffected beaches and 125 hatchlings were subsequently released in adjacent waters to minimize egg and hatchling mortality (NMFS, unpublished data[3]). According to the data available from NMFS at the time of this consultation, there were 481 confirmed deaths of Kemp's ridley sea turtles in the vicinity of the *Deepwater Horizon* oil spill site and this number is considered a conservative one (NMFS, unpublished data). While the cause of death is not certain for many of the carcasses recovered, these numbers represent the highest total mortality by far of any of the extant sea turtle species occurring in the Gulf since the blowout first occurred (approximately 83 percent of all identified sea turtle deaths). It is expected that the acute and chronic events of the *Deepwater Horizon* oil spill as well as other historical spills will continue to threaten the survival and recovery of Kemp's ridley sea turtles for years to come although more research will need to be done to determine the long term effects these past spills have on survival and/or reproduction (see the *Environmental Baseline* section of this Opinion for more information on oil spill effects specific to the action area).

Strandings events observed over the years illustrate the vulnerability of Kemp's ridley turtles to the impacts of human activities in nearshore Gulf of Mexico waters and these threats are expected to continue for years to come (TEWG, 1998). Efforts are underway to examine the carcasses to try to determine the cause of death although fishing activities as well as acute toxicosis as a result of harmful algal blooms are traditionally the main culprits. Stranding events like these directly reduce the abundance of sea turtle populations in the Gulf and can significantly impact the ability of the species to recover given other stressors occurring as a result or in conjunction with strandings.

Environmental Baseline

The environmental baseline for this opinion includes the effects of several activities that affect the survival and recovery of threatened and endangered species and its habitat (including designated critical habitat), and ecosystem, within the action area. As noted above, sea turtles found in the action areas may travel widely throughout the Atlantic, Gulf of Mexico, and Caribbean Sea. Therefore, individuals found in an action area can potentially be affected by activities anywhere within this wide range.

The environmental baseline includes the past and present impacts of all state, tribal, local, private, and other human activities in the action area, including impacts of these activities which will occur contemporaneously with this consultation. Unrelated Federal actions affecting the

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3 Sea turtle mortality and nest relocation data associated with the *Deepwater Horizon* Oil spill event is available at: http://www.nmfs.noaa.gov/pr/health/oilspill/turtles.htm.

same species or critical habitat that have completed formal or informal consultation are also part of the environmental baseline, as are Federal and other actions within the action area that may benefit listed species or critical habitat. It clearly identifies how actions affect the status and trend of the listed species or critical habitat of the opinion. To provide the reader with a more comprehensive discussion of the all the activities affecting the species found in the action area, we have included activities occurring in areas to which these species could migrate during the course of their life cycle.

A number of human activities have contributed to the current status of listed sea turtle species in the action area. Some of those activities, (e.g. commercial harvesting of individuals as well as eggs) no longer occur in the U.S., yet are still a problem in other countries. Other human activities are ongoing and appear to be directly or indirectly affecting these species. Additionally, unrelated factors may be acting together to affect listed species, such as global warming.

Taken together, the components of the environmental baseline for the action area include sources of natural mortality as well as influences from natural oceanographic and climatic features in the action areas. Circulation and productivity patterns influence food distribution and habitat quality for listed species. The effects of climatic variability on these species in the action areas and the availability of food remain largely undetermined; however, it is likely that any changes in weather and oceanographic conditions resulting in effects on population dynamics (i.e. sex-ratios) as well as food availability would have dire consequences for sea turtle species.

The most significant activities affecting sea turtles in the Atlantic are fisheries and conservation activities directed at fisheries. Other environmental impacts to turtles may result from vessel operations, discharges, dredging, military activities, oil and gas development activities, industrial cooling water intake, aquaculture, recreational fishing, coastal development, habitat degradation, directed take, marine debris, as well as scientific research and conservation efforts.

Natural Sources of Stress and Mortality

Disease and Red Tide. A disease known as fibropapilloma is a major threat to listed turtles in many areas of the world including the action area. 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). It was first described in green turtles in the Florida Keys in the 1930's. Since then it has been recorded in many green turtle populations around the world as well as other sea turtle species, such as loggerheads (Huerta et al., 2002), most notably present in green turtles of Hawaii, Florida, and the Caribbean. In Florida, up to 50% of the immature green turtles captured in the Indian River Lagoon are infected, and there are similar reports from other sites in Florida, including Florida Bay, as well as from Puerto Rico and the U.S. Virgin Islands. In addition, scientists have documented FP in populations of loggerhead, olive ridley, and flatback turtles (Huerta et al. 2002). The effects of FP at the population level are not well understood and could be a serious threat to their recovery. The cause of the disease remains unknown. Research to determine the cause of this disease is a high priority and is underway.

Harmful algal blooms, such as a red tide, impact both sea turtles in the action area. During four red tide events along the west coast of Florida, sea turtle stranding trends indicated that these events were acting as a mortality factor (Redlow et al., 2003).

Predation and Invasive Species. Predation of sea turtle eggs and hatchlings by native and introduced species occurs on almost all sea turtle nesting beaches throughout the Gulf of Mexico. The most common predators at the primary nesting beaches in the southeastern United States are ghost crabs (*Ocypode quadrata*), raccoons (*Procyon lotor*), feral hogs (*Sus scrofa*), foxes (*Urocyon cinereoargenteus* and *Vulpes vulpes*), coyotes (*Canis latrans*), armadillos (*Dasypus novemcinctus*), and red fire ants (*Solenopsis invicta*) (Stancyk, 1982; Dodd, 1988). In the absence of well managed nest protection programs, predators may take significant numbers of eggs.

An increased human presence at some nesting beaches or close to nesting beaches has lead to secondary threats such as the introduction of exotic fire ants, feral hogs, dogs and an increased presence of native species (e.g. raccoons, armadillos, and opossums) which raid and feed on turtle eggs. Non-native vegetation has invaded many coastal areas and often out competes native species. Non-native vegetation is usually less-stabilizing and can lead to increased erosion and degradation of suitable nesting habitat. Non-native vegetation may also form impenetrable root mats that can prevent proper nest cavity excavation, invade and desiccate eggs, or trap hatchlings. In light of these issues, conservation and long-term protection of sea turtle nesting and foraging habitats is an urgent and high priority need. The invasive Australian pine (*Casuarina equisetifolia*) is also particularly harmful to sea turtles throughout the state of Florida because they out compete native species and cause excessive shading of the beach that would not otherwise occur. Studies in Florida suggest that nests laid in shaded areas are subjected to lower incubation temperatures, which may alter the natural hatchling sex ratios (Marcus and Maley, 1987; Schmelz and Mezich, 1988; Hanson et al., 1998).

Hurricanes. Hurricanes and tropical storms are common in the Gulf of Mexico and have the potential to directly injure or kill targeted species and/or modify habitat in the action area. Degradation of the estuarine and riverine habitat as a result of high hurricane activity may result in loss of spawning and foraging habitat important to Gulf sturgeon or indirectly affect habitat through increased erosion. Sea turtle nests may also be unearthed during storm events and cause mortality of sea turtle hatchlings. Sand accretion, rainfall, and wave action that result from these storms can also reduce hatchling success. Additionally, with more intense storms expected in the coming years based on climate modeling, it is expected that sea turtle nesting habitat will be further impacted [Goldenburg et al., 2001; Webster et al., 2005; Intergovernmental Panel on Climate Change (IPCC), 2007] and may result in a decrease in hatching success and hatchling emergence in the action area (Martin, 1996; Ross, 2005; Pike and Stiner, 2007; Prusty et al., 2007; Van Houton and Bass, 2007).

Climate Variability. Naturally occurring climatic patterns, such as the El Niño and La Niña events, as well as longer time-scale climate variability are identified as major causes of changing marine productivity and may therefore influence listed species' prey abundance in the action area (Mantua et al., 1997; Francis et al., 1998; Beamish et al., 1999; Hare et al., 1999; Benson and Trites, 2002). For example, decade-scale climatic regime shifts have been related to changes in zooplankton in the North Atlantic (Fromentin and Planque, 1996) and decadal trends in the

North Atlantic Oscillation (NAO) (Hurrell, 1995) can affect the position of the Gulf Stream (Taylor et al., 1998) and other circulation patterns in the North Atlantic that act as important migratory pathways for various life stages of sea turtles and marine fish. Alteration of climate due to anthropogenic activities may also increase hurricane activity within the Gulf of Mexico leading to an increase in debris in nearshore and offshore waters, thereby resulting in increased entanglement, ingestion, or drowning as well as increased physical destruction of sea turtle nests and further degradation of river and estuarine habitats. However, gaps in information and the complexity of climatic interactions complicate the ability to predict the effects that climate variability may have to these species from year to year.

Increasing air temperatures are a particular concern for nesting sea turtles in the action area as sex is determined by temperature in the middle third of incubation with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25-35°C (Ackerman, 1997). Based on modeling done for loggerhead sea turtles, a 2°C increase in air temperature would be expected to result in production of 100 percent females while a 3°C increase in air temperature would likely exceed the thermal threshold of turtle clutches, resulting in death (Hawkes et al., 2007). Glen et al. (2003) also reported that incubation temperatures for green sea turtles appeared to affect hatchling size with smaller turtles produced at higher incubation temperatures; however, it is unknown whether this effect is species specific or what impact this has on offspring survival. Thus, changes in air temperature as a result of global climate change may alter sex ratios and may reduce hatchling production for nesting beaches throughout the action area (Hawkes et al., 2007; Hamann et al., 2007).

Anthropogenic Sources of Stress and Mortality

Federal Activities

Fisheries. Threatened and endangered sea turtles are adversely affected by several types of fishing gears used throughout the action area. Gillnet, longline, other types of hook-and-line gear, trawl gear, and pot fisheries have all been documented as interacting with sea turtles. Available information suggests sea turtles can be captured in any of these gear types when the operation of the gear overlaps with the distribution of sea turtles. For all fisheries for which there is an FMP or for which any federal action is taken to manage that fishery, impacts have been evaluated under section 7. Formal section 7 consultation have been conducted on the following fisheries, occurring at least in part within the action area, found likely to adversely affect threatened and endangered sea turtles: Atlantic bluefish, Atlantic herring, Atlantic mackerel/squid/butterfish, Atlantic sea scallop, Atlantic swordfish/tuna/shark/billfish, coastal migratory pelagic, dolphin-wahoo, Gulf of Mexico (GOM) reef fish, monkfish, Northeast multispecies, South Atlantic snapper-grouper, Southeast shrimp trawl, spiny dogfish, red crab, skate, commercial directed shark, summer flounder/scup/black sea bass fisheries, tilefish, Atlantic highly migratory species (HMS) fishery, GOM/South Atlantic spiny lobster, and GOM stone crab. A brief summary of each consultation is provided below but more detailed information can be found in the respective biological opinions.

NMFS found the operation of the *Atlantic bluefish fishery* was likely to adversely affect Kemp's ridley and loggerhead sea turtles, but not likely to jeopardize their continued existence (NMFS

2010a). The majority of commercial fishing activity in the North and Mid-Atlantic occurs in the late spring to early fall, when bluefish (and sea turtles) are most abundant in these areas (NEFSC 2005a).

NMFS' consultation on the *Atlantic Herring fishery* FMP concluded that the federal herring fishery may adversely affect loggerhead, leatherback, Kemp's ridley, and green sea turtles as a result of capture in gear used in the fishery (NMFS 1999b), but not jeopardize their continued existance. NMFS currently authorizes the use of trawl, purse seine, and gillnet gear in the commercial herring fishery (64 FR 4030). There is no direct evidence of takes of ESA-listed species in the herring fishery from the NMFS sea sampling program. However, observer coverage of this fishery has been minimal. Sea turtles have been captured in comparable gear used in other fisheries that occur in the same area as the herring fishery.

The *Atlantic mackerel/squid/butterfish fisheries* are managed under a single FMP that includes both the short-finned squid (Illex illecebrosus) and long-finned squid (Loligo pealei) fisheries. The most recent biological opinion concluded that the continued authorization of the FMP was likely to adversely affect sea turtles, but not jeopardize their continued existence (NMFS 2010b). Trawl gear is the primary fishing gear for these fisheries, but several other types of gear may also be used, including hook-and-line, pot/trap, dredge, pound net, and bandit gear. Entanglements or entrapments of sea turtles have been recorded in one or more of these gear types.

It was previously believed that the *Atlantic Sea Scallop fishery* was unlikely to take sea turtles given differences in depth and temperature preferences for sea turtles and the optimal areas where the fishery occurs. However, after the reopening of a closed area in the mid-Atlantic, and the accumulation of more extensive observer effort, NMFS conducted a formal section 7 consultation on the fishery (NFMS 2012b). NMFS concluded that operation of the fishery may adversely affect loggerhead, Kemp's ridley, green, and leatherback sea turtles as a result of capture in scallop dredge and/or trawl gear.

The *Atlantic HMS pelagic fisheries for swordfish, tuna, and billfish* are known to incidentally capture large numbers of sea turtles, particularly in the pelagic longline component (NMFS 2004). Pelagic longline, pelagic driftnet, bottom longline, and/or purse seine gear have all been documented taking sea turtles. A permanent prohibition on the use of driftnet gear in the swordfish fishery was published in 1999.

NMFS recently completed a consultation on the continued authorization of the *coastal migratory pelagic* fishery in the Gulf of Mexico and South Atlantic (NMFS 2007). In the Gulf of Mexico, hook-and-line, gillnet, and cast net gears are used. Gillnets are the primary gear type used by commercial fishermen in the South Atlantic regions as well, while the recreational sector uses hook-and-line gear. The hook-and-line effort is primarily trolling. The biological opinion concluded that green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles may be adversely affected by operation of the fishery. However, the proposed action was not expected to jeopardize the continued existence of any of these species.

The South Atlantic FMP for the *dolphin-wahoo fishery* was approved in December 2003. NMFS's consultation concluded that green, hawksbill, Kemp's ridley, leatherback, and

loggerhead sea turtles may be adversely affected by the longline component of the fishery, but it was not expected to jeopardize their continued existence (NMFS 2003). In addition, pelagic longline vessels can no longer target dolphin-wahoo with smaller hooks because of hook size requirements in the pelagic longline fishery.

The incidental take for sea turtles specified in the February 2005 biological opinion on the *Gulf of Mexico reeffish fishery* was substantially exceeded in 2008 by the bottom longline component of the fishery. In May 2009, NMFS published an emergency rule, which was intended to reduce the number of sea turtle takes by the reef fish fishery in the short-term while the Gulf of Mexico Fishery Management Council develops long-term measures in Amendment 31 to the Reef Fish Fishery Management Plan (RFFMP). The new biological opinion, which considered the continued authorization of reef fish fishing under the RFFMP, including any measures proposed in Amendment 31, was completed October 2009 (NMFS 2009).

The federal *monkfish fishery* occurs from Maine to the North Carolina/South Carolina border and is jointly managed by the New England Fishery Management Council (NEFMC) and Mid-Atlantic Fishery Management Council (MAFMC), under the Monkfish FMP (NEFSC 2005b). The current commercial fishery operates primarily in the deeper waters of the Gulf of Maine, Georges Bank, and southern New England, and effort has recently increased dramatically in the mid-Atlantic. The monkfish fishery uses several gear types that may entangle sea turtles, including gillnet, trawl gear and scallop dredges, which are the principal gear types that have historically landed monkfish. Monkfish (also known as "goosefish" or "angler") are found in inshore and offshore waters from the northern Gulf of St. Lawrence to Florida, although primarily distributed north of Cape Hatteras. As fishing effort moves further south, there is a greater potential for interactions with sea turtles.

Following an event in which over 200 sea turtle carcasses washed ashore in an area where large-mesh gillnetting had been occurring, NMFS published new restrictions for the use of gillnets with larger than 8-inch stretched mesh, in the EEZ off of North Carolina and Virginia (67 FR 71895, December 3, 2002). This rule was in response to a direct need to reduce the impact of this fishery on sea turtles. The rule was subsequently modified on April 26, 2006, by modifying the restrictions to the use of gillnets with greater than or equal to 7-inch stretched mesh when fished in federal waters from the North Carolina/South Carolina border to Chincoteague, Virginia. Consultation was completed on October 29, 2010 (NMFS 2010c)

Multiple gear types are used in the *Northeast Multispecies fishery* FMP, which manages 15 different commercial fisheries. Data indicated that gear type of greatest concern is the sink gillnet gear, which has taken loggerhead and leatherback sea turtles (*i.e.*, in buoy lines and/or net panels). The Northeast multispecies sink gillnet fishery has historically occurred from the periphery of the Gulf of Maine to Rhode Island in water as deep as 360 feet. In recent years, more of the effort in the fishery has occurred in offshore waters and into the Mid-Atlantic. Participation in this fishery has declined because extensive groundfish conservation measures have been implemented; the latest of these occurring under Amendment 13 to the Multispecies FMP. Consultation on the Northeast Multispecies fishery was reinitiated on April 2, 2008, based on new information on the capture of loggerhead sea turtles in this fishery (NMFS 2010d).

The *South Atlantic snapper-grouper fishery* (NMFS 2006a) uses spear and powerhead, black sea bass pot, and hook-and-line gear. Hook-and-line gear used in the fishery includes commercial bottom longline gear and commercial and recreational vertical line gear (e.g., handline, bandit gear, and rod-and-reel). The consultation found only hook-and-line gear likely to adversely affect, green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles.

The *Southeast shrimp trawl fishery* affects more sea turtles than all other activities combined (NRC 1990). Revisions to the TED regulations (68 FR 8456, February 21, 2003), requiring larger openings in TEDs enhanced the TED effectiveness in reducing sea turtle mortality resulting from trawling. This determination was based, in part, on the opinion's analysis that shows the revised TED regulations are expected to reduce shrimp trawl related mortality by 94 percent for loggerheads and 97 percent for leatherbacks. Interactions between sea turtles and the shrimp fishery may also be declining because of reductions of fishing effort unrelated to fisheries management actions. In recent years, low shrimp prices, rising fuel costs, competition with imported products, and the impacts of recent hurricanes in the Gulf of Mexico have all impacting the shrimp fleets; in some cases reducing fishing effort by as much as 50 percent for offshore waters of the Gulf of Mexico (GMFMC 2007).

Indirect effects of shrimp trawling on sea turtles would include the disturbance of the benthic habitat by the trawl gear. The effect bottom trawls have on the seabed is mainly a function of bottom type. In areas where repeated trawling occurs, fundamental shifts in the structure of the benthic community have been documented (Auster *et al.* 1996) which may affect the availability of prey items for foraging turtles. The overall effects to benthic communities that may result from long-term and chronic disturbance from shrimp fishing needs further evaluation.

The primary gear types for the *Spiny dogfish fishery* are sink gillnets, otter trawls, bottom longline, and driftnet gear (NEFSC 2003). Spiny dogfish are landed in every state from Maine to North Carolina, throughout a broad area with the distribution of landings varying by area and season. During the fall and winter months, spiny dogfish are captured principally in Mid-Atlantic waters from New Jersey to North Carolina. During the spring and summer months, spiny dogfish are landed mainly in northern waters from NY to ME. Sea turtles can be incidentally captured in all gear sectors of this fishery. Although there have been delays in implementing the FMP (NMFS 2010e), quota allocations are expected to be substantially reduced over the 4.5-year rebuilding schedule; this should result in a substantial decrease in effort directed at spiny dogfish. The reduction in effort should be of benefit to protected turtle species by reducing the number of gear interactions that occur.

The *Red crab fishery* is a pot/trap fishery that occurs in deep waters along the continental slope. There have been no recorded takes of ESA-listed species in the red crab fishery. However, given the type of gear used in the fishery, takes of loggerhead and leatherback sea turtles may be possible where gear overlaps with the distribution of ESA-listed species. The red crab commercial fishery has traditionally been composed of less than six vessels fishing trap gear. The fishery appears to have remained small (approximately two vessels) through the mid-1990's. But between 1995 and 2000 there were as many as five vessels with the capacity to land an average of approximately 78,000 pounds of red crab per trip. Following concerns that red crab could be overfished, an FMP was developed and became effective on October 21, 2002.

Traditionally, the main gear types used in the *Skate fishery* (NMFS 2010f) include mobile otter trawls, gillnet gear, hook and line, and scallop dredges, although bottom trawling is by far the most common gear type with gillnet gear is the next most common gear type. The Northeast skate complex is comprised of seven different skate species. The seven species of skate are distributed along the coast of the northeast U.S. from the tide line to depths exceeding 700m (383 fathoms). There have been no recorded takes of ESA-listed species in the skate fishery. However, given that sea turtles interactions with trawl and gillnet gear have been observed in other fisheries, sea turtle takes in gear used in the skate fishery may be possible where the gear and sea turtle distribution overlap.

The commercial *HMS Atlantic shark fisheries* (NMFS 2012c) uses bottom longline and gillnet gear. The recreational sector of the fishery uses only hook-and-line gear. To protect declining shark stocks the proposed action seeks to greatly reduce the fishing effort in the commercial component of the fishery. These reductions are likely to greatly reduce the interactions between the commercial component of the fishery and sea turtles.

The *Summer Flounder, Scup and Black Sea Bass fisheries* are known to interact with sea turtles. Otter trawl gear is used in the commercial fisheries for all three species (NMFS 2010g). Floating traps and pots/traps are used in the scup and black sea bass fisheries, respectively (MAFMC 2007). Significant measures have been developed to reduce the take of sea turtles in summer flounder trawls and trawls that meet the definition of a summer flounder trawl (which would include fisheries for other species like scup and black sea bass). TEDs are required throughout the year for trawl nets fished from the North Carolina/South Carolina border to Oregon Inlet, North Carolina, and seasonally (March 16-January 14) for trawl vessels fishing between Oregon Inlet, North Carolina, and Cape Charles, Virginia.

The North Carolina inshore fall *southern flounder gillnet fishery* was identified as a source of large numbers of sea turtle mortalities in 1999 and 2000, especially loggerhead sea turtles. In 2001, NMFS issued an ESA section 10 permit to North Carolina with mitigative measures for the southern flounder fishery. Subsequently, the sea turtle mortalities in these fisheries were drastically reduced. The reduction of sea turtle mortalities in these fisheries reduces the negative effects these fisheries have on the environmental baseline.

The management unit for the *Tilefish* FMP is all golden tilefish under U.S. jurisdiction in the Atlantic Ocean north of the Virginia/North Carolina border. Tilefish have some unique habitat characteristics, and are found in a warm water band (8-18º C) approximately 250 to 1200 feet deep on the outer continental shelf and upper slope of the U.S. Atlantic coast. Because of their restricted habitat and low biomass, the tilefish fishery in recent years has occurred in a relatively small area in the Mid-Atlantic Bight, south of New England and west of New Jersey.

The *Atlantic Highly Migratory Species* (HMS) and Associated Fisheries are known to take sea turtles via pelagic longline, pelagic driftnet, bottom longline, hand line (including bait nets), and/or purse seine gear. The opinion analyzed the effects of proposed regulatory modifications to the HMS FMP that address the impacts of the HMS pelagic longline fishery on endangered green, hawksbill, Kemp's ridley, and leatherback sea turtles and on threatened loggerhead and

olive ridley sea turtles. However, the proposed action was not expected to jeopardize the continued existence of any of these.

Based on limited observer data available, NMFS also anticipates that continued operation of the U.S. shark drift gillnet portion of the fishery would result in the capture of loggerhead sea turtles, leatherbacks, Kemp's ridley sea turtles, and hawksbill sea turtles. NMFS anticipates that continued operation of the bottom longline fishery component would result in the capture of loggerhead sea turtles, leatherback, Kemp's ridley, green, and hawksbill sea turtles. Since potential for take in other HMS fisheries is low, NMFS anticipated that the proposed action was not expected to jeopardize the continued existence of any of these.

The commercial *Gulf of Mexico/South Atlantic spiny lobster fishery* (NMFS 2009a) consists of diving, bully net and trapping sectors; recreational fishers are authorized to use bully net and hand-harvest gears. The consultation determined that, although evidence that the commercial trap sector of the fishery adversely affects these species, the continued authorization of the fishery would not jeopardize the continued existence of green, hawksbill, Kemp's ridley leatherback, and loggerhead sea turtles.

The *Gulf of Mexico stone crab fishery* (NMFS 2009b) is unique in that only the claws of the crab are harvested (Muller *et al.* 2006). The fishery operates primarily nearshore and fishing techniques have changed little since the implementation of the federal Stone Crab Fishery Management Plan. The commercial and recreational fishery consists of trap/pot, and recreational hand harvest. Stone crab traps are known to adversely affect sea turtles via entanglement and forced submergence. The fishery is currently management through spatio-temporal closures, effort limitations, harvest limitations, permit requirements, trap construction requirements, and a passive trap limitation program managed by the State of Florida. Recreational fishers must follow the same guidelines as commercial fishers unless otherwise noted. The consultation determined the continued authorization of the fishery would not jeopardize the continued existence of green, hawksbill, Kemp's ridley leatherback, and loggerhead sea turtles.

Vessel Activities. Potential sources of adverse effects from federal vessel operations in the action area and throughout the range of sea turtles include operations of the U.S. Navy and Coast Guard (USCG), which maintain the largest Federal vessel fleets, the Environmental Protection Agency, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Army Corps of Engineers (USACE). NMFS has conducted formal consultations with the USCG, the U.S. Navy, and NOAA on their vessel operations. Through the section 7 process, where applicable, NMFS has and will continue to establish conservation measures for all these agency vessel operations to avoid or minimize adverse effects to listed species. At the present time, however, they present the potential for some level of interaction.

Since the U.S. Navy consultation only covered operations out of Mayport, Florida, potential still remains for U.S. Navy vessels to adversely affect sea turtles when they are operating in other areas within the range of these species. Similarly, operations of vessels by other Federal agencies within or near the action area (NOAA, EPA, USACE) may adversely affect sea turtles. However, the in-water activities of those agencies are limited in scope, as they operate a limited

number of vessels or are engaged in research/operational activities that are unlikely to contribute a large amount of risk.

Private and commercial vessel operations also have the potential to interact with sea turtles. For example, shipping traffic in Massachusetts Bay is estimated at 1,200 ship crossings per year with an average of three per day. Similar traffic may exist in many other areas where sea turtles occur. The invention and popularization of new technology resulting in high speed catamarans for ferry services and whale watch vessels operating in congested coastal areas contributes to the potential for impacts from privately-operated vessels. In addition to commercial traffic and recreational pursuits, private vessels participate in high speed marine events concentrated in the southeastern United States that are a particular threat to sea turtles. The magnitude of these marine events is not currently known. The sea turtle stranding network (STSSN) also reports many records of vessel interaction (propeller injury) with sea turtles off coastal states such as New Jersey and Florida, where there are high levels of vessel traffic.

Dredging. The construction and maintenance of federal navigation channels has also been identified as a source of sea turtle mortality. Hopper dredges move relatively rapidly (compared to sea turtle swimming speeds) and can entrain and kill sea turtles.

Oil and Gas Exploration. The U.S. Corps of Engineers (USACE) and the Bureau of Ocean Energy Management (BOEM) authorize oil and gas exploration, well development, production, and abandonment/rig removal activities that may adversely affect sea turtles. Both of these agencies have consulted numerously with the NMFS on these types of activities. These activities include the use of seismic arrays for oil and gas exploration in the Gulf of Mexico, the impacts of which have been analyzed in opinions for individual and multi-lease sales. NMFS anticipates incidental takes of sea turtles from vessel strikes, noise, marine debris, and the use of explosives to remove oil and gas structures.

Electrical Generating Plants. Another action with federal oversight (the Federal Energy Regulatory Commission and the Nuclear Regulatory Agency) impacting sea turtles is the operation of electrical generating plants. Sea turtles entering coastal or inshore areas have been affected by entrainment in the cooling-water systems of electrical generating plants, though it is important to note that almost all of the turtles are caught and released alive; NMFS estimates the survival rate at 98.5% or greater (NMFS 1997).

*Navigation Channel Construction and Maintenance***.** The construction and maintenance of Federal navigation channels and sand mining ("borrow") has also been identified as a source of turtle mortality. Hopper dredges, which are frequently used in ocean bar channels and sometimes in harbor channels and offshore borrow areas, move relatively rapidly and can entrain and kill sea turtles, presumably as the drag arm of the moving dredge overtakes the slower moving turtle.

State or Private Actions

State Fisheries. Various fishing methods used in state fisheries, including trawling, pot fisheries, fly nets, and gillnets are known to incidentally take listed species, but information on these fisheries is sparse (NMFS SEFSC 2001). Although few of these state regulated fisheries are

currently authorized to incidentally take listed species, several state agencies have approached NMFS to discuss applications for a section 10(a)(1)(B) incidental take permit. Since NMFS' issuance of a section 10(a)(1)(B) permit requires formal consultation under section 7 of the ESA, the effects of these activities are considered in section 7 consultation. Any fisheries that come under a section 10(a)(1)(B) permit in the future will likewise be subject to section 7 consultation. Although the past and current effects of these fisheries on listed species is currently not determinable, NMFS believes that ongoing state fishing activities may be responsible for seasonally high levels of observed strandings of sea turtles on both the Atlantic and Gulf of Mexico coasts. Most of the state data are based on extremely low observer coverage or sea turtles were not part of data collection; thus, these data provide insight into gear interactions that could occur but are not indicative of the magnitude of the overall problem. In addition to the lack of interaction data, there is another issue that complicates the analysis of impacts to sea turtles from these fisheries. Certain gear types may have high levels of sea turtle takes, but very low rates of serious injury or mortality. For example, the hook and line takes rarely result in death, but trawls and gillnets frequently do. Leatherbacks seem to be susceptible to a more restricted list of fisheries, while the hard shelled turtles, particularly loggerheads, seem to appear in data on almost all of the state fisheries.

Other state bottom trawl fisheries that are suspected of incidentally capturing sea turtles are the horseshoe crab fishery in Delaware (Spotila *et al.* 1998) and the whelk trawl fishery in South Carolina and Georgia. In South Carolina, the whelk trawling season opens in late winter and early spring when offshore bottom waters are > 55ºF. One criterion for closure of this fishery is water temperature: whelk trawling closes for the season and does not reopen throughout the state until six days after water temperatures first reach 64ºF in the Fort Johnson boat slip. Based on the South Carolina Department of Natural Resources Office of Fisheries Management data, approximately six days will usually lapse before water temperatures reach 68ºF, the temperature at which sea turtles move into state waters. From 1996-1997, observers onboard whelk trawlers in Georgia reported a total of three Kemp's ridley, two green, and two loggerhead sea turtles captured in 28 tows for a CPUE of 0.3097 turtles/100 ft net hour. As of December 2000, TEDS are required in Georgia state waters when trawling for whelk. Trawls for cannonball jellyfish and Florida try nets may also be a source of interactions.

A detailed summary of the gillnet fisheries currently operating along the mid- and southeast U.S. Atlantic coastline, which are known to incidentally capture loggerheads, can be found in the TEWG reports (1998, 2000). Although all or most nearshore gillnetting is prohibited by state regulations in state waters of South Carolina, Georgia, Florida, Louisiana, and Texas, gillnetting in other states' waters and in federal waters does occur. Of particular concern are the nearshore and inshore gillnet fisheries of the mid-Atlantic operating in Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina state waters and/or federal waters. Incidental captures in these gillnet fisheries (both lethal and non-lethal) of loggerhead, leatherback, green and Kemp's ridley sea turtles have been reported. In addition, illegal gillnet incidental captures have been reported in South Carolina, Florida, Louisiana and Texas (NMFS SEFSC 2001).

Georgia and South Carolina prohibit gillnets for all but the shad fishery. This fishery was observed in South Carolina for one season by the NMFS SEFSC (McFee *et al.* 1996). No takes

of protected species were observed. Florida banned all but very small nets in state waters, as has the state of Texas. Louisiana, Mississippi and Alabama have also placed restrictions on gillnet fisheries within state waters such that very little commercial gillnetting takes place in southeast waters, with the exception of North Carolina. Gillnetting activities in North Carolina associated with the southern flounder fishery had been implicated in large numbers of sea turtle mortalities. The Pamlico Sound portion of that fishery was closed and has subsequently been reopened under a section 10(a)(1)(B) permit.

Pound nets are a passive, stationary gear that are known to incidentally capture loggerhead sea turtles in Massachusetts, Rhode Island, New Jersey, Maryland, New York (Morreale and Standora 1998), Virginia (Bellmund *et al.* 1987) and North Carolina (Epperly *et al.* 2000). Although pound nets are not a significant source of mortality for loggerheads in New York (Morreale and Standora 1998) and North Carolina (Epperly *et al.* 2000), they have been implicated in the stranding deaths of loggerheads in the Chesapeake Bay from mid-May through early June (Bellmund *et al.* 1987). Pound net leaders with greater than or equal to 12 inches (30.5 cm) stretched mesh and leaders with stringers have been documented to incidentally take sea turtles (Bellmund et al., 1987, NMFS SEFSC 2001).

Incidental captures of loggerheads in fish traps set in Massachusetts, Rhode Island, New York, and Florida have been reported. Although no incidental captures have been documented from fish traps set in North Carolina and Delaware (Anon. 1995), they are another potential anthropogenic impact to loggerheads and other sea turtles. Lobster pot fisheries are prosecuted in Massachusetts (Prescott 1988), Rhode Island (Anon. 1995), Connecticut (Anon. 1995) and New York. Although they are more likely to entangle leatherback sea turtles, lobster pots set in New York are also known to entangle loggerhead sea turtles. No incidental capture data exist for the other states. Long haul seines and channel nets in North Carolina are known to incidentally capture loggerhead and other sea turtles in the sounds and other inshore waters. No lethal takes have been reported (NMFS SEFSC 2001).

Recreational fishermen have reported hooking turtles when fishing from boats, piers, and beach, banks, and jetties. Commercial fishermen fishing for reef fish and for sharks with both single rigs and bottom longlines have also reported hooked turtles (NMFS 2001). A detailed summary of the known impacts of hook and line incidental captures to loggerhead sea turtles can be found in the TEWG reports (1998, 2000).

Vessel Traffic. Commercial traffic and recreational pursuits can adversely effect sea turtles through propeller and boat strikes. Turtles swimming or feeding at or just beneath the surface of the water are particularly vulnerable to boat and vessel strikes, which can result in serious propeller injuries and death (Hazel *et al.* 2007). Private vessels participate in high speed marine events concentrated in the southeastern United States and are a particular threat to sea turtles. The magnitude of these marine events is not currently known. The Sea Turtle Stranding and Salvage Network (STSSN) also reports many records of vessel interaction (propeller injury) with sea turtles off coastal states such as New Jersey and Florida, where there are high levels of vessel traffic.

Other Potential Sources of Impacts in the Baseline

Significant anthropogenic impacts threaten nesting populations of all species in areas within as well as outside of the U.S. These impacts include poaching of eggs, immatures and adults as well as beach development problems. The impacts from these activities are difficult to measure.

Habitat Loss. Loss or degradation of nesting habitat resulting from erosion control through beach nourishment and armoring, beachfront development, artificial lighting, and non-native vegetation is a serious threat affecting nesting females and hatchlings. Although beach nourishment, or placing sand on beaches, may provide more sand, the quality of that sand, and hence the nesting beach, may be less suitable than pre-existing natural beaches. Sub-optimal nesting habitat may cause decreased nesting success, place an increased energy burden on nesting females, result in abnormal nest construction, and reduce the survivorship of eggs and hatchlings (Mann 1977; Ackerman 1980; Mortimer 1990).

Beach armoring (e.g., bulkheads, seawalls, soil retaining walls, rock revetments, sandbags, and geotextile tubes) can impede a turtle's access to upper regions of the beach/dune system, thereby limiting the amount of available nesting habitat (Mazaris et al. 2009). Impacts also can occur if structures are installed during the nesting season. For example, unmarked nests can be crushed or uncovered by heavy equipment, nesting turtles and hatchlings can get caught in construction debris or excavations, and hatchlings can get trapped in holes or crevices of exposed riprap and geotextile tubes. In many areas of the world, sand mining (removal of beach sand for upland construction) seriously reduce or degrade/destroy sea turtle nesting habitats or interfere with hatchling movement to sea (NMFS 2003).

Artificial lighting on or near the beach adversely affects both nesting and hatchling sea turtles. Specifically, artificial lighting may deter adult female turtles from emerging from the ocean to nest and can disorient or misorient emerging hatchlings away from the ocean (Ehrhart 1983, Salmon and Witherington 1995). Hatchlings have a tendency to orient toward the brightest direction, which on natural, undeveloped beaches is commonly toward the broad open horizon of the sea. However, on developed beaches, the brightest direction is often away from the ocean and toward lighted structures. Hatchlings unable to find the ocean, or delayed in reaching it, are likely to incur high mortality from dehydration, exhaustion, or predation (Peters and Verhoeven 1994; Salmon et al. 1995). Hatchlings lured into lighted parking lots or toward streetlights can get crushed by passing vehicles. The extent to which these activities reduce sea turtle nesting and hatchling production is unknown. However, more and more coastal counties are adopting stringent protective measures to protect hatchling sea turtles from the disorienting effects of beach lighting.

Marine Debris. Ingestion of marine debris can be a serious threat to sea turtles. Sea turtles living in the pelagic (open ocean) environment commonly ingest or become entangled in marine debris (e.g., tar balls, plastic bags, plastic pellets, balloons, and ghost fishing gear) as they feed along oceanographic fronts, where debris and their natural food items converge (Bugoni *et al.* 2001; Pichel *et al.* 2007; Mrosovsky *et al.* 2009). This is especially problematic for turtles that spend all or significant portions of their life cycle in the pelagic environment (e.g., leatherbacks,

juvenile loggerheads, and juvenile green turtles). Some types of marine debris may be directly or indirectly toxic to sea turtles on their migration to (and potentially within) the action area, such as oil. Turtles can become entangled in derelict gillnets, pound nets, and the lines associated with longline and trap/pot fishing gear. Turtles entangled in these types of fishing gear may drown and often suffer serious injuries to their flippers from constriction by the lines or ropes.

Environmental Contamination. Coastal runoff, marina and dock construction, dredging, aquaculture, oil and gas exploration and extraction, increased under water noise and boat traffic can degrade marine habitats used by sea turtles (Colburn *et al*. 1996). The development of marinas and docks in inshore waters can negatively impact nearshore habitats. An increase in the number of docks built increases boat and vessel traffic. Fueling facilities at marinas can sometimes discharge oil, gas, and sewage into sensitive estuarine and coastal habitats. Although these contaminant concentrations do not likely affect the more pelagic waters, the species of turtles analyzed in this biological opinion travel between near shore and offshore habitats and may be exposed to and accumulate these contaminants during their life cycles.
There are studies on organic contaminants and trace metal accumulation in green and leatherback sea turtles (Aguirre *et al.* 1994; Caurant *et al.* 1999; Corsolini *et al.* 2000). Mckenzie *et al.* (1999) measured concentrations of chlorobiphenyls and organochlorine pesticides in sea turtles tissues collected from the Mediterranean (Cyprus, Greece) and European Atlantic waters (Scotland) between 1994 and 1996. Omnivorous loggerhead turtles had the highest organochlorine contaminant concentrations in all the tissues sampled, including those from green and leatherback turtles (Storelli *et al.* 2008). It is thought that dietary preferences were likely to be the main differentiating factor among species. Decreasing lipid contaminant burdens with turtle size were observed in green turtles, most likely attributable to a change in diet with age. Sakai et al (1995) found the presence of metal residues occurring in loggerhead turtle organs and eggs. Storelli et al (1998) analyzed tissues from twelve loggerhead sea turtles stranded along the Adriatic Sea (Italy) and found that characteristically, mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals and porpoises (Law *et al.* 1991). No information on detrimental threshold concentrations are available, and little is known about the consequences of exposure of organochlorine compounds to sea turtles. Research is needed on the short- and long-term health and fecundity effects of chlorobiphenyl, organochlorine, and heavy metal accumulation in sea turtles.

Nutrient loading from land-based sources, such as coastal communities and agricultural operations, are known to stimulate plankton blooms in closed or semi-closed estuarine systems. The effects on larger embayments are unknown. An example is the large area of the Louisiana continental shelf with seasonally-depleted oxygen levels (<2mg/i) is caused by eutrophication from both point and non-point sources. Most aquatic species cannot survive at such low oxygen levels and these areas are known as “dead zones.” The oxygen depletion, referred to as hypoxia, begins in late spring, reaches a maximum in mid-summer, and disappears in the fall. Since 1993, the average extent of mid-summer bottom-water hypoxia in the northern GOM has been approximately 16,000 km2, approximately twice the average size measured between 1985 and 1992. The hypoxic zone attained a maximum measured extent in 2002, when it was about 22,000 km^2 which is largest than the state of Massachusetts (U.S. Geological Service, 2005). The

hypoxic zone has impacts on the animals found there, including sea turtles, and the ecosystem-level impacts continue to be investigated.

Acoustic impacts. NMFS and the U.S. Navy have been working cooperatively to establish a policy for monitoring and managing acoustic impacts from anthropogenic sound sources in the marine environment. Acoustic impacts to sea turtles can include temporary or permanent injury, habitat exclusion, habituation, and disruption of other normal behavior patterns. There are other more indirect factors; for a complete list refer to NMFS SEFSC (2001).

International. For sea turtle species in the Atlantic, international activities, particularly fisheries, are significant factors impacting populations. NMFS estimates that, each year, thousands of sea turtles of all species are incidentally caught and a proportion of them killed incidentally or intentionally by international activities. The impact of international fisheries is a significant factor in the baseline inhibiting sea turtle recovery. Additional information on the impacts of international fisheries is found in NMFS SEFSC (2001) and Lewison *et al.* (2004).

Climate change at normal rates (thousands of years) was not historically a problem for sea turtles species since they have shown unusual persistence over a scale of millions of years. However, there is a 90% probability that warming of the earth's atmosphere since 1750 is due to human activities resulting in atmospheric increases in carbon dioxide, methane, and nitrous oxide (IPCC 2007). All reptiles including sea turtles have a tremendous dependence on their thermal environment for regulating physiological processes and for driving behavioral adaptations (Spotila et al. 1997). In the case of sea turtles, where many other habitat modifications are documented (beach development, loss of foraging habitat, etc.), the prospects for accentuated synergistic impacts on survival of the species may be even more important in the long-term. Atmospheric warming creates habitat alteration which may change sex ratios, reproductive periodicity, marine habitats, or prey resources such as crabs and other invertebrates. It may increase hurricane activity leading to an increase in debris in nearshore and offshore waters, resulting in increase in entanglement, ingestion, or drowning. Atmospheric warming may change convergence zones, currents and other oceanographic features that are relevant to various sea turtles' life stages.

Southeast Area Monitoring and Assessment Program-South Atlantic Shallow Water Trawl Survey (SEAMAP-SASWTS).

This research is on-going and has conducted over 4,123 otter trawling tows in or adjacent to the action area and taken over 270 turtles since 1987, with no reported mortalities. Indirect effects of this trawling in the action area on sea turtles are as those discussed under shrimp trawling above (disturbance of benthic habitat). Also, captured turtles are forcibly submerged in trawls and undergo respiratory and metabolic stress. While no mortalities have been reported since 1987, risk of mortality remains possible under this activity.

Other ESA Section 10 Sea Turtle Permits.

Regulations developed under the ESA allow for the issuance of permits allowing take of certain ESA-listed species for the purposes of scientific research under Section 10(a)(1)(a) of the ESA.

In addition, the ESA allows for the NMFS to enter into cooperative agreements with states developed under Section 6 of the ESA, to assist in recovery actions of listed species. Prior to issuance of these authorizations, the proposal must be reviewed for compliance with Section 7 of the ESA.

Sea turtles are the focus of research activities authorized by a Section 10 permit under the ESA. As of April 2013, there were 30 active scientific research permits directed toward sea turtles that are applicable to the action area of this biological opinion. Authorized activities range from photographing, weighing, and tagging sea turtles incidentally taken in fisheries, blood sampling, tissue sampling (biopsy) and performing laparoscopy on intentionally captured turtles. The number of authorized takes varies widely depending on the research and species involved but may involve the taking of hundreds of turtles annually. Most of takes authorized under these permits are expected to be non-lethal. 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. However, despite these safeguards research activity may result in cumulative effects on sea turtle populations.

Conservation and Recovery Actions Shaping the Environmental Baseline

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 Atlantic HMS, Gulf of Mexico reef fish, and South Atlantic snapper-grouper fishery, and TED requirements for Southeast shrimp trawl fishery. In addition to regulations, outreach programs have been established and data on sea turtle interactions with recreational fisheries has been collected through the Marine Recreational Fishing Statistical Survey (MRFSS). The summaries below discuss all of these measures in more detail.

Reducing Threats from Pelagic Longline and Other Hook-and-Line Fisheries
On May 1, 2009 NMFS published an emergency rule (74 FR 20229), effective from May 18, 2009 through October 28, 2009, prohibiting bottom longlining for Gulf reef fish east of 85°30'W longitude (near Cape San Blas, Florida) and in the portion of the EEZ shoreward of the 50-fathom depth contour. The emergency rule was intended to reduce sea turtle takes in the short-term while the Gulf of Mexico Fishery Management Council developed long-term protective measures through Amendment 31 to the Fishery Management Plan for Reef Fish Resources in the Gulf of Mexico.

NMFS published the final rule to implement sea turtle release gear requirements and sea turtle careful release protocols in the Gulf of Mexico reef fish fishery on August 9, 2006 (71 FR 45428). These measures require owners and operators of vessels with federal commercial or charter vessel/headboat permits for Gulf reef fish to comply with sea turtle release protocols and have on board specific sea turtle release gear. NMFS is currently conducting rulemaking to implement similar release gear and handling requirements for the South Atlantic snapper-grouper 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. The current reduction in turtle interactions, seems to corroborate the rulemaking. 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 2006; Watson *et al.* 2005)

Revised Use of Turtle Excluder Devices in Trawl Fisheries

NMFS has also 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.

Significant measures have been developed to reduce the take of sea turtles in summer flounder trawls and trawls that meet the definition of a summer flounder trawl (which would include fisheries for other species like scup and black sea bass) by requiring TEDs in trawl nets fished from the North Carolina/South Carolina border to Cape Charles, Virginia. However, the TED requirements for the summer flounder trawl fishery do not require the use of larger TEDs that are used in the shrimp trawl fishery to exclude leatherbacks, as well as large, benthic, immature and sexually mature loggerheads and green sea turtles.

NMFS has also been working to develop a TED, which can be effectively used in a type of trawl known as a flynet, which is sometimes used in the Mid-Atlantic and Northeast fisheries to target sciaenids and bluefish. Limited observer data indicate that takes can be quite high in this fishery. A top-opening flynet TED was certified this summer, but experiments are still ongoing to certify a bottom-opening TED.

Placement of Fisheries Observers to Monitor Sea Turtle Takes

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). This rule also extended the number of days NMFS observers placed in response to a determination by the Assistant Administrator that the unauthorized take of sea turtles may be likely to jeopardize their continued existence under existing regulations, from 30 to 180 days.

Final Rules for Large-Mesh Gillnets
In March 2002, NMFS published new restrictions for the use of gillnets with larger than 8-inch stretched mesh, in federal waters (3-200 nautical miles) off North Carolina and Virginia. These restrictions were published in an interim final rule under the authority of the ESA (67 FR 13098) and were implemented to reduce the impact of the monkfish and other large-mesh gillnet fisheries on ESA-listed sea turtles in areas where sea turtles are known to concentrate. Following review of public comments submitted on the interim final rule, NMFS published a final rule on December 3, 2002, that established the restrictions on an annual basis. As a result, gillnets with larger than 8-inch stretched mesh were not allowed in federal waters (3-200 nautical miles) in the areas described as follows: (1) north of the North Carolina/South Carolina border at the coast to Oregon Inlet at all times; (2) north of Oregon Inlet to Currituck Beach Light, North Carolina, from March 16-January 14; (3) north of Currituck Beach Light, North Carolina, to Wachapreague Inlet, Virginia, from April 1-January 14; and (4) north of Wachapreague Inlet, Virginia, to Chincoteague, Virginia, from April 16-January 14. On April 26, 2006, NMFS published a final rule (71 FR 24776) that included modifications to the large-mesh gillnet restrictions. The new final rule revised the gillnet restrictions to apply to stretched mesh that is greater than or equal to 7 inches. Federal waters north of Chincoteague, Virginia, remain unaffected by the large-mesh gillnet restrictions. These measures are in addition to Harbor Porpoise Take Reduction Plan measures that prohibit the use of largemesh gillnets in southern Mid-Atlantic waters (territorial and federal waters from Delaware through North Carolina out to 72º 30'W longitude) from February 15-March 15, annually.

Sea Turtle Handling and Resuscitation Techniques
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. Persons 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.

Outreach and Education, Sea Turtle Entanglements, and Rehabilitation
There is 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 dead sea turtles, but also rescue and rehabilitate any live stranded sea turtles.

A final rule (70 FR 42508) published on July 25, 2005, allows any agent or employee of NMFS, the USFWS, the U.S. Coast Guard, or any other federal land or water management agency, or any agent or employee of a state agency responsible for fish and wildlife, when acting in the course of his or her official duties, to take endangered sea turtles encountered in the marine environment if such taking is necessary to aid a sick, injured, or entangled endangered sea turtle, or dispose of a dead endangered sea turtle, or salvage a dead endangered sea turtle that may be useful for scientific or educational purposes. NMFS already affords the same protection to sea turtles listed as threatened under the ESA [50 CFR 223.206(b)].

Other Actions
A recovery plan for the loggerhead sea turtle was published January 2009 (second revision: 74 FR 2995). A 2011 Final Bi-National (U.S. and Mexico) Revised Recovery Plan for Kemp's

ridley was published in September 2011. Recovery teams comprised of sea turtle experts have been convened and are currently working towards revising these plans based upon the latest and best available information. Five-year status reviews have been completed for green, Kemp's ridley, leatherback, and loggerhead sea turtles. These reviews were conducted to comply with the ESA mandate for periodic status evaluation of listed species to ensure that their threatened or endangered listing status remains accurate. Each review determined that no delisting or reclassification of a species status (i.e., threatened or endangered) was warranted at this time. However, further review of species data for the green, and leatherback was recommended, to evaluate whether distinct population segments (DPS) should be established for these species (NMFS and USFWS 2007a-e). The final rule to list nine distinct population segments (DPSs) of Loggerhead sea turtles under the ESA was published September 2011 (75 FR 58868).

Effects of the Proposed Action

Pursuant to Section 7(a)(2) of the ESA, federal agencies are directed 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. Direct adverse effects of the permitted activities on listed species that are within the action area would include disruption of feeding, breeding, resting and other behaviors. Some displacement may result from these activities. The duration of the behavioral disruptions and displacements are expected to vary by species and type of disturbance.

In this section, we describe the potential physical, chemical, or biotic stressors associated with the proposed action, 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(s) those individuals comprise and to the listed species those populations represent.

For this consultation, we are particularly concerned about behavioral disruptions that may result in listed sea turtles that fail to feed or breed successfully or fail to complete their life history because these responses are likely to have population-level consequences. The proposed permit would authorize non-lethal "takes" by harassment of listed species during activities. The ESA does not define harassment nor has NMFS defined the term pursuant to the ESA through regulation. For this Opinion, we adopt the USFWS' definition of harass. Harass is defined by USFWS as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering that are essential to sea turtles' life history or its contribution to the population the animal represents.

The purpose of this assessment is, then, to determine if it is reasonable to expect that the research, as conducted under the permits, can be expected to have direct or indirect effects on threatened and endangered sea turtle species that appreciably reduce their likelihood of surviving

and recovering in the wild or result in destruction or adverse modification of critical habitat. Including assessing the direct and indirect effect of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). Jeopardy analyses compare reductions in a species' likelihood of surviving and recovering in the wild associated with a *specific* action with the species' likelihood of surviving and recovering in the wild that was established in the *Status of the Species* section of an Opinion. Jeopardy analyses also consider the importance of the action area to a listed species and the effects of other human actions and natural phenomena (that were summarized in the *Environmental Baseline*) on a species' likelihood of surviving and recovering in the wild. As a result, jeopardy analyses in biological opinions distinguish between the effects of a specific action on a species' likelihood of surviving and recovering in the wild and a species' background likelihood of surviving and recovering given the full set of human actions and natural phenomena that threaten a species.

This section will assess the types of effects that are expected from the proposed action, the extent of those effects, and the overall impact of those effects on sea turtle populations.

Standards Used in Effects Analysis

The analyses in this Opinion are based on an implicit understanding that the listed sea turtle species considered in this Opinion are threatened or endangered with local or global extinction by a wide array of human activities and natural phenomena. We have outlined many of those activities in the *Status of the Species* section of this Opinion. NMFS also recognizes that some of these other human activities and natural phenomena pose serious threats to the survival of these listed species (and other flora and fauna). Further, NMFS recognizes that such species will not recover without addressing the full range of human activities and natural phenomena such as patterns of beach erosion, predation on turtle eggs, and turtle captures, injuries, and deaths in other domestic and international fisheries and other State, federal, and private activities that could cause these animals to become extinct in the foreseeable future.

Nevertheless, this Opinion focuses solely on whether the direct and indirect effects of the proposed action can be expected to appreciably reduce the listed sea turtles' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution or would result in a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Jeopardy analyses in biological opinions distinguish between the effects of a specific action on a species' likelihood of surviving and recovering in the wild and a species' background likelihood of surviving and recovering given the full set of human actions and natural phenomena that threaten a species.

This biological opinion treats sea turtle populations in the Atlantic Ocean as distinct from the Pacific Ocean populations for the purposes of this consultation. This approach is also consistent with traditional jeopardy analyses: the loss of sea turtle populations in the Atlantic basin would result in a significant gap in the distribution of each turtle species, which makes these

populations biologically significant. Finally, the loss of these sea turtle populations in the Atlantic basin would dramatically reduce the distribution and abundance of these species and would, by itself, appreciably reduce the entire species' likelihood of surviving and recovering in the wild.

Conservative Decisions- Providing the Benefit of the Doubt to the Species
The analysis in this section is based upon the best available commercial and scientific data on sea turtle biology and the effects of the proposed action. However, there are instances where there is limited information upon which to make a determination. In those cases, in keeping with the direction from the U.S. Congress to provide the "benefit of the doubt" to threatened and endangered species [House of Representatives Conference Report No. 697, 96th Congress, Second Session, 12 (1979)], we will generally make determinations which provide the most conservative outcome for listed species.

Exposure Analyses

Exposure analyses identify the co-occurrence of ESA-listed species within the action's effects in space and time, and identify the nature of that co-occurrence. They identify as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the action's effects and the population(s) or subpopulation(s) those individuals represent. Individuals exposed may be of either sex or of any age.

The proposed actions will expose listed sea turtle species to disturbance from boat, capture, sampling and collection activities. The applicants have requested authorization to increase capture of Kemp's ridley to 32 and loggerhead to 50. Animals will be measured, photographed/video, flipper and passive integrated transponder (PIT) tagged, weighed, and released. Since these species are highly mobile, and because the proposed activities are to take place at multiple times of year, individual listed species may suffer repeated exposures.

Response Analyses

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 animals 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. The proposed activities have the potential to produce disturbances that may affect listed sea turtles.

The responses by animals to human disturbance are similar to their responses to potential predators (Beale and Monaghan, 2004; Frid, 2003; Frid and Dill, 2002; Gill and Sutherland, 2001; Harrington and Veitch, 1992; Lima, 1998; Romero, 2004). These responses include interruptions of essential behavior and physiological processes such as feeding, mating, resting,

digestion etc. This can result in stress, injury and increased susceptibility to disease and predation (Frid and Dill, 2002; Romero, 2004; Walker et al., 2006).

Capture

Although this permit does not entail any actual capture, since it is incidental to commercial fishing operations and permitted, it does result in stress due to being captured. Sea turtles that are forcibly submerged undergo respiratory and metabolic stress that can lead to severe disturbance of their acid-base balance. While most voluntary dives by sea turtles appear to be aerobic, showing little if any increases in blood lactate and only minor changes in acid-base status (pH level of the blood)(Lutz and Bentley 1985), sea turtles that are stressed as a result of being forcibly submerged through entanglement consume oxygen stores, triggering an activation of anaerobic glycolysis, and subsequently disturbing their acid-base balance, sometimes to lethal levels. It is likely that the rapidity and extent of the physiological changes that occur during forced submergence are functions of the intensity of struggling as well as the length of submergence (Lutcavage and Lutz, 1997). Other factors to consider in the effects of forced submergence include the size of the turtle, ambient water temperature, and multiple submergences. Larger sea turtles are capable of longer voluntary dives than small turtles, so juveniles may be more vulnerable to the stress due to handling. During the warmer months, routine metabolic rates are higher, so the impacts of the stress may be magnified. With each forced submergence, lactate levels increase and require a long (even as much as 20 hours) time to recover to normal levels. Turtles are probably more susceptible to lethal metabolic acidosis if they experience multiple captures in a short period of time, because they would not have had time to process lactic acid loads (in Lutcavage and Lutz 1997). Capture and handling activities may markedly affect metabolic rate (St. Aubin and Geraci 1988), reproduction (Mahmoud and Licht 1997), and hormone levels (Gregory et al. 1996). Understanding the physiological effects of capture methodology is essential to conducting research on endangered sea turtles, since safe return to their natural habitat is required. However, literature pertaining to the physiological effects of capture on sea turtles is scarce. No additional mortalities or injuries are expected as a result of this research.

Measuring, Photographing, Weighing and Tagging

Handling, measuring, photographing and weighing can result in raised levels of stressor hormones in sea turtles. The additional on-board holding time imposes an additional stressor on these already acidotic turtles (Hoopes et al. 2000). It has been suggested that the muscles used by sea turtles for swimming might also be used during lung ventilation (Butler et al. 1984). Thus, an increase in breathing effort in negatively buoyant animals may have heightened lactate production. However, the handling, measuring, photographing and weighing procedures are simple, non-invasive, with a relatively short time period and NMFS does not expect that individual turtles would normally experience more than short-term stresses as a result of these activities. No injury is expected from these activities, and turtles will be worked up as quickly as possible to minimize stresses resulting from their capture.

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 must be re-tagged if captured again at a later date, which subjects them to additional effects of tagging. Turtles can experience some discomfort during the tagging procedures and these procedures will produce some level of pain. The discomfort is usually 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 applied to the flipper should heal completely in a short period of time. Similarly, turtles that must be re-tagged should also experience minimal short-term stress and heal completely in a short period of time. Re-tagging is not expected to appreciably affect these turtles.

Effects of Transport and Holding

Given the precautions that will be taken by the researchers to ensure the safety of the turtles and the permit conditions relating to transport and holding, NMFS believes that any transport and holding of the animals will have minimal and insignificant effects on the animals, and therefore are insignificant and discountable. All animals will be transported and held under climate-controlled conditions and later returned to the sea.

Boat Strikes, Noise and Visual Disturbance

There is a potential for boat strikes, noise and visual disturbance to listed species resulting from the proposed activities of the permit. However, because of the trained research personnel, maneuverability and slow operating speeds of the research vessels, boat strikes are extremely unlikely and noise and visual disturbance would be discountable. As a result, any risk of boat related disturbances to listed species is highly unlikely and no reduction in the fitness of any individual listed sea turtle is expected.

Summary of Effects

The short-term stresses resulting from capture, handling, measuring, photographing, weighing, flipper tagging, and PIT tagging, are expected to be minimal. The Permit contained conditions to mitigate adverse impacts to turtles from these activities. As discussed above, turtles would be worked up as quickly as possible to minimize stresses resulting from the research and 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 applicant would be required to exercise care when handling animals to minimize any possible injury. An experienced veterinarian or veterinarian technician would be named by the applicant for emergencies. During release, turtles would be lowered as close to the water's surface as possible, to prevent potential injuries.

Species' Response to Effects of the Proposed Action

Actions that result in mortality affect listed species through the impact of the loss of individual turtles and also through the loss of the reproductive potential of each turtle to its respective population. Similarly, serious injuries to listed species due to an action that result in an animal's

inability to reproduce affects a listed species due to the loss of that animal's reproductive potential. These effects have the potential to reduce the likelihood of survival and recovery of species.

Mortality and serious injury under the research as described under the proposed actions are not expected. The effects of the proposed handling, tagging, measuring, weighing, and photographing have been determined to have the potential to elicit short-term changes in sea turtle behavior, but are not likely to result in long-term effects on these individuals or populations. Therefore, NMFS does not expect the research procedures that would be authorized under the proposed action to result in more than short-term effects on individual animals due to the conditions concerning research procedures and placed on the applicant. 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 certain protocols identified in the proposed action. The data generated by the applicant over the duration of this study will provide beneficial information that will be important to the management and recovery of threatened and endangered species. The information collected as a direct result of permit issuance will be available to implement the goals identified in the Recovery Plans for sea turtles. Based on the above, NMFS believes it is reasonable to assume that issuance of the proposed permit will have beneficial effects for sea turtles. Issuance of this permit is not likely to appreciably reduce the numbers, distribution, or reproduction of loggerhead or Kemp's ridley sea turtles in the wild that would appreciably reduce the likelihood of survival and recovery of these species.

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 in this Opinion. Future Federal actions, including research authorized under ESA Section 10(a)1(A), 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. Future cumulative effects from these and other types of federal actions will be investigated in future consultations, most notably in the *Status of the Species* and *Environmental Baseline* sections of Opinions which inform the effects analyses for specific federal actions. Other possible effects that may be acting in conjunction with federal actions and could possibly contribute to a cumulative impact on listed species are described below.

NMFS expects the natural phenomena in the action area (e.g., oceanographic features, storms, natural mortality) will continue to influence listed species as described in the *Environmental Baseline* section of this Opinion. Climatic variability has the potential to affect listed species in the action area in the future; however, the prediction of any specific effects leading to a decision on the future survival and recovery of listed species is currently speculative. Nevertheless, possible effects of climatic variability for listed sea turtles include the alteration of community composition and structure, changes to migration patterns or community structure, changes to species abundance, increased susceptibility to disease and contaminants, alterations to prey composition and altered timing of breeding. Atmospheric warming creates habitat alteration which may change sex ratios and affect reproductive periodicity for nesting sea turtles. Also,

climate variability may increase hurricane activity leading to an increase in debris in nearshore and offshore waters, thereby resulting in increased entanglement, ingestion, or drowning as well as increased physical destruction of sea turtle nests.

We also expect anthropogenic effects described in the *Environmental Baseline* will continue, including habitat degradation, vessel traffic and risk of ship strikes, and interactions with fishing gear. Expected increases in vessel traffic would further increase collision risks for sea turtles by the increased traffic itself and/or through habituation of animals to the sounds of oncoming traffic making them more prone to being struck. The number of vessels and tonnage of goods shipped by the U.S. fleet are increasing (e.g. there has been nearly a 30 percent increase in volume between 1980 and 2000) (NRC, 2003) and will lead to more vessel traffic throughout the action area in the future.

For sea turtle species in the Atlantic, international activities, particularly fisheries, are significant factors impacting populations. NMFS estimates that, each year, thousands of sea turtles of all species are incidentally caught and a proportion of them killed incidentally or intentionally by international activities. The impact of international fisheries is a significant factor in the baseline inhibiting sea turtle recovery. Due to insufficient information on future management regimes associated with commercial and recreational fisheries, we cannot estimate the probability of future injuries or deaths of listed sea turtles due to interactions with these fisheries. However, given interactions with fisheries in the action area during the recent past, such interactions remains a major threat to the survival and recovery of sea turtles globally.

As the size of human communities increase, there is an accompanying increase in habitat alterations resulting from an increase in housing, roads, commercial facilities, and other infrastructure that result in increased discharge of sediments and pollution into the marine environment. These activities are expected to continue to degrade the habitat of listed species as well as that of the prey on which they depend. Pollutants may also affect prey populations which could impact food and habitat availability for other listed sea turtle species in the future.

Additionally, unrelated factors may be acting together to affect listed species. For example, vessel effects combined with the stresses of reduced prey availability or increased contaminant loads may reduce foraging success and lead to chronic energy imbalances and poorer reproductive success which all may work to lower an animal's ability to suppress disease (Williams et al., 2002; NMFS, 2008). The net effect of these disturbances is dependent on the size and percentage of the population affected, the ecological importance of the disturbed area to the animals, the parameters that influence an animal's sensitivity to disturbance or the accommodation time in response to prolonged disturbance (Geraci and St. Aubin, 1980). More studies need to be done to identify the long term effects to listed sea turtles from current stressors as well as the potential additive effect that multiple stressors acting in conjunction over time will have on the survival and recovery of these species.

After reviewing the available information, NMFS is not aware of any additional future non-federal activities or potential stressors reasonably certain to occur in the action area that could contribute to a cumulative impact to ESA listed or ESA proposed species affected by the proposed action.

Integration and Synthesis of Effects

As explained in the *Approach to the Assessment* section, risks to listed individuals are measured using changes to an individual's "fitness" – i.e., the individual's growth, survival, annual reproductive success, and lifetime reproductive success. When listed plants or animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the population(s) those individuals represent or the species those populations comprise (Brandon, 1978; Mills and Beatty, 1979; Stearns, 1992; Anderson, 2000). 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 narrative that follows integrates and synthesizes the information contained in the Status of the Species, the Environmental Baseline, and the Effects of the Action sections of this Opinion to assess the risk the proposed activities pose to loggerhead, and Kemp's ridley sea turtles. There are known cumulative effects (i.e., from future state, local, tribal, or private actions) that fold into our risk assessment for this species. This section provides an integration and synthesis of the information presented in the Status of the Species, Environmental Baseline, Cumulative Effects, and Effects of the Action sections of this Opinion. The intent of the following discussion is to provide a basis for determining the additive effects of the take authorized in the permit amendment on loggerhead and Kemp's ridley sea turtles, in light of their present and anticipated future status.

While the loss of all these turtles, including eggs, has likely adversely affected the ability of all loggerhead and Kemp's ridley sea turtle populations considered in this Opinion to maintain or increase their numbers by limiting the number of individuals in these populations, the loss of reproductive adults results in reductions in future reproductive output.

Species with delayed maturity such as sea turtles are demographically vulnerable to increases in mortality, particularly of juveniles and subadults, those stages with higher reproductive value. The potential for an egg to develop into a hatchling, into a juvenile, and finally into a sexually mature adult sea turtle varies among species, populations, and the degree of threats faced during each life stage. Each juvenile that does not survive to produce will be unable to contribute to the maintenance or improvement of the species' status. Reproducing females that are prematurely killed due the threats mentioned in the above sections, while possibly having contributing something before being removed from the population, will not be allowed to realize their reproductive potential. Similarly, reproductive males prematurely removed from the population will be unable to make their reproductive contribution to the species' population.

As described in the Effects of the Action section of this Opinion, the research activities that would take place under amended Permit 13543-01 are not expected to result in mortality or injury to any of the sea turtles. The capture, handling, tagging, measuring, photographing, and weighing will only result in temporary stress to the animal and are not expected to have more than short-term effects on individual loggerhead and Kemp's ridley sea turtles. These non-lethal interactions will not affect the turtle's ability to reproduce and contribute to the maintenance or recovery of the species. These effects are expected to be short-term because the take is non-lethal and previous experience with the type of proposed research activities has demonstrated

that it is reasonable to expect that effects will be minimal. This research will affect the turtles by harassing individual turtles during the research thus raising levels of stressor hormones, and the turtle may experience some discomfort during capture, tagging, tissue sampling and lavage procedures. Based on past observations of similar research, these effects are expected to dissipate within approximately a day. Based on this prior information and experience, and conditions placed on the Permit Holder, NMFS does not expect the applicant's proposal to conduct the research as described above to result in more than short-term effects on the individual animals. NMFS also does not expect any delayed mortality of any turtles following their release as a direct result of the research based on past research efforts by other researchers and adherence to certain protocols identified in the proposed action.

Although some degree of stress or pain is likely for individual turtles captured, handled and tagged, and while tagging and tissue sampling will result in tissue injuries, none of the research procedures are expected to result in mortality or reduced fitness of individuals. The proposed permit is not expected to affect the population's reproduction, distribution, or numbers. Because the proposed amendment is not likely to reduce the particular population's likelihood of surviving and recovering in the wild, it is not likely to reduce the species' likelihood of surviving and recovering in the wild.

NMFS does not expect the proposed amendment to increase the number of takes to appreciably reduce the loggerhead, or Kemp's ridley sea turtles likelihood of survival and recovery in the wild by adversely affecting their birth rates, death rates, or recruitment rates. In particular, NMFS does not expect the proposed research Permits to affect adult, female turtles in a way that appreciably reduces the number of animals born in a particular year; the reproductive success of adult female turtles; the survival of young turtles; or the number of young turtles that annually recruit into the adult, breeding populations of any population of loggerhead or Kemp's ridley sea turtles.

The proposed amendment is not expected to have more than short-term effects on loggerhead and Kemp's ridley sea turtle populations. The data generated by the applicants regarding these populations over the duration of these studies will provide beneficial information that will be important to the management and recovery of threatened and endangered species. The information collected as a direct result of Permit issuance will be used to implement the goals identified in the Recovery Plans for the U.S. Atlantic Populations of sea turtles.

Conclusion

After reviewing the current status of the loggerhead and Kemp's ridley sea turtles, the environmental baseline for the action area, the effects of the take authorized in this permit amendment, and probable cumulative effects, it is NMFS' biological opinion that issuance of this permit, as proposed, will not reduce the likelihood of the survival and recovery of their populations in the wild by reducing their numbers, distribution, or reproduction, and therefore is not likely to jeopardize the continued existence of these species and is not likely to destroy or adversely modify designated critical habitat.

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 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. Harass is defined by USFWS as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Amount or Extent of Take

The permit is for the directed take, for research purposes, of listed sea turtles; no incidental take of other listed species is anticipated or authorized.

This opinion does not authorize any take of other listed species or immunize any actions from the prohibitions of section 9(a) of the ESA. Take is authorized by section 10(a)(1)(a) as specified in the permit.

CONSERVATION RECOMMENDATIONS

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

The 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.* NMFS' Permits Division should work with the sea turtle recovery team 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.

2. *Estimation of actual levels of "take."* NMFS' Permits Division should review the annual reports and final reports submitted by researchers that have conducted research on sea turtles as well as any data and results that can be obtained from the permit holders. This should be used to estimate

the numbers of sea turtles killed and harassed by these investigations, and how the harassment affects the life history of individual animals. The results of the study should be provided to the ESA Interagency Cooperation Division for use in the consultations of future research activities.

RENITIATION NOTICE

This concludes formal consultation on the NMFS' proposed issuance of the modified scientific research permit 13543-01. 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 take, specified in the permit, is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of take is exceeded, section 7 consultation must be reinitiated immediately.

Literature Cited

Abella, E., Marco, A., Lopez-Jurado, L.F., 2007. Success of Delayed Translocation of Loggerhead Turtle Nests. The Journal of Wildlife Management 71, 2290-2296.

Ackerman, R.A. 1980. Physiological and ecological aspects of gas exchange by sea turtle eggs. American Zoologist 20: 575-583.

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

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

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

Aguilar, R., J. Mas, and X. Pastor. 1995. Impact of Spanish swordfish longline fisheries on the loggerhead sea turtle Caretta caretta population in the western Mediterranean. Pages 1-6 in Richardson, J.I. and T.H. Richardson (compilers). Proceedings of the Twelfth Annual Sea Turtle Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-361.

Aguirre A.A., Bonde R.K., and J.A. Powell. 2002. Biology, movements and health assessment of free-ranging manatees in Belize. In: 51st Annual Wildlife Disease Association Conference, Humboldt State University, Arcata, CA, p 135.

Aguirre, A. A., Balazs, G. H., Zimmerman, B. and Galey, F. D. 1994. Organic Contaminants and Trace Metals in the Tissues of Green Turtles (Chelonia mydas) Afflicted with Fibropapillomas in the Hawaiian Islands. Marine pollution bulletin 28: 109.

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

Anonymous. 1995. State and federal fishery interactions with sea turtles workshop. November 22, 1996. iife Sciences Center, Dalhousie University, Halifax, Nova Scotia. 266pp.

Auster, P.J., R.J. Malastesta, R.W. Langton, L. Watling, P.C. Valentine, C.L.S. Donaldson, E.W. Langton, A.N. Shepard, and I.G. Babb. 1996. The impacts of mobile fishing gear on the sea floor habitats in the Gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Reviews in Fisheries Science 4:185-200.

Awbrey, F.T., J.A. Thomas, and R.A. Kastelein. 1988. Low-frequency underwater hearing sensitivity in belugas Delphinapterus leucas. Journal of the Acoustical Society of America 84:2273-2275.

Babcock, H. L. 1937. The sea turtles of the Bermuda Islands, with a survey of the present state of the turtle fishing industry. Proceedings of the Zoological Society of London 107: 595-601.

Balazs, G. H. 1985. Impact of ocean debris on marine turtles: entanglement and ingestion. In: Proceedings of the workshop on the fate and impact of marine debris, 27-29 November, 1984, Vol. 54 (Shomura, R. S. and Yoshida, H. O., eds.). pp. 367-429. U.S. Department of Commerce NOAA Technical Memorandum, NMFS-SWFC.

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

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

Bartol, S.M., J.A. Musick, and M.L. Lenhardt. 1999. Auditory Evoked Potentials of the Loggerhead Sea Turtle (Caretta caretta). Copeia 3: 836-840.

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

Bellmund, S.A., J.A. Musick, R.C. Klinger, R.A. Byles, J.A. Keinath, and D.E. Barnard. 1987. Ecology of sea turtles in Virginia. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virgina

Bishop, C. A., Brooks, R. J., Carey, J. H., Ng, P., Norstrom, R. J. and Lean, D. R. S. 1991. The case for a cause-effect between environmental contamination and development in eggs of the common snapping turtle (Chelydra serpentina) from Ontario, Canada. Journal of Toxicology and Environmental Health 33: 521-547.

Bishop, C. A., Brown, G. P., Brooks, R. J., Lean, D. R. S. and Carey, J. H. 1994. Organochlorine contaminant concentrations in eggs and their relationship to body size and clutch characteristics of the female common snapping turtle (Chelydra serpentina) in Lake Ontario, Canada. Archives of Environmental Contamination and Toxicology 27: 82-87.

Bjorndal, K. A., A. B. Bolten and C. J. Lagueux. 1994. Ingestion of Marine Debris by Juvenile Sea Turtles in Coastal Florida Habitats. Marine Pollution Bulletin, Vol. 28, No. 3, pp. 154-158

Bjorndal, K. A., Bolten, A. B. and Martins, H. R. 2000. Somatic growth model of juvenile loggerhead sea turtles: duration of the pelagic stage. Marine Ecology Progress Series 202: 265-272.

Bjorndal, K.A. and A.B. Bolten (editors). 2000. Proceedings of a workshop on assessing abundance and trends for in-water sea turtle populations. NOAA Technical Memorandum NMFS-SEFSC-445. 83 pages.

Bjorndal, K.A., 1997, Foraging ecology and nutrition of sea turtles. In: Lutz, P.L., Musick, J.A. (Eds.). The Biology of Sea Turtles. CRC Press, Boca Raton, Florida, pp. 199–231.

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

Boisvert, M.J. and D.F. Sherry. 2000. A system for the automated recording of feeding behavior and body weight. Physiology and Behavior 71:147-151.

Bolten, AB. 1999. Techniques for measuring sea turtles. In Research and Management Techniques for the Conservation of Sea Turtles, Eckert KL , Bjorndal KA , Abreu-Grobois FA , Donnelly M (eds). IUCN/SSC Marine Turtle Specialist Group Publication 4; 110-114

Bolten, A.B. 2003. Active swimmers - passive drifters: the oceanic juvenile stage of loggerheads in the Atlantic system. Pages 63-78 in Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Bolten, A.B., Bjorndal KA, Martins HR, Dellinger T, Biscoito MJ, Encalada SE, Bowen BW. 1998. Transatlantic developmental migrations of loggerhead sea turtles demonstrated by mtDNA sequence analysis. Ecol. Appl., 8, 1–7

Bolten, A.B., K.A. Bjorndal, and H.R. Martins. 1994. Life history model for the loggerhead sea turtle (Caretta caretta) population in the Atlantic: potential impacts of a longline fishery. Pages 48-55 in Balazs, G.H. and S.G. Pooley (editors). Research Plan to Assess Marine Turtle Hooking Mortality: Results of an Expert Workshop Held in Honolulu, Hawaii, November 16-18, 1993. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-201.

Bouchard, S., Moran, K., Tiwari, M., Wood, D., Bolten, A., Eliazar, P., Bjorndal, K., 1998. Effects of Exposed Pilings on Sea Turtle Nesting Activity at Melbourne Beach, Florida. Journal of Coastal Research 14, 1343-1347.

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

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

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. 533 pages

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

Brito, M., J.L. 1998. The marine turtle situation in Chile. Pages 12-15 in Epperly, S.P. and J. Braun (compilers). Proceedings of the Seventeeth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-415.

Broderick, A. C. and Godley, B. J. 1999. Effect of tagging marine turtles on nesting behaviour and reproductive success. - Anim. Behav. 58: 587-591.

Bugoni, L., Krause, L., Virgínia Petry, M., 2001. Marine Debris and Human Impacts on Sea Turtles in Southern Brazil. Marine Pollution Bulletin 42, 1330-1334.

Carocci, F., Majkowski, J., 1998. Atlas of tuna and billfish catches. CD-ROM version 1.0. FAO, Rome, Italy.

Carr, A. F., Carr, M. H. and Meylan, A. B. 1978. The ecology and migrations of sea turtles. The western Caribbean green turtle colony. Bulletin of the American Museum of Natural History 162: 1-46.

Carr, A.F. 1952. Handbook of Turtles. The turtles of the United States, Canada, and Baja California. Comstock Publishing Associates, Cornell University Press, Ithaca, New York.

Carr, A.F. 1954. The passing of the fleet. American Institute of Biological Science Bulletin 4: 17-19.

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

Carr, A.F. 1987. Impact of nondegradable marine debris on the ecology and survival outlook of sea turtles. Marine Pollution Bulletin 18(6B):352-356.

Carr, A.F. 1987. New perspectives on the pelagic stage of sea turtle development. Conservation Biology 1: 103-121.

Casper, B.M., and D. Mann. 2004. The hearing abilities of the Nurse Shark, Ginglymostoma cirratum, and the Yellow Stingray, Urobatis jamaicensis. Presentation at American Elasmobranch Society Meeting, University of South Florida, College of Marine Science, St. Petersburg, FL, May 28.

Casper, B.M., Lobel P.S., Yan H.Y. 2003. The hearing sensitivity of the little skate, Raja erinacea: a comparison of two methods. Environ Biol Fishes 68:371–379

Castroviejo, J., B. J. Juste, J. Pérez Del Val, R. Castelo R. and Gil. 1994. Diversity and status of sea turtle species in the Gulf of Guinea Islands. Biodiversity and Conservation 3: 828-836.

Caurant, F., Bustamante, P., Bordes, M., Miramand, P., 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, 1085–1091.

CETAP 1982. A Characterization of marine mammals and turtles in the Mid- and North Atlantic areas of the U.S. outer continental shelf: final report of the Cetacean and Turtle Assessment Program. Kingston, R.I., Cetacean and Turtle Assessment Program. University of Rhode Island. Graduate School of Oceanography. United States. Bureau of Land Management

Cheatwood, J.L., Jacobson, E.R., May, P.G., Farrell, T.M., Homer, B.L., Samuelson, D.A., Kimbrough, J.W., 2003. An outbreak of fungal dermatitis and stomatitis in a free-ranging population of pigmy rattlesnakes (Sistrurus miliarius barbouri) in Florida. J Wildl Dis 39, 329-337.

Chevalier, J. and Girondot, M. 1998. Dynamique de ponte des tortues marines en Guyane francxaise pendant la saison 1997. Bulletin de la Socie´te´ Herpe´tologique de France, 85e86, 5e19.

Clugston, J.P., 1996. Retention of T-bar anchor tags and passive integrated transponder tags by Gulf sturgeons. North American Journal of Fisheries Management 16, 4.

Colburn, T., D. Dumanoski, and J.P. Myers. 1996. Our stolen future. Dutton (Penguin Books USA), New York.

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

Coston-Clements, L. and Hoss, D. E. 1983. Synopsis of Data on the Impact of Habitat Alteration on Sea Turtles around the Southeastern United States. pp. 57 pp.

Cox, T.M., Lewison R.L., Zydelis R., Crowder L., Safina C., Read J. 2007. Comparing effectiveness of experimental and implemented bycatch reduction measures: the ideal and the real. Conserv Biol 21:1155–1164

Crabbe, M.J.C., 2008. Climate change, global warming and coral reefs: Modelling the effects of temperature. Computational Biology and Chemistry 32, 311-314.

Crouse, D.T., 1999. The consequences of delayed maturity in a human-dominated world. In: Musick, J.A. (Ed.), Life in the Slow Lane: Ecology and Conservation of Long-Lived Marine Animals, American Fisheries Society Symposium, pp. 195-202.

Dare, M.R., 2003. Mortality and Long-Term Retention of Passive Integrated Transponder Tags by Spring Chinook Salmon. North American Journal of Fisheries Management 23, 1015-1019.

Delgado C, Dellinger T, Varo N, Lopez-Jurado LF. 2008. Preliminary approach to the hatchlings sex-ratio of a population of Caretta caretta of Boa Vista Island, Cape Verde Archipelago (Western Africa)—an update for 2004 season. In: Kalb H, Rohde AS, Gayheart K, Shanker Kc (eds) Proceedings of the twenty-fifth annual symposium on sea turtle biology and conservation. NOAA Technical Memorandum NMFS-SEFSC-582, pp 166–167

Dellinger, T. and C. Freitas. 2000. Movements and diving behaviour of pelagic stage loggerhead sea turtles in the North Atlantic: preliminary results obtained through satellite telemetry. Pages 155-157 in Kalb, H.J. and T. Wibbels (compilers). Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-443.

Dellinger, T. and H. Encarnaçâo. 2000. Accidental capture of sea turtles by the fishing fleet based at Madeira Island, Portugal. Page 218 in Kalb, H.J. and T. Wibbels (compilers). 180 Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-443.

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

Doughty, R. W. 1984. Sea turtles in Texas: a forgotten commerce. Southwestern Historical Quarterly 88: 43-70.

Dow, W., K. Eckert, M. Palmer and P. Kramer. 2007. An Atlas of Sea Turtle Nesting Habitat for the Wider Caribbean Region. The Wider Caribbean Sea Turtle Conservation Network and The Nature Conservancy. WIDECAST Technical Report No. 6. Beaufort, North Carolina. 267 pages

Dutton, P. and G.H. Balazs. 1995. Simple biopsy technique for sampling skin for DNA analysis of sea turtles. Marine Turtle Newsletter. No. 69, pp 9-10.

Eckert, K.L. 1993. The biology and population status of marine turtles in the North Pacific Ocean. Honolulu, Hawaii, NOAA Tech. Memo. NMFS-SWFSC-186. 156 pp.

Eckert, K.L., K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly (Editors). 1999. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

Eckert, S.A. 1998. Perspectives on the use of satellite telemetry and other electronic technologies for the study of marine turtles, with reference to the first year long tracking of leatherback sea turtles. In: S.P. Epperly and J. Braun (Compilers). Proceedings of the Seventeenth Annual Sea Turtle Symposium. U.S. Department of Commerce NOAA Technical Memorandum NMFS-SEFSC-415. pp. 44-46.

Ehrhart, L. M., Redfoot, W. E. and Bagley, D. A. 1996. A study of the population ecology of in-water marine turtle populations on the east-central Florida coast from 1982-96. Vol. . pp. 164 pp. Department of Biology, University of Central Florida, Orlando.

Ehrhart, L.M. 1983. Marine turtles of the Indian River Lagoon System. Florida Sci. 46: 337-346.

Ehrhart, LM., D.A. Bagley, and W.E. Redfoot. 2003. Loggerhead turtles in the Atlantic Ocean: geographic distribution, abundance, and population status. Pages 157-174 in Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Epperly, S. P., Braun, J., Chester, A. J., Cross, F. A., Merriner, J. V. and Tester, P. A. 1995. Winter distribution of sea turtles in the vicinity of Cape Hatteras and their interactions with the summer flounder trawl fishery. Bulletin of Marine Science 56: 547-568.

Epperly, S.P., J. Braun, and A. Veishlow. 1995b. Sea turtles in North Carolina waters. Conserv. Biol. 9: 384-394

Epperly, S.P., J. Braun, and A.J. Chester. 1995a. Aerial surveys for sea turtles in North Carolina inshore waters. Fishery Bulletin 93:254.

Epperly, S.P., J. Braun-McNeil, A.L. Bass, D.W. Owens, and R. M. Patterson. 2000. Inwater population index surveys: North Carolina, U.S.A. Proceedings of the 18th Annual Sea Turtle Symposium, March 3-7, 1998, Sinaloa, Mexico. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-SEFSC-436:62

Ernst, LH. and R.W. Barbour. 1972. Turtles of the United States. Univ. Kentucky Press, Lexington, Ky.

Fleming, E.H. 2001. Swimming Against the Tide: Recent surveys of exploitation, trade, and management of marine turtles in the Northern Caribbean. TRAFFIC North America. Washington, D.C.

Foley A, Schroeder A, Redlow A, Fick-Child K, Teas W. 2005. Fibropapillomatosis in stranded green turtles (Chelonia mydas) from the eastern United States (1980–98): trends and associations with environmental factors. J Wildl Dis 41:29–41

Foley, A., B. Schroeder, and S. MacPherson. 2008. Post-nesting migrations and resident areas of Florida loggerheads. Pages 75-76 in Kalb, H., A. Rohde, K. Gayheart, and K. Shanker (compilers). Proceedings of the Twenty-fifth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-582.

Forbes, G.A. 1999. Diet Sampling and Diet Component Analysis 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.

Forbes, G.A., and C.J. Limpus. 1993. A non-lethal method for retrieving stomach contents from sea turtles. Wildl. Res. 20:339-343.

FPL (Florida Power & Light Co.) St. Lucie Plant. 2000. Annual environmental operating report 1999. Juno Beach, Fla.

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

Frazer, N.B., Ehrhart, L.M., 1985. Preliminary Growth Models for Green, Chelonia mydas, and Loggerhead, Caretta caretta, Turtles in the Wild. Copeia 1985, 73-79.

Frazier, J. G. 1980. Marine turtles and problems in coastal management. In: Coastal Zone '80: Proceedings of the Second Symposium on Coastal and Ocean Management 3, (Edge, B. C., ed.). pp. 2395-2411. American Society of Civil Engineers, Washington, D.C.

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. 429 pages.

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

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

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

Fritts, T. H., M. A. McGehee, Coastal Ecosystems Project., U.S. Fish and Wildlife Service. Office of Biological Services. and United States. Minerals Management Service. Gulf of Mexico OCS

Region. 1982. Effects of petroleum on the development and survival of marine turtle embryos. Washington, D.C., U.S. Dept. of the Interior/Minerals Management Service, Gulf of Mexico Outer Continental Shelf Regional Office.

Fritts, T.H. and M.A. McGehee. 1982. Effects of petroleum on the development and survival of marine turtle embryos. U.S. Fish and Wildlife Service report FWS/OBS-82/37. 41 pages.

Garrison, L.P., and L. Stokes. 2012. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2010. NOAA Technical Memorandum NMFS-SEFSC-624:1-53.

Gavilan, F.M. 2001. Status and distribution of the loggerhead turtle, Carettacaretta, in the wider Caribbean region. In Marine turtle conservation in the widerCaribbean region: a dialogue for effective regional management. Pp 36-40.Eckert,K.L. & Abreu Grobois, F.A. (Eds). St. Croix, U.S. Virgin Is.

Germano, D.J., Williams, D.F., 2005. Population Ecology of Blunt-Nosed Leopard Lizards in High Elevation Foothill Habitat. Journal of Herpetology 39, 1-18.

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

Gill, J.A., and W.J. Sutherland. 2001. Predicting the consequences of human disturbance from behavioral decisions. In: Gosling, L.M., Sutherland, W.J. (Eds.), Behavior and Conservation. Cambridge University Press, Cambridge, pp. 51-64.

Gilman, E., Kobayashi, D., Swenarton, T., Brothers, N., Dalzell, P., Kinan-Kelly, I., 2007. Reducing sea turtle interactions in the Hawaii-based longline swordfish fishery. Biological Conservation 139, 19-28.

GMFMC. 2007. Final Amendment 27 to the reef fish fishery management plan and Amendment 14 to the shrimp fishery management plan. Including the Supplemental Environmental Impact Statement, Regulatory Impact Review, and Regulatory Flexibility Act Analysis). June 2007. pp.380. Gulf of Mexico Fishery Management Council, 2203 North Lois Avenue, Suite 1100, Tampa, Florida 33607.

Graff, D. 1995. Nesting and hunting survey of the turtles of the island of São Tomé. Progress Report July 1995, ECOFAC Componente de São Tomé e Príncipe, 33 pp.

Green, J.A., P.J. Butler, A.J. Woakes, and I.L. Boyd. 2004. Energetics of the molt fast in female macaroni penguins Eudyptes chrysolophus. Journal of Avian Biology 35:153-161.

Gregory, L.F., Gross, T.S., Bolten, A.B., Bjorndal, K.A., Guillette, J.L.J., 1996. Plasma Corticosterone Concentrations Associated with Acute Captivity Stress in Wild Loggerhead Sea Turtles (Caretta caretta). General and Comparative Endocrinology 104, 312-320.

Guseman, J. L. and Ehrhart, L. M. 1992. Ecological geography of Western Atlantic loggerheads and green turtles: evidence from remote tag recoveries. In: Proceedings of the 11th Annual Workshop

on Sea Turtle Biology and Conservation, Vol. 302 (Salmon, M. and Wyneken, J., eds.). pp. 50 (abstract). U.S. Department of Commerce NOAA Technical Memorandum, NMFS-SEFSC-302.

Hamann, M., C.T. Cuong, N.D. Hong, P. Thuoc, and B.T. Thuhien. 2006. Distribution and abundance of marine turtles in the Socialist Republic of Veit Nam. Biodiversity and Conservation 15:3703-3720.

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

Hawkes, L.A., Broderick A.C., Coyne M.S., Godfrey M.H., Godley B.J. 2007. Only some like it hot – quantifying the environmental niche of the loggerhead sea turtle. Diversity and Distributions 13:447-457.

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

Henwood, T. A. and Ogren, L. H. 1987. Distribution and migrations of immature Kemp's ridley turtles (Lepidochelys kempii) and green turtles (Chelonia mydas) off Florida, Georgia, and South Carolina. Northeast Gulf Science 9: 153-159.

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

Hildebrand, H. 1982. A historical review of the status of sea turtle populations in the Western Gulf of Mexico. In: Biology and Conservation of Sea Turtles, (Bjorndal, K. A., ed.). pp. 447-453. Smithsonian Institution Press, Washington, D.C.

Hildebrand, H. 1987. A reconnaissance of beaches and coastal waters from the border of Belize to the Mississippi River as habitats for marine turtles. Report to NOAA/NMFS/SEFC Panama City Laboratory, purchase order NA-84-CF-A-134.

Hirth, H.F. 1980. Some Aspects of the Nesting Behavior and Reproductive Biology of Sea Turtles. American Zoologist 20, 507-523.

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

Holloway-Adkins K.G. 2001. A comparative study of the feeding ecology of Chelonia mydas (green turtle) and the incidental ingestion of Prorocentrum spp. MS thesis, University of Central Florida, Orlando, FL

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

Hopkins-Murphy S.R., Owens D.W., Murphy T.M. 2003. Ecology of immature loggerheads on foraging grounds and adults in internesting habitat in the eastern United States. In: Loggerhead Sea Turtles (eds Bolten AB, Witherington BE), pp. 79–92. Smithsonian Press, Washington, D.C.

Huerta, P., H. Pineda, A. Aguirre, T. Spraker, L. Sarti, and A. Barragán. 2002. First confirmed case of fibropapilloma in a leatherback turtle (Dermochelys coriacea), p. 193. In A. Mosier, A. Foley, and B. Brost (ed.), Proceedings of the 20th Annual Symposium on Sea Turtle Biology and Conservation. National Oceanic and Atmospheric Administration technical memorandum NMFS-SEFSC-477. U.S. Department of Commerce, Washington, D.C.

Innis, C., Nyaoke, A.C., Williams, C.R., Dunnigan, B., Merigo, C., Woodward, D.L., Weber, E.S., Frasca, S. 2009. Pathologic and Parasitologic findings of cold-stunned Kemp's ridley sea turtles (Lepidochelys kempii) stranded on Cape Cod, MA. 2001-2006. Journal of Wildlife Diseases 45, 594-610.

Intergovernmental Panel on Climate Change. 2007. Climate change 2007: the physical science basis. Summary for Policymakers. Unpublished (http://www.ipcc.ch/SPM2feb07.pdf).

Ivar do Sul, J.A., Costa, M.F., 2007. Marine debris review for Latin America and the Wider Caribbean Region: From the 1970s until now, and where do we go from here? Marine Pollution Bulletin 54, 1087-1104.

Kamezaki, N., Y. Matsuzawa, O. Abe, H. Asakawa, T. Fujii, K. Goto, S. Hagino, M. Hayami, M. Ishii, T. Iwamoto, T. Kamata, H. Kato, J. Kodama, Y. Kondo, I. Miyawaki, K. Mizobuchi, Y. Nakamura, Y. Nakashima, H. Naruse, K. Omuta, M. Samejima, H. Suganuma, H. Takeshita, T. Tanaka, T. Toji, M. Uematsu, A. Yamamoto, T. Yamato, and I. Wakabayashi. 2003. Loggerhead turtles nesting in Japan. Pages 210-217 in Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Keller, J.M., Kucklick, J.R., Stamper, M.A., Harms, C.A., McClellan-Green, P.D., 2004. Associations between Organochlorine Contaminant Concentrations and Clinical Health Parameters in Loggerhead Sea Turtles from North Carolina, USA. Environmental Health Perspectives 112, 1074-1079.

Keller, J.M., McClellan-Green, P.D., Kucklick, J.R., Keil, D.E., Peden-Adams, M.M., 2006. Effects of Organochlorine Contaminants on Loggerhead Sea Turtle Immunity: Comparison of a Correlative Field Study and <italic>In Vitro</italic> Exposure Experiments. Environ Health Perspect 114.

LaCasella, E.L., P.H. Dutton, and S.P. Epperly. 2005. Genetic stock composition of loggerheads (Caretta caretta) encountered in the Atlantic northeast distant (NED) longline fishery using additional mtDNA analysis. Pages 302-303 in Frick M., A. Panagopoulou, A.F. Rees, and K. Williams (compilers). Book of Abstracts of the Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.

Lagueux, C.J. 1998. Demography of marine turtles harvested by Miskito Indians of Atlantic Nicaragua, In R, Byles and Y. Fernandez (compilers). Proceedings of the 16th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412: 90.

Laurent, L. Casale, P. Bradai, M. N. Godley, B. J. Gerosa, G. Broderick, A. C. Schroth, W. Schierwater, B. Levy, A. M. Freggi, D. 1998. Molecular resolution of marine turtle stock composition in fishery bycatch: a case study in the Mediterranean. Molecular Ecology 7, 1529-1542.

Law, R.J., Fileman, C.F., Hopkins, A.D., Baker, J.R., Harwood, J., Jackson, D.B., Kennedy, S., Martin, A.R. and R.J. Morris. 1991. Concentrations of trace metals in the livers of marine mammals (seals, porpoises and dolphins) from waters around the British Isles. Marine Pollution Bulletin 22:183-191.

Legler, J.M. 1977. Stomach flushing: a technique for chelonian dietary studies. Herpetologica 33:281-284.

Lenhardt, M.L. 2003. Effects of Noise on Sea Turtles, Proceedings of the First International Conference on Acoustic Communication by Animals, University of Maryland, July 27-30.

Lewison, R.L., L.B. Crowder, and D.J. Shaver. 2003. The impact of turtle excluder devices and fisheries closures on loggerhead and Kemp's ridley strandings in the western Gulf of Mexico. Conservation Biology 17(4):1089-1097.

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: recent developments from behavioral, reproductive, and ecological perspecitves. 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. J. 1985. A study of the loggerhead sea turtle, Caretta caretta, in eastern Australia. Ph.D. dissertation. Univ. Queensland, Brisbane, Australia.

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

Loehefener, R. R., W. Hoggard, C. L. Roden, K. D. Mullin, and C. M. Rogers. 1989. Petroleum structures and the distribution of sea turtles. In: Proc. Spring Ternary Gulf of Mexico Studies Meeting, Minerals Management Service, U.S. Department of the Interior.

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

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

Lutcavage, M. and Musick, J. A. 1985. Aspects of the biology of sea turtles in Virginia. Copeia 1985: 449-459.

Lutcavage, M. E. and Lutz, P. L. 1991. Voluntary diving metabolism and ventilation in the loggerhead sea turtle. J. Exp. Mar. Biol. Ecol. 147, 287–296.

Lutcavage, M. E. and Lutz, P. L. 1997. Diving physiology. In: The Biology of Sea Turtles, Vol. vol. 1 (Lutz, P. L. and Musick, J. A., eds.). pp. 277–296. CRC Press, Boca Raton, Florida.

Lutcavage, M. E., P. L. Lutz, G. D. Bossart, and D. M. Hudson. 1995. Physiologic and clinicopathologic effects of crude oil on loggerhead sea turtles. Arch. Environ. Contam. Toxicol. 28: 417–422

Lutcavage, M. E., P. Plotkin, B. Witherington, and P. L. Lutz. 1997. Human impacts on sea turtle survival. In: The Biology of Sea Turtles, Vol. vol. 1 (Lutz, P. L. and Musick, J. A., eds.). pp. 387-432. CRC Press, Boca Raton, Florida.

Lutz, P. L. and M. Lutcavage. 1989. The effects of petroleum on sea turtles: applicability to Kemp‘s ridley. In: C.W. Caillouet, Jr. and A.M. Landry, Jr. (editors), Proceedings of the First International Symposium on Kemp‘s Ridley Sea Turtle Biology, Conservation and Management. TAMU-SG89-105:52-54.

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

Mann, T.M. 1977. Impact of developed coastline on nesting and hatchling sea turtles in southeastern Florida. Unpublished M.S. Thesis. Florida Atlantic University; Boca Raton, Florida.

Marcano, L.A. and J.J. Alio-M. 2000. Incidental capture of sea turtles by the industrial shrimping fleet off northwestern Venezuela. NOAA Tech. Memo. NMFS-SEFSC-436:107.

Margaritoulis, D., R. Argano, I. Baran, F. Bentivegna, M.N. Bradai, J.A. Camiñas, P. Casale, G. De Metrio, A. Demetropoulos, G. Gerosa, B.J. Godley, D.A. Haddoud, J. Houghton, L. Laurent, and B. Lazar. 2003. Loggerhead turtles in the Mediterranean Sea: present knowledge and conservation perspectives. Pages 175-198 in Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Márquez, M.R. 1994. Synopsis of biological data on the Kemp's ridley turtle, Lepidochelys kempi (Garman, 1880). NOAA Tech. Mere. NMFS-SEFSC-343, 1-91.

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. .

Martin, R. E. and Ernst, R. G. 2000. Physical and Ecological Factors Influencing Sea Turtle Entrainment Levels at the St. Lucie Nuclear Plant. pp. 62 pp.

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

McFee, W. E., Wolf, D. L., Parshley, D. E. and Fair, P. A. 1996. Investigations of marine mammal entanglement associated with a seasonal coastal net fishery. pp. 104. U.S. Department of Commerce NOAA Technical Memorandum, NMFS-SEFSC-386.

McKenzie, C., Godley, B.J., Furness, R.W., 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.

Mendonça, M.T. and L.M. Ehrhart. 1982. Activity, population size and structure of immature Chelonia mydas and Caretta caretta in Mosquito Lagoon, Florida. Copeia 1982(1):161- 167.

Meylan, A. M., B. Schroeder, and A. Mosier. 1994. Marine turtle nesting activity in the state of Florida, 1979-1992, p. 83. In: K. A. Bjorndal, A. B. Bolten, D. A. Johnson, and P. J. Eliazar (comps.), Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351

Meylan, A., Schroeder, B. and Mosier, A. 1995. Sea turtle nesting activity in the state of Florida. Florida Marine Research Publications 52: 1-51.

Meylan, A.B. 1982. Sea turtle migration – evidence from tag returns. Pages 91-100 in Bjorndal, K.A. (editor). Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Meylan, A.B., Bjorndal, K.A., Turner, B.J., 1983. Seaturtles nesting at Melbourne beach, Florida, II. Post-nesting movements of Caretta caretta. Biological Conservation 26, 79-90.

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

Milton, S., P. Lutz, and G. Shigenaka. 2003. Oil toxicity and impacts on sea turtles. In: G. Shigenaka (editor), Oil and Sea Turtles: Biology, Planning, and Response. NOAA National Ocean Service. p: 35-47.

Moore, C.J., Moore, S.L., Leecaster, M.K., Weisberg, S.B., 2001. A Comparison of Plastic and Plankton in the North Pacific Central Gyre. Marine Pollution Bulletin 42, 1297-1300.

Morreale, S.J. and E.A. Standora. 1998. Early life stage ecology of sea turtles in northeastern U.S. waters. NOAA Technical Memorandum NMFS-SEFSC-413. 49 pages.

Mortimer, J.A., 1990. The Influence of Beach Sand Characteristics on the Nesting Behavior and Clutch Survival of Green Turtles (Chelonia mydas). Copeia 1990, 802-817.

Mosier, A.E. and B.E. Witherington. 2002. Documented effects of coastal armoring structures on sea turtle nesting behavior. Pages 304-306 in Mosier, A., A. Foley, and B. Brost (compiler).

Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-477.

Mrosovsky, N. 1981. "Plastic Jellyfish." Marine Turtle Newsletter (17): 5-6.

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

Muller, R.G., T.M. Bert, and S.D. Gerhart. 2006. The 2006 Stock Assessment Update for the Stone Crab, Menippe spp. Fishery in Florida. Florida Fish and Wildlife Commission. Florida Marine Research Institute, 100 Eight Avenue Southeast. St. Petersburg, FL 33701-5020. IHR 2006-011. July, 31.

Murphy, T. M. and Hopkins, S. R. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region. pp. 67 pp. LaMER, Inc. Green Pond, South Carolina.

Murray, K.T. 2006. Estimated average annual bycatch of loggerhead sea turtles (Caretta caretta) in U.S. Mid-Atlantic bottom otter trawl gear, 1996-2004. NMFS Northeast Fisheries Science Center Reference Document 06-19.

Musick, J. A. and Limpus, C. J. 1997. Habitat utilization and migration in juvenile sea turtles. In: The Biology of Sea Turtles, Vol. vol. 1 (Lutz, P. L. and Musick, J. A., eds.). pp. 137-164. CRC Press, Boca Raton, Florida.

Myrberg AA Jr. 2001. The acoustical biology of elasmobranchs. Environ Biol Fishes 60:31–45

NEFSC. 2005. 41st Northeast Regional Stock Assessment Workshop (41st SAW). US Dep Commer, Northeast Fish. Sci. Cent. Ref. Doc. 05-10. 36 p.

Nelson, D. R.1967. Hearing thresholds, frequency discrimination, and acoustic orientation in the lemon shark, Negaprion brevirostris (Poey). Bull. Mar. Sci., 17(3): 741-768.

NMFS (National Marine Fisheries Service). 1989. Endangered Species Act section 7 consultation on the effects of commercial fishing activities in the Southeast Region on Threatened and Endangered Species. Biological Opinion, April 28.

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

NMFS and USFWS. 1992. Recovery Plan for the Kemps' Ridley Sea Turtle. National Marine Fisheries Service, Washington, D.C. pp. 40.

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

NMFS and USFWS. 1998. Recovery Plan for U.S. Pacific Populations of the Loggerhead Turtle. Prepared by the Pacific Sea Turtle Recovery Team.

NMFS and USFWS. 2007. Loggerhead sea turtle (Caretta caretta) 5-year review: Summary and evaluation. Silver Spring, MD, National Marine Fisheries Service: 65.

NMFS and USFWS. 2009. Loggerhead sea turtle (Caretta caretta) 2009 status review under the U.S. Endangered Species Act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service. Silver Spring, MD. 222 pp.

NMFS and USFWS. 2011. 2011 Final Bi-National (U.S. and Mexico) Revised Recovery Plan in English and Spanish (2nd revision). National Marine Fisheries Service. Silver Spring, MD.

NMFS SEFSC (Southeast Fisheries Science Center). 2001. Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the Western North Atlantic. NOAA Technical Memorandum, NMFS-SEFSC-455. 226 pp.

NMFS. 1989b. Endangered Species Act section 7 consultation concerning the issuing of exemptions for commercial fishing operations under section 114 of the Marine Mammal Protection Act. Biological Opinion. July 5.

NMFS. 1992. ESA section 7 consultation on shrimp trawling, as proposed by the Councils, in the southeastern United States from North Carolina through Texas under the 1992 revised sea turtle conservation regulations. Biological Opinion. August 19. 26 pp.

NMFS. 1994. ESA section 7 consultation on,shrimp trawling in the southeastern United States under the sea turtle conservation regulations. Biological Opinion. November 14. 24 pp..

NMFS. 1995a. Characterization of the Reef Fish Fishery of the Eastern U.S. Gulf of Mexico. Report to the Gulf of Mexico Fishery Management Council Reef Fish Management 167

NMFS. 1995b. Endangered Species Act section 7 consultation on United States Coast Guard vessel and aircraft activities along the Atlantic coast. Biological Opinion. September 15.

NMFS. 1996a. ESA Biological Opinion on Shrimp Trawling in the southeastern United States under the Sea Turtle Conservation Regulations. June 11. 28 pp.

NMFS. 1996b. ESA Biological Opinion on Shrimp Trawling in the Southeastern United States under the Sea Turtle Conservation Regulations. November 13. 38 pp.

NMFS. 1997. Section 7 consultation on the continued hopper dredging of channels and borrow areas in the southeastern United States. National Marine Fisheries Service Southeast Regional Office, September 25, 1997.

NMFS. 1997b. Endangered Species Act section 7 consultation on Navy activities off the southeastern United States along the Atlantic Coast. Biological Opinion. May 15.

NMFS. 1998. ESA Biological Opinion on Shrimp Trawling in the Southeastern United States under the Sea Turtle Conservation Regulations. March 24. 32 pp.

NMFS. 2000. Smalltooth Sawfish Status Review. NMFS, SERO. December. 73 pp.

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. 2002a. Status of red grouper in United States waters of the Gulf of Mexico during 1986-2001, revised. NOAA, NMFS, SEFSC, 75 Virginia Beach Drive, Miami, Florida 33149. Contribution No. SFD-01/02-175rev. 65 p.

NMFS. 2002b. Endangered Species Act – Section 7 Consultation on Shrimp Trawling in the Southeastern United States, under the Sea Turtle Conservation Regulations and as managed by the Fishery Management Plans for Shrimp in the South Atlantic and Gulf of Mexico. Biological Opinion. December 2.

NMFS. 2002c. Endangered Species Act section 7 consultation on the proposed Gulf of Mexico outer continental shelf lease sale184. Biological Opinion. July 11.

NMFS. 2002d. Endangered Species Act section 7consultation on proposed Gulf of Mexico outer continental shelf multi-lease sales (185, 187, 190, 192, 194, 196, 198, 200, 201). Biological Opinion. November 29.

NMFS. 2003a. Endangered Species Act section 7 consultation on the continued operation of Atlantic shark fisheries (commercial shark bottom longline and drift gillnet fisheries and recreational shark fisheries) under the Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks (HMS FMP) and the Proposed Rule for Draft Amendment 1 to the HMS FMP. Biological Opinion. July.

NMFS. 2003b. Endangered Species Act section 7 consultation on Gulf of Mexico Outer Continental Shelf oil and gas lease sales 189 and 197. Biological Opinion. August 30.

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

NMFS. 2004b. Endangered Species Act section 7 reinitiation of consultation on the Atlantic Pelagic Longline Fishery for Highly Migratory Species. Biological Opinion, June 1.

NMFS. 2004c. Endangered Species Act section 7 consultation on the Eglin Gulf test and training range. Biological Opinion. October 20.

NMFS. 2004d. Evaluating Bycatch: A National Approach to Standardized Bycatch Monitoring Programs. NOAA Technical Memorandum NMFS-F/SPO-66. October. 108 p.

NMFS. 2005a. Endangered Species Act– Section 7 consultation on the continued authorization of reef fish fishing under the Gulf of Mexico Reef Fish Fishery Management Plan and Proposed Amendment 23. Biological Opinion. February 15. 115 p. plus appendices.

NMFS. 2005b. Endangered Species Act – Section 7 Consultation on Eglin Gulf Test and Training Range, Precision Strike Weapons (PSW) Test (5-Year Plan). Biological Opinion, March 14.

NMFS. 2006a. Endangered Species Act – Section 7 Consultation on Minerals management Service, Permitting Structure Removal Operations on the Gulf of Mexico Outer Continental Shelf. August 2006. 102 p.+ appendices.

NMFS. 2006b. Endangered Species Act – Section 7 Consultation on the Continued Authorization of Shrimp Trawling as Managed under the Fishery Management Plan (FMP) for the Shrimp Fishery of the Gulf of Mexico (GOM) and its effects on Smalltooth Sawfish. Biological Opinion. January 13.

NMFS. 2007a. Endangered Species Act – Section 7 consultation on the Continued Authorization of Fishing under the Fishery Management Plan (FMP) for Coastal Migratory Pelagic Resources in Atlantic and Gulf of Mexico. Biological Opinion. August 13.

NMFS. 2007b. Endangered Species Act section 7 consultation on Gulf of Mexico Oil and Gas Activities: Five-Year Leasing Plan for Western and Central Planning Areas 2007-2012. Biological Opinion. June 29.

NMFS. 2008. Endangered Species Act – Section 7 Consultation on the Continued Authorization of Shark Fisheries (Commercial Shark Bottom Longline, Commercial Shark Gillnet and Recreational Shark Handgear Fisheries) as Managed under the Consolidated Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks (Consolidated HMS FMP), including Amendment 2 to the Consolidated HMS FMP. Biological Opinion. May 20.

NMFS. 2009a. Fisheries of the United States 2009. NMFS, Silver Spring, MD. Status of US Fisheries. http://www.nmfs.noaa.gov/sfa/statusoffisheries/SOSmain.htm

NMFS. 2009b. Grouper Fishery Trends in the Gulf of Mexico, 2004-2008. SERO-LAPP-2009- 01. 71 pp.

NMFS. 2009c. Smalltooth Sawfish Recovery Plan, Silver Spring, MD.

NMFS. 2009d. Endangered Species Act – Section 7 Consultation on the Continued Authorization of Fishing under the Fishery Management Plan (FMP) for Spiny Lobster in the South Atlantic and Gulf of Mexico. Biological Opinion. August 27.

NMFS. 2009e. Cumulative effects of Amendment 31 regulations upon effective effort impacting sea turtle takes in the Gulf of Mexico reef fish bottom longline fishery. 23 p.

NMFS. 2009f. Draft Environmental Assessment and Regulatory Impact Review for Rule to Reduce Sea Turtle Bycatch by the Eastern Gulf of Mexico Bottom Longline Component of the Reef Fish Fishery. National Marine Fisheries Service, Southeast Regional Office, 263 13th Avenue South, St. Petersburg, FL 33701-5505.

NMFS. 2009g. Endangered Species Act – Section 7 Consultation on the Corps of Engineers, M.B. Miller Pier, Bay County, Florida. May 1

NMFS. 2010a. Endangered Species Act – Section 7 Consultation on the Atlantic Bluefish Fishery Management Plan, Biological Opinion. October 29

NMFS. 2010b. Endangered Species Act – Section 7 Consultation on the Federal Atlantic Mackerel, Squid and Atlantic Butterfish Fishery Management Plan (FMP), Biological Opinion. October 29

NMFS. 2010c. Endangered Species Act – Section 7 Consultation on the Monkfish Fishery Management Plan, Biological Opinion. October 29

NMFS. 2010d. Endangered Species Act – Section 7 Consultation on the Northeast Multispecies Fishery Management Plan, Biological Opinion. October 29

NMFS. 2010e. Endangered Species Act – Section 7 Consultation on the Spiny Dogfish Fishery Management Plan, Biological Opinion. October 29

NMFS. 2010f. Endangered Species Act – Section 7 Consultation on the Northeast Skate Complex Fishery Management Plan, Biological Opinion. October 29

NMFS. 2010g. Endangered Species Act – Section 7 Consultation on the Summer Flounder, Scup and Black Sea Bass Fishery Management Plan, Biological Opinion. October 29

NMFS. 2012a. ESA Section 7 reinitiation consultation on the Continued Implementation of the Sea Turtle Conservation Regulations, as Proposed to Be Amended, and the Continued Authorization of the Southeast U.S. Shrimp Fisheries in Federal Waters under the Magnuson-Stevens Act. Biological Opinion.

NMFS. 2012b. Endangered Species Act – Section 7 Consultation on the Atlantic Sea scallop Fishery Management Plan, Biological Opinion. July 12

NMFS. 2012c. Endangered Species Act – Section 7 Consultation on the Continued Authorization of the Atlantic Shark Fisheries via the Consolidated HMS Fishery Management Plan as Amended by Amendments 3 and 4 and the Federal Authorization of a Smoothhound Fishery, Biological Opinion. December 12

NRC (National Research Council). 1990. Decline of the sea turtles: causes and prevention. National Academy Press, Washington, D.C. 274 pp.

Ober. H.K. 2010. Effects of oil spills on marine and coastal wildlife. Department of Wildlife Ecology and Conservation. University of Florida. Accessed online on July 9, 2010. http://www.wec.ufl.edu/Effects%20of%20oil%20spills%20on%20wildlife.pdf

Ogren, L. H. 1989. Distribution of juvenile and sub-adult Kemp's ridley sea turtle: Preliminary results from 1984-1987 surveys. In: First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management, Oct. 1-4, 1985. Galveston, Texas, (Caillouet, C. W. and Landry, A. M., eds.). pp. 116-123. Texas A&M University.

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.W. Ruiz. 1980. New methods of obtaining blood and cerebrospinal fluid from turtles. Herpetologica 36(1):17-20.

Peters, A., Verhoeven, K.J.F., 1994. Impact of Artificial Lighting on the Seaward Orientation of Hatchling Loggerhead Turtles. Journal of Herpetology 28, 112-114.

Peters, J. A. 1954. The amphibians and reptiles of the coast and coastal sierra of Michoacan, Mexico. Occasional Papers of the Museum of Zoology, University of Michigan 554: 1-37.

Peterson, E. A. 1966. Hearing in the lizard: Some comments on the auditory capacities of a nonmammalian ear. Herpetologica, 22(3), 161-171.

Pichel, W.G., Churnside, J.H., Veenstra, T.S., Foley, D.G., Friedman, K.S., Brainard, R.E., Nicoll, J.B., Zheng, Q., Clemente-Colón, P., 2007. Marine debris collects within the North Pacific Subtropical Convergence Zone. Marine Pollution Bulletin 54, 1207-1211.

Plotkin, P. and A.F. Amos. 1988. Entanglement in and ingestion of marine turtles stranded along the south Texas coast. Pages 79-82 in B.A. Schroeder, compiler. Proceedings of the eighth annual workshop on sea turtle conservation and biology. NOAA Technical Memorandum NMFS/SEFC-214.

Plotkin, P., and A.F. Amos. 1990. Effects of anthropogenic debris on sea turtles in the northwestern Gulf of Mexico, Pages 736-743 in: R. S. Shomura and M.L. Godfrey eds. Proceedings Second International Conference on Marine Debris. NOAA Technical Memorandum. NOAA-TM-NMFS-SWFC-154.

Pritchard, P. C. H. 1969. Endangered species: Kemp's ridley turtle. Florida Naturalist 49: 12-19.

Pritchard, P.C.H. 2002. Global status of sea turtles: an overview. Document INF-001 prepared for the Inter-American Convention for the Protection and Conservation of Sea Turtles, First Conference of the Parties (COP1IAC), First part August 6-8, 2002.

Pritchard, P.C.H., Bacon, P., Berry, F., Carr, A., Fletemeyer, J., Gallagher, R., Hopkins, S., Lankford, R., Marquez-M., R., Ogren, L., Pringle, W., Jr., Reichart, H., Witham, R., 1983, Manual of sea turtle research and conservation techniques. In: Bjorndal, K.A., Balazs, G.H. (Eds.), Prepared for the Western Atlantic Sea Turtle Symposium. Center for Environmental Education, Washington, D.C., p. 125.

Provancha, J. A., M. Mota, R. H. Lowers, D. M. Scheidt, M. A. Corsello. 1998. Relative abundance and distribution of marine turtles inhabiting Mosquito Lagoon, Florida, U.S.A. In Proceedings of the 17th annual symposium on sea turtle biology and conservation, Orlando, Florida, S. P. Epperly and J. Braun (compilers). NOAA Technical Memorandum NMFS-SEFSC-415, pp. 84–85.

Provancha, M.J., P.A. Schmalzer, and C.R. Hall. 1986. Effects of the December 1983 and January 1985 freezing air temperatures on select aquatic poikilotherms and plant species of Merritt Island, Florida. Florida Sci. 49:199-212.

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.

Rebel, T. P. 1974. Sea turtles and the turtle industry of the West Indies, Florida and the Gulf of Mexico. University of Miami Press, Coral Gables, Florida.

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

Renaud, M. L., Carpenter, J. A. and Williams, J. A. 1995. Movement of Kemp's ridley sea turtles captured near dredged channels at Bolivar Roads Pass and Sabine Pass, Texas and Calcasieu Pass, Louisiana, May 1994 through December 4, 1994. pp.

Richards, P.M. 2007. Estimated takes of protected species in the commercial directed shark bottom longline fishery 2003, 2004, and 2005. NMFS Southeast Fisheries Science Center Contribution PRD-06/07-08, June 2007. 21 pages.

Ridgeway, S.H., E.G. Wever, J.G. McCormic, J. Palin, and J.H. Anderson. 1969. Hearing in the Giant Sea Turtle, Chelonia mydas. Proceedings of the National Academy of Sciences, 64(3): 884-900.

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

Sakai, H., Ichihashi, H., Suganuma, H. and Tatsukawa, R. 1995. Heavy metal monitoring in sea turtles using eggs. Marine Pollution Bulletin 30: 347-353.

Salmon, M., and Witherington, B.E., 1995. Artificial Lighting and Seafinding by Loggerhead Hatchlings: Evidence for Lunar Modulation. Copeia 1995, 931-938.

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

Schroeder, B. A., Foley, A. M., Witherington, B. E. and Mosier, A. E. 1998. Ecology of marine turtles in Florida Bay: Population structure, distribution, and occurrence of fibropapilloma. Vol. 415. pp. 265-267.

Schroeder, B.A., A.M. Foley, and D.A. Bagley. 2003. Nesting patterns, reproductive migrations, and adult foraging areas of loggerhead turtles. Pages 114-124 in Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Seney, E.E., B.M. Higgins, and A.M. Laundry, Jr. 2010. Satellite transmitter attachment techniques for small juvenile sea turtles. Journal of Experimental Marine Biology and Ecology.

Shaver, D. J. 1991. Feeding ecology of wild and head-started Kemp's ridley sea turtles in south Texas waters. Journal of Herpetology 25: 327-334.

Shaver, D. J. 1994. Relative abundance, temporal patterns, and growth of sea turtles at the Mansfield Channel, Texas. Journal of Herpetology 28: 491-497.

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

Skalski, J., S. Smith, R. Iwamoto, J. Williams and A. Hoffmann. 1998. Use of passive integrated transponder tags to estimate survival of migrant juvenile salmonids in the Snake and Columbia rivers. Canadian Journal of Fisheries and Aquatic Sciences 55:1484-1493.

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

Spotila, J.R., M.P. O'Connor and F.V. Paladino. 1997. Thermal biology. In: P.L. Lutz and J. A. Musick (editors), The Biology of Sea Turtles. CRCPress. Boca Raton, Florida. 297-341.

Spotila, J.R., P.T. Plotkin, and J.A. Keinath. 1998. In water population survey of sea turtles of Delaware Bay. Unpublished Report. Final Report to NMFS Office of Protected Resources for work conducted under Contract No. 43AANF600211 and NMFWS Permit No. 1007 by Drexel University, Philadelphia, Penna., 21 pp.

St. Aubin, D.J., and Geraci, J.R. 1988. Capture and handling stress suppresses circulating levels of thyroxine (T4) and triiodothyronine (T3) in beluga whales Delphinapterus leucas. Physiol. Zool. 61: 170–175.

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

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

Storelli, M. M., E.Ceci and Marcotrigiano, G. O. 1998. Distribution of heavy metal residues in some tissues of Caretta caretta (Linnaeus) specimens beached along the Adriatic Sea (Italy). Bulletin of Environmental Contamination and Toxicology 60: 546-552.

Storelli, M.M., Barone, G., Storelli, A., Marcotrigiano, G.O., 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, 908-913.

Storelli, M.M., Marcotrigiano, G.O., 2003. Heavy metal residues in tissues of marine turtles. Marine Pollution Bulletin 46, 397-400.

Stoskopf, M. K. 1993. Shark pharmacology and toxicology. Pages 809–816 in M. Stoskopf, editor. Fish medicine. Saunders, Philadelphia.

Szymanski, M.D., D.E. Bain, K. Kiehl, S.Pennington, S. Wong and K.R. Henry. 1999. Killer whale (Orcinus orca) hearing: Auditory brainstem response and behavioral audiograms. Journal of the Acoustical Society of America 106:1134-1141.

Terhune, J.M., 1976. Audibility Aspects of Sonic Tracking of Marine Mammals. Journal of Mammalogy 57, 179-180.

TEWG (Turtle Expert Working Group). 1998. An assessment of the Kemp's ridley (Lepidochelys kempii) and loggerhead (Caretta caretta) sea turtle populations in the western North Atlantic. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SEFSC-409, 96 pp.

TEWG. 2000. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. U.S. Dep. Commer. NOAA Tech. Mem. NMFS-SEFSC-444, 115 pp.

TEWG. 2009. An Assessment of the Loggerhead Turtle Population in the Western North Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-575, 131p.

Thompson, W. L. 2004. Future directions in estimating abundance of rare or elusive species. Pages 389–399 in W. L. Thompson, editor. Sampling rare or elusive species. Island Press, Washington, D.C.

Tucker, A.D. 2010. Nest site fidelity and clutch frequency of loggerhead turtles are better elucidated by satellite telemetry than by nocturnal tagging efforts: Implications for stock estimation. Journal of Experimental Marine Biology and Ecology 383, 48-55.

U.S. Fish and Wildlife Service 1999. South Florida multi-species recovery plan. Atlanta, Georgia, 2172p.

U.S. Geological Services. 2005. The Gulf of Mexico Hypoxic Zone. Posted January 5. http://toxics.usgs.gov/hypoxia/hypoxic_zone.html

van Dam, R. and Sarti, L. 1989. Sea turtle biology and conservation on Mona Island, Puerto Rico. Report for 1989. Vol. . pp. 12 pp.

Walker, B.G., Boersma, P.R., Wingfield, J.C., 2006. Habituation of adult Magellenic penguins to human visitation as expressed through behavior and corticosterone secretion. Conservation Biology 20, 146-154.

Watson, J.W., D.G. Foster, S. Epperly, and A. Shah. 2004. Experiments in the western Atlantic Northeast Distant Waters to evaluate sea turtle mitigation measures in the pelagic longline fishery. Report on experiments conducted in 2001 -2003. February 4, 2004. 123 pages.

Watson, J.W., S.P. Epperly, A.K. Shah, and D.G. Foster. 2005. Fishing methods to reduce sea turtle mortality associated with pelagic longlines. Canadian Journal of Fisheries and Aquatic Sciences 62:965-981.

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

Weishampel, J.F., Bagley, D.A., Ehrhart, L.M., Rodenbeck, B.L., 2003. Spatiotemporal patterns of annual sea turtle nesting behaviors along an East Central Florida beach. Biological Conservation 110, 295-303.

Wetherall, J. 1997. Mortality of sea turtles in the Hawaii longline fishery: a preliminary assessment of population impacts. Southwest Fisheries Science Center Administrative Report H-97-07. 52 pages.

Wever, E. G., and Vernon, J. A. 1956. The sensitivity of the turtle's ear as shown by its electrical potentials. Proceedings of the National Academy of Sciences of the United States of America, 42(4), 213.

Wibbels, T., D.W. Owens, C. Limpus, P. Reed and M. Amoss. 1990. Seasonal changes in gonadal steroid concentrations associated with migration, mating, and nesting in loggerhead sea turtles. Gen. Comp. Endocrinol. 79: 154-164

Williams, E.H., Bunkley-Williams, L., Peters, E.C., Pinto-Rodriguez, B., Matos-Morales, R., Mignucci-Giannoni, A.A., Hall, K.V., Rueda-Almonacid, J.V., Sybesma, J., De Calventi, I.B., Boulon, R.H., 1994. An Epizootic of Cutaneous Fibropapillomas in Green Turtles Chelonia mydas of the Caribbean: Part of a Panzootic? Journal of Aquatic Animal Health 6, 70-78.

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

Witham, R. 1978. Does a problem exist relative to small sea turtles and oil spills? pp. 629-632.

Witherington, B. and Ehrhart, L. M. 1989. Hypothermic stunning and mortality of marine turtles in the Indian River Lagoon system, Florida. Copeia 1989: 696-703.

Witherington, B.E. 1994. Flotsam, jetsam, post-hatchling loggerheads, and the advecting surface smorgasbord. In: Proc. 14th Ann. Symp. Sea Turtle Biology and Conservation, K. A. Bjorndal, A. B. Bolten, D. A. Johnson, and P. J. Eliazar, compilers. NOAA Technical Memorandum. NMFS-SEFSC-351, Miami, Fla. p. 166.

Witherington, B.E. and K. A. Bjorndal. 1991. Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles, Caretta caretta. Biol. Cons. 55(2): 139-149.

Witherington, B., S. Hirama, and A. Mosier. 2003. Effects of beach armoring structures on marine turtle nesting. Florida Fish and Wildlife Conservation Commission final project report to the U.S. Fish and Wildlife Service. 26 pages.

Witherington, B., S. Hirama, and A. Mosier. 2007. Changes to armoring and other barriers to sea turtle nesting following severe hurricanes striking Florida beaches. Florida Fish and Wildlife Conservation Commission final project report to the U.S. Fish and Wildlife Services. 11 pages.

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

Witherington, B.E. 1999. Reducing threats to nesting habitat. Pages 179-183 in Eckert, K.L., 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.

Witherington, B.E. 2002. Ecology of neonate loggerhead turtles inhabiting lines of downwelling near a Gulf Stream front. Marine Biology 140:843-853.

Witherington, B.E., Herren, R., Bresette, M., 2006b, Caretta caretta – Loggerhead Sea Turtle. Chelonian Research Monographs 3, 74-89.

Witherington, B.E., K.A. Bjorndal, and C.M. McCabe. 1990. Temporal pattern of nocturnal emergence of loggerhead turtle hatchlings from natural nests. Copeia 1990(4):1165-1168.

Witkowski, S. A. and Frazier, J. G. 1982. Heavy metals in sea turtles. Marine Pollution Bulletin 13: 254-255.

Witzell, W. N., Bass, A. L., Bresette, M. J., Singewald, D. A. and Gorham, J. C. 2002. Origin of immature loggerhead sea turtles (Caretta caretta) at Hutchinson Island, Florida: evidence from DNA markers. Fishery Bulletin 100: 624-631.

Witzell, W.N. 2002. Immature Atlantic loggerhead turtles (Caretta caretta): suggested changes to the life history model. Herpetological Review 33(4):266-269.

Work, T.M., and G.H. Balazs. 1999. Quantification of tumor severity and hematology in green turtles afflicted with fibropapillomatosis in the Hawaiian Islands. J. Wildl. Dis.

Wright, I.E., S.D. Wright, and J.M. Sweat. 1998. Use of passive integrated transponder (PIT) tags to identify manatees (Trichechus manatus latirostris). Marine Mammal Science 14(3):5.

Yañez, I. L., A. R. Gaos, and R. M. Aruaz. 2010. Eastern Pacific leatherback, green, and olive ridley sea turtle nesting at Playa Naranjo; first census in eight years K. Dean, and M. C. L. Castro, editors. 28th Annual Symposiumon Sea Turtle Biology and Conservation. National Marine Fisheries Service.

Zieman, J. C., J. W. Fourqurean, andR. L. Iverson. 1989. Distribution, abundance and productivity of seagrasses and macroalgae in Florida Bay.Bulletin of Marine Science 44:29