National Oceanic and Atmospheric Administration'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 Oceanic and Atmospheric Administration's National Marine Fisheries Service

Activity Considered: Proposal to issue permit No. 15802 to Gregg Poulakis for research on smalltooth sawfish in coastal waters of the southeastern U.S., pursuant to section 10(a)(1)(A) of the Endangered Species Act

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

Approved by:

Date: JUN 0 1 2012

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA) (16 U.S.C. 1531 *et seq.*) requires each federal agency to insure 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 designated for such species. When a federal agency's action "may affect" listed species or designated critical habitat, that agency is required to consult formally with either the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the listed resources that may be affected. Federal agencies are exempt from this requirement if they have concluded that an action "may affect", but is "unlikely to adversely affect" listed species or designated critical habitat, and NMFS and/or USFWS concur with that conclusion (50 CFR 402.14[b]).

This document represents NMFS' Biological Opinion (Opinion) on the effects to ESA-listed species and designated critical habitat resulting from the proposed issuance of scientific research permit No. 15802. Issuance of a scientific research permit represents a federal action that is subject to the consultation requirements under section 7 of the ESA. The ESA prohibits "takes"[1] of threatened and endangered species with only a few specific exceptions. The applicable exceptions in this case are an exemption of "takes" to

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[1] The ESA defines "take" as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct

listed species for scientific purposes related to species recovery under Section 10(a)(1)(A) of the ESA. For the actions described in this document, the action agency is NMFS' Office of Protected Resources – Permits and Conservation Division (Permits Division). The consulting agency is NMFS' Office of Protected Resources – Endangered Species Act Interagency Cooperation Division (ESA Interagency Cooperation Division). This Opinion is based on information submitted by the Permits Division as part of their initiation package (i.e., draft environmental assessment, draft permit, original application provided by the applicant, etc.), recovery plans, monitoring reports, published and unpublished scientific information on the biology and ecology of the listed species affected, and other relevant sources of information.

CONSULTATION HISTORY

On January 9, 2012, the Permits Division requested formal consultation with the ESA Interagency Cooperation Division on a proposed action to issue scientific research permit No. 15802 to Gregg Poulakis of the Florida Fish and Wildlife Conservation Commission (FWC) to conduct research on smalltooth sawfish (*Pristis pectinata*) in coastal waters of the southeastern U.S. for a period of five years.

On January 12, 2012, the Permits Division informed the ESA Interagency Cooperation Division that the applicant requested to add an additional tagging method that was not included in the original application. As a result of this change in the proposed action, the ESA Interagency Cooperation Division requested an updated description of the proposed tagging methods and information on the anticipated effects to smalltooth sawfish.

Upon receiving the additional information, the ESA Interagency Cooperation Division initiated formal consultation on April 11, 2011.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The Permits Division proposes to issue permit No. 15802 to FWC (Gregg Poulakis, responsible party) for direct "takes" to smalltooth sawfish and five species of sea turtles [i.e., loggerhead (*Caretta caretta*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), and leatherback (*Dermochelys coriacea*)] for the purposes of scientific research, pursuant to section 10(a)(1)(A) of the ESA. Research efforts will be focused at the mouths of the Peace, Myakka, and Caloosahatchee rivers in the Charlotte Harbor estuarine system on the southwest coast of Florida although occasional sampling may occur in other areas from Texas to North Carolina if reliable and sufficient reports of smalltooth sawfish encounters warrant sampling in those areas. The objective of the research is to obtain data on smalltooth sawfish movements and habitat use (juveniles and adults), relative abundance of juveniles, temporal and spatial distributions, and baseline assessments of health (e.g., toxicology). While sea turtles are not directly targeted, researchers do intend to measure and handle sea turtles before release and thus requested that takes to sea turtles be included in their permit. Takes are expected to be in the form of capture, wounding, and harassment[2]. Direct capture of smalltooth sawfish and opportunistic capture of sea turtles would occur using seines, gillnets, hook and line, and longlines. Wounding would occur to all individuals caught on hook and line and longlines as well as from tag attachment, biopsy sampling, and blood sampling. Additional harassment to smalltooth sawfish would occur from capture, handling, measuring, weighing, and ultrasounds while sea turtles would be harassed through capture, handling, and measuring only before release.

Table 1 below displays the proposed take to listed species included in the draft permit. No mortality is currently proposed and all individuals are expected to be released alive with no serious injuries. The permit would be valid for five years from the date of issuance.

Table 1. Proposed Takes to Listed Species for Permit No. 15802

SPECIES	LIFE STAGE	NO. ANIMALS TAKEN	TAKE ACTIVITY	DETAILS
Smalltooth Sawfish	Juvenile (less than 2 meters)	125 (annually)	Capture*, measure, genetic and blood sample, biopsy punch, PIT tag, rototag, acoustic tag, CTD tag, ultrasound, release	Recaptured sawfish will only be captured, measured, and released. Tags will be reapplied if lost.
Smalltooth Sawfish	Juvenile (2-3 meters)	15 (annually)	Capture*, measure, genetic and blood sample, biopsy punch, PIT tag, rototag, CTD tag, external satellite tag, ultrasound, release	Recaptured sawfish will only be captured, measured, and released. Tags will be reapplied if lost.
Smalltooth Sawfish	Adult (3 meters or larger)	50 (annually)	Capture*, measure, genetic and blood sample, biopsy punch, PIT tag, rototag, acoustic tag, CTD tag, ultrasound, release	Recaptured sawfish will only be captured, measured, and released. Tags will be reapplied if lost.

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2 The ESA does not define harassment nor has NMFS defined the term pursuant to the ESA through regulation. However, the Marine Mammal Protection Act defines harassment as “any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal population in the wild or has the potential to disturb a marine mammal or marine mammal population in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering” [16 U.S.C. 1362(18)(A)].

Table 1 Continued…

SPECIES	LIFE STAGE	NO. ANIMALS TAKEN	TAKE ACTIVITY	DETAILS
Smalltooth Sawfish	Adult (3 meters or larger)	15 (annually)	Capture*, measure, genetic and blood sample, biopsy punch, PIT tag, rototag, CTD tag, external satellite tag, ultrasound, release	Recaptured sawfish will only be captured, measured, and released. Tags will be reapplied if lost.
Loggerhead Sea Turtle	All (except hatchlings)	10 (over the life of the permit)	Capture*, measure carapace and release	Captures are incidental to sawfish sampling
Green Sea Turtle	All (except hatchlings)	10 (over the life of the permit)	Capture*, measure carapace and release	Captures are incidental to sawfish sampling
Kemp's Ridley Sea Turtle	All (except hatchlings)	10 (over the life of the permit)	Capture*, measure carapace and release	Captures are incidental to sawfish sampling
Hawksbill Sea Turtle	All (except hatchlings)	6 (over the life of the permit)	Capture*, measure carapace and release	Captures are incidental to sawfish sampling
Leatherback Sea Turtle	All (except hatchlings)	6 (over the life of the permit)	Capture*, measure carapace and release	Captures are incidental to sawfish sampling

*Capture by longline, hook and line, gillnets, or seine nets

The following is a summary of the research actitivities proposed for permit No. 15802:

Capture by Longline, Hook and Line, Gillnet, and Seine Nets
Researchers propose to directly capture smalltooth sawfish and opportunistically capture sea turtles by way of longlines, hook and line, gill nets, and seine nets. The type of gear used varies depending on location, habitat, and season. Researchers will conduct both random sampling and directed sampling with defined areas at the mouths of the Peace, Myakka, and Caloosahatchee rivers in the Charlotte Harbor estuarine system on the southwest coast of Florida although additional areas will sampled if researchers receive reports of occurrences through the sawfish reporting network. Researchers anticipate conducting 10-12 sampling days each month throughout the year.

Longlines will consist of a heavy monofilament mainline 800 meters long with gangions spaced every ten meters along the line. Each gangion is equipped with 15/0 corrodible non-offset circle hooks. Longlines will be fished for one hour from the time the last hook is deployed and will be placed further offshore in deeper waters than other gear types.

Hook and line will consist of a large reel with heavy line and a one meter leader baited with fish species such as mullet, stingray, and ladyfish. Hook and line will be used during waiting periods or in conjunction with gillnets and longlines.

Gillnet sizes to be utilized include 45, 91, and 183 meters with 152 millimeter (6 inch) stretched mesh. Researchers expect gillnets to be placed in coastal waters and estuaries where sawfish are frequently spotted. Gillnets will be constantly monitored while being set and checked every 30 minutes if the water temperature is less than 30^{o}C and every 20 minutes if the water temperature is greater than 30^{o}C.

Seine nets are 183 meters by 3 meters with 25 millimeter nylon mesh. Seine nets are sometimes used to capture smalltooth sawfish when they are spotted in shallow waters. Seine nets will be constantly monitored from the beginning of the set until the sample is completed.

Handling, Measurements, and Ultrasound Examinations

For smaller sawfish that are captured [less than three meters total length (TL)], researchers will fill a net well in the stern of the boat with water or use a small plastic wading pool as a temporary environment. Larger sawfish (over three meters TL) will be tethered to the side of the boat using ropes tied around the rostrum and body, including around the caudal peduncle (i.e., base of tail) and their gills will be kept submerged. All captured sawfish will undergo a suite of measurements including precaudal length, rostrum length, rostral tooth count per side, rostral tooth length, disc width, maximum total length, and clasper length to the nearest millimeter.

In addition to measurements, researchers will also perform ultrasound examinations to determine stomach contents, gonad size, and brood size in the case of adult females. The time required for ultrasounds is around five minutes for juveniles and up to ten minutes for adults due to adults typically having more stomach contents. During the ultrasound procedure, the spiracles and gills will be kept in the water at all times. Also, researchers will not keep any captured individuals out of the water longer than one minute without having water run through its mouth and over its gills to minimize stress. After processing, sawfish captured in shallow water will be released by gently placing them in the water and leading them away from the boat. In deeper waters, sawfish will be released by gently placing them in the water and allowing them to descend on their own.

When sea turtles are captured in nets or on longlines, they will also be handled, measured, and photographed although researchers will take the least amount of time possible before releasing them to minimize stress.

Tissue and Blood Sampling

Researchers propose to take a small fin clip (around one square centimeter) from each captured sawfish for genetic and stable isotope analysis. Samples will be taken from the free rear tip of a dorsal fin. In addition, researchers will obtain biopsy samples from the dorsal flank of each sawfish to determine baseline levels of skin and muscle histology, environmental toxins, and validation of stable isotope results derived from fin clips. To obtain biopsy samples, researchers will use a hand-held biopsy punch (six millimeter diameter; eight millimeters deep; with safety flange to prevent insertion beyond eight millimeters). In cases where a sawfish is observed to have external lesions, the biopsy punch will be taken in this area for histopathological evaluation. This will allow for identification of pathogens (e.g., fungi, bacteria, viruses) or characterization of tumors. A new sterile punch will be used for each sample that is taken.

Blood samples (1-5 milliliters) will be obtained via caudal venipuncture using a sterile needle and syringe for conducting hormone assays. The caudal vein lies ventral to the caudal artery, with both vessels encased in the hemal arch of the caudal vertebrae. The amount of blood drawn depends on the size of the sawfish sampled although researchers will limit the amount of blood drawn to less than six percent of total blood volume. This typically results in researchers sampling one milliliter for sawfish under one kilogram, three milliliters for individuals between one and two kilograms, and five milliliters for individuals over two kilograms in weight.

Tagging

Researchers are proposing to attach rototags, passive integrated transponder (PIT) tags, external acoustic tags, Conductivity Temperature Depth (CTD) tag, and/or satellite tags (e.g., Wildlife Computers) to sampled smalltooth sawfish. All individuals will receive an internal PIT tag, a CTD tag, and external acoustic tags. Sonic tag frequency will be between 69 kilohertz and 81 kilohertz. For the CTD and acoustic tags, they will either be epoxied to a rototag that is attached to the sawfish' dorsal fin or are attached through a neoprene clasp method (described below). In addition, 15 larger juveniles (between two and three meters TL) and 15 adult smalltooth sawfish (three meters or larger TL) would also receive an external satellite tag attached using a harness assembly (described below). Duration of tag attachment depends on initial placement and sawfish habitat use although tags are known to remain on individuals for several months based on the researchers' prior use.

PIT tags are small (12 millimeters in length and 1.5 millimeters in diameter), implantable tags that are inserted with a small hypodermic needle to position the tag into the musculature at the base of the first dorsal fin. Because they are implanted, they are not easily shedded by the animal as it grows. All sawfish caught in this project will have a PIT tag implanted unless scanning the animal reveals that an implantable tag already exists.

Researchers will attach external acoustic and CTD tags by either epoxying them to a rototag that is then affixed to the dorsal fin or attaching them by way of neoprene clasp. For the first method, researchers will punch a 3-5 millimeter hole through the fin with a leather hole-punch, and then fasten the two halves of the roto tag together through the fin (see **Figure 1** below). The CTD and external acoustic tags will be epoxied on top of the rototag under this method. For the second type of attachment method, two small 1-2 millimeter holes are created through the base of the first dorsal fin using a surgical needle. Antichaffing tubing is inserted through the anterior hole and monofilament line is threaded through the tubing and also threaded through two equally sized strips of neoprene on either side of the fin. This neoprene acts as a cushion between the animal and two equally sized plastic plates, allowing water flow and preventing necrosis. The CTD and acoustic tags will then be fastened with epoxy to the plastic backings and the clasp attached to either side of the fin (see **Figure 2** below). After the tags are secure, metal (nickel plated brass) crimps will be used to secure the monofilament loops. The metal crimps will corrode over time releasing the tag, leaving two small holes. The proposed procedure will be performed in less than five minutes without anesthesia with the animal remaining in the water.

Figure 1. **Acoustic transmitter attached to external fin tag with marine epoxy.** Transmitters are epoxied to a rototag. Source: Poulakis et al., 2010.

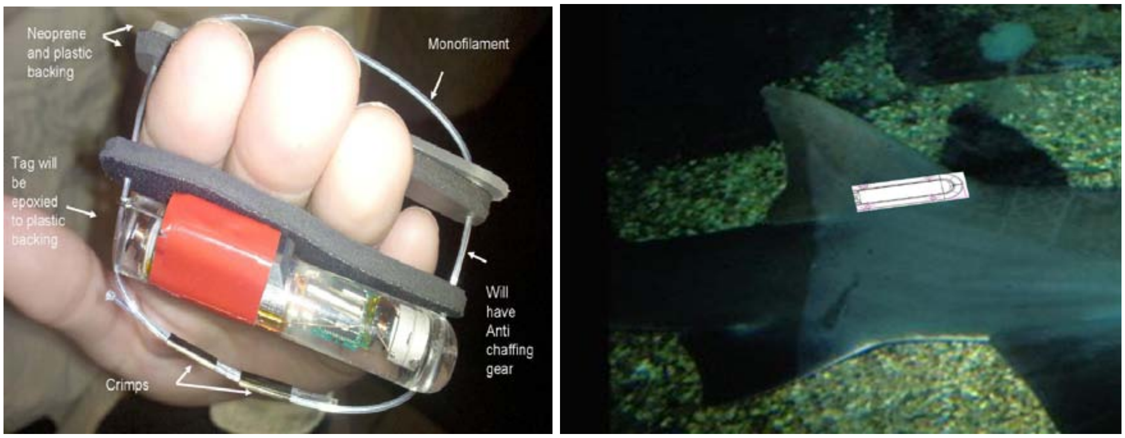

Figure 2. **Photograph of a neoprene clasp and the position of the tag assembly**. Source: John Carlson, NMFS Permit No. 13330.

Finally, satellite tags will be attached via a harness assembly to larger juveniles (between 2 and 3 meters TL) and adults (over three meters TL). After a captured sawfish is restrained alongside the research vessel, a hollow, stainless steel dart applicator is pushed through the thickened, anterior portion of the first dorsal fin near the dorsal fin origin. The free end of the harness assembly is threaded into the applicator through the dorsal fin and the applicator is then extracted from the opposite side of the dorsal fin. The harness is then pulled through the dorsal fin, and the free end of steel cable is inserted into the open sides of the two double copperlock crimps. When attached, the satellite tag trails just behind the dorsal fin as the sawfish is released (see **Figure 3** below). The metal crimps will corrode over time and the tag will slip off the animal leaving a small hole. The satellite tag is approximately 18 centimeters long and has a diameter of 25 millimeters.

Figure 3. **Photograph of a smalltooth sawfish tagged with a similar harness assembly**. Source: John Carlson, NMFS Permit No. 13330.

<u>Mitigation Measures</u>

The following section summarizes the measures associated with permit No. 15802 to mitigate effects to targeted and non-targeted protected species during research activities. More detailed information may be found in the associated permit and Environmental Assessment documents. The following conditions are included in the draft permit:

1. In the event a serious injury or mortality[3] of a protected species occurs, the Researchers must suspend permitted activities and contact the Chief, NMFS Permits and Conservation Division by phone within two business days. Researchers must also submit a written incident report. The Permits Division may grant authorization to resume permitted activities based on review of the incident report and in consideration of the Terms and Conditions of the permit.

2. If authorized take is exceeded, the Researchers must cease all permitted activities and notify the Chief, NMFS Permits and Conservation Division by phone as soon as possible but not later than two business days. Researchers must also submit a written incident report within two weeks of the incident. The incident report must

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[3] This permit does not allow for unintentional serious injury and mortality caused by the presence or actions of researchers. This includes, but is not limited to; deaths resulting from infections related to sampling procedures; and deaths or injuries sustained by animals during capture and handling, or while attempting to avoid researchers or escape capture.

include a complete description of the events and identification of steps that will be taken to reduce the potential for additional exceedance of authorized take.

3. All researchers shall be properly trained in sawfish and sea turtle handling procedures as recommended by NMFS. Care shall be taken when handling sawfish and sea turtles to minimize any possible injury to the animals. In the event a smaller sawfish is brought aboard for sampling researchers shall ensure the sawfish is placed on a clean, safe surface that will minimize the chance of injury to the animal and it shall be returned to the water as soon as possible to minimize stress.

4. Smalltooth sawfish shall not be held out of the water for longer than one minute. If an animal has to be held for a longer period out for sampling, sea water shall be run through the mouth or into the spiracles such that the water runs over the animal's gills.

5. All sawfish shall be examined for existing tags, including PIT tags if possible, before attaching or inserting new ones. If existing tags are found, the tag identification numbers shall be recorded and included in the annual report.

6. For satellite transmitters: Total weight of transmitter attachments for any one sawfish must not exceed two percent of the body mass of the animal. Each attachment must be made so that there is no risk of entanglement. The transmitter attachment must either contain a weak link or have no gap between the transmitter and the sawfish that could result in entanglement, and be as hydrodynamic as possible.

7. Blood or tissue sampling and tagging (sawfish):

    a. Sterile techniques must be used at all times.

    b. Sterilized instruments shall be used when taking a fin clip from sawfish.

    c. No more than two samples shall be taken from each sawfish.

    d. Tissue sampling and tagging shall be performed by the Principal Investigator (PI) or qualified co-investigators (CIs) unless a qualified research associate (RA) is supervised by the PI or CI.

8. During release from boats, animals shall be lowered as close to the water's surface as possible to prevent potential injuries.

9. Transfer of biological samples: Transfer of biological samples from the permit holder to researchers other than those specifically identified in the application requires written approval from NMFS. The terms and conditions concerning any

samples collected under the authorization remain in effect as long as the Permit Holder maintains authority and responsibility of the material taken.

10. Sea Turtle Capture and Handling:

    a. Sea turtles shall be protected from temperature extremes of heat and cold, provided adequate air flow, and kept moist. Turtles shall be placed on pads for cushioning and this surface shall be cleaned and disinfected between turtles. The area surrounding the turtle may not contain any materials that could be accidentally ingested.

    b. Researchers shall be trained in and follow the NOAA protocol as outlined in "Careful Release Protocols for Sea Turtle Release with Minimal Injury" for de-hooking turtles and resuscitating comatose turtles. Researchers must have appropriate equipment to allow them to follow the protocol.

    c. The Permit Holder, PI, CI(s), or RA(s) shall carefully observe newly released turtles and record observations on the turtle's apparent ability to swim and dive in a normal manner. If a turtle is not behaving normally within one hour of release, the turtle shall be recaptured and taken to a rehabilitation facility.

11. Sea Turtle Hooking Information Included in Reports: Information shall be recorded whether the animal was:

    a. Hooked externally with or without entanglement.

    b. Hooked in upper or lower jaw with or without entanglement. Includes ramphotheca, but not any other jaw/mouth tissue parts.

    c. Hooked in cervical esophagus, glottis, jaw joint, soft palate, tongue, and/or other jaw/mouth tissue parts not categorized elsewhere, with or without entanglement. Includes events where insertion point of hook is visible through the mouth.

    d. Hooked in esophagus at or below level of the heart with or without entanglement. Includes events where the insertion point of the hook is not visible when viewed through the mouth.

    e. Entangled only, no hook involved.

    f. Comatose/resuscitated.

12. Researchers shall also record whether the animal was:

a. Released with hook and with trailing line greater than or equal to half the length of the carapace (line trailing, turtle not entangled).

b. Released with hook and with trailing line less than half the length of the carapace (line is trailing, turtle is not entangled).

c. Released entangled with hook (line not trailing, turtle entangled).

d. Released with all gear removed.

13. <u>Longline and Drum Line Gear:</u>

a. Hooks must be corrodible, non-offset circle hooks and equal to or greater than 14/0.

b. Researchers shall only use fish to bait the hooks. They shall not bait the hooks with squid.

c. Bait shall be single hooked (i.e., not threaded).

d. This gear shall be checked (pulled up and examined for catch) every hour or sooner. Researchers shall tend the gear while it is in the water and remove it if dolphins move into the area.

14. <u>Netting Bycatch Special Conditions:</u>

a. When possible, nets used to catch smalltooth sawfish must be large enough to diminish bycatch of other species while still allowing capture of smalltooth sawfish.

b. Highly visible buoys shall be attached to the float line of each net at a spacing of every 10 yards or less. Each float shall be attached to the net as it is being deployed.

c. Nets must be fully checked at least every 30 minutes, and more often when animals are observed in the net. The float line shall be observed at all times for all movements indicating an animal has encountered the net. If so, the net must be immediately checked. "Net checking" is defined as a complete and thorough visual check of the net either by snorkeling the net in clear water or by pulling up on the top line such that the full depth of the net is viewed along the entire length. Researchers must plan for unexpected circumstances or demands of the research activities and have the ability and resources to meet this net checking condition (e.g., if one animal is very entangled and requires extra time and effort to remove from the net, researchers must have sufficient staff and resources to continue checking the rest of the net at the same time).

d. Nets must not be put in the water when marine mammals or crocodiles are observed within 500 yards of the research vicinity, and the animals must be allowed to either leave or pass through the area safely before net setting is initiated. Should any marine mammals or crocodiles 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 and crocodiles in the vicinity aware of the net. If marine mammals or crocodiles persist within the vicinity of the research area, nets must be removed.

e. Researchers shall make safety and health of any entangled animals a high priority, cutting the net if necessary to more quickly remove the animal.

15. <u>In Waters Where Manatee are Present</u>: The following conditions to the permit are offered by the USFWS to prevent and minimize interactions with endangered Florida manatee (*Trichecus manatus*):

    a. <u>Avoiding manatee interaction</u>:

        i. Vessel personnel must be informed it is illegal to purposely or by mistake harm, harass, or otherwise "take" manatees, and to obey all posted manatee protection speed zone, 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.

        ii. Research crew should wear polarized sunglasses to reduce glare while on the water and keep a look out for manatees. The crew shall include at least one member dedicated to watching for manatees during all in-water activities.

        iii. All vessels engaged in netting and trapping must operate at the slowest speed consistent with such activities. All netting and trapping must be limited to 30 minutes after sunrise to 30 minutes before sunset.

        iv. Rope attaching floats to nets should not have kinks or contain slack that could present an entanglement hazard to manatee.

        v. Netting 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 minutes has elapsed since the manatee was last observed within the safety zone.

b. <u>If a manatee is incidentally captured</u>:

   i. Devote all efforts to freeing the animal recognizing manatees must breathe and surface approximately every 4 minutes. The Permit Holder or PI must brief all researchers to ensure they understand freeing a manatee can be 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.

   ii. As appropriate, turn off the vessel or put engine in neutral.

   iii. Release tension on the net allowing the animal opportunity to free itself. Exercise caution when assisting the animal in freeing itself. Manatees are docile animals but can thrash violently if captured or become entangled in a net. A 1,200 to 3,500-pound 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.

   iv. Immediately contact the Florida Fish and Wildlife Conservation Commission (FWC), Division of Law Enforcement, and as soon as FWC is notificed, contact Nicole Adimey (USFWS) to report any gear or vessel interactions, or sighting of manatees. Also contact NMFS (Chief, Permits and Conservation Division) as soon as possible.

16. <u>Submerged Aquatic Vegetation, Coral Communities, Live or Hard Bottom Ecosystems</u>:

    Researchers must take all steps to identify submerged aquatic vegetation (SAV), coral communities, and live/hard bottom habitats and avoid setting gear in such areas. Also researchers must avoid adverse impacts to Essential Fish Habitat (EFH), by using 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 shall be made to recover the lost gear to avoid further damage to benthic habitat and impacts related to "ghost fishing."

    a. *Johnson's sea grass and critical habitat.* No research activities shall be conducted over, on, or immediately adjacent to Johnson's sea grass or in Johnson's sea grass critical habitat.

    b. *Other sea grass species*. Researchers must avoid conducting research over, on, or immediately adjacent to any non-listed sea grass species. If it cannot be avoided, then the following avoidance/minimization measures must be implemented:

   i. In order to reduce the potential for sea grass damage, anchors must be set by hand when water visibility is acceptable. Anchors must be placed in unvegetated areas within seagrass meadows or areas having relatively sparse vegetation coverage. Anchor removal must be conducted in a manner that will avoid the dragging of anchors and anchor chains.

   ii. Researchers must take great care to avoid damaging any sea grass species and if the potential for anchor or net drag is evident researchers must suspend research activities immediately.

   iii. Researchers shall be careful not to tread or trample on seagrass and coral reef habitat.

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

17. Non-listed Bycatch: All incidentally captured species (e.g., fishes) must be released alive as soon as possible. Catch data on these species shall be included in the annual permit report.

18. No activities are allowed in Sanctuary Preservation Areas, Special Use (Research Only) Areas, or Ecological Reserves of the Florida Keys National Marine Sanctuary without prior permit or approval (Sanctuary Superintendent).

19. As practicable, researchers shall document sightings of listed species not targeted by this research. While the researchers will be able to avoid harassing these species, they shall attempt to document these sightings and provide enough information in their annual reports to provide the Permits Division with important and relevant information. When possible, identification of the organism to the species level is ideal, but less specific information is also beneficial. Other information such as GPS coordinates, time of day, water depth, water temperature, dissolved oxygen, weather conditions, etc. should also be provided to the Permits Division in the annual report, as practicable.

20. Individuals conducting permitted activities must possess qualifications commensurate with their roles and responsibilities.

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

22. The Permit holder must submit annual reports to the Chief, NMFS Permits and Conservation Division and a final report must be submitted within 180 days after expiration of the permit, or, if the research concludes prior to permit expiration, within 180 days of completion of the research.

23. Research results must be published or otherwise made available to the scientific community in a reasonable period of time.

24. The Permit Holder must provide written notification of planned field work to the appropriate Assistant Regional Administrator(s) for Protected Resources. Such notification must be made at least two weeks prior to initiation of a field trip/season and must include the locations of the intended field study and/or survey routes, estimated dates of research, and number and roles of participants.

25. To the maximum extent practicable, the Permit Holder must coordinate permitted activities with activities of other Permit Holders conducting the same or similar activities on the same species, in the same locations, or at the same times of year to avoid unnecessary disturbance of animals.

In addition to the above conditions, researchers plan to remove gear from the water when sea turtles and marine mammals are spotted at the surface. Even though researchers request to handle and measure any sea turtles caught incidentally in passive gear (i.e., longline or gillnets), they will not seek to directly capture them and will avoid any sea turtles spotted at the surface. This mitigation measure will serve to minimize effects to listed sea turtles as a result of this proposed action.

APPROACH TO THE ASSESSMENT

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

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

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

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

When individual listed plants or animals are expected to experience reductions in fitness in response to an action, those fitness reductions are likely to reduce the abundance, reproduction, or growth rates (or increase the variance in these measures) of the populations those individuals represent (see Stearns, 1992). Reductions in at least one of these variables (or one of the variables we derive from them) is a necessary condition for reductions in a population's viability, which is itself a necessary condition for reductions in a species' viability. As a result, when listed plants or animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (e.g., 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 is a *necessary* condition for reductions in a population's viability, reducing the fitness of individuals in a population is not always *sufficient* to reduce the viability of the population(s) those individuals represent. Therefore, if we conclude that listed plants or animals are likely to experience reductions in their fitness, we determine whether those fitness reductions are likely to reduce the viability of the populations the individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, variance in these measures, or measures of extinction risk). In this step of our analyses, we use the population's base condition (established in the *Environmental Baseline* and *Status of the Species* sections) as our point of reference. If we conclude that reductions in the fitness of individuals 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) as our point of reference. Our final jeopardy 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.

Destruction or adverse modification[4] determinations must be based on an action‘s effects on the conservation value of habitat that has been designated as critical to threatened or endangered species. If an area encompassed in a critical habitat designation is likely to be exposed to the direct or indirect consequences of the proposed action on the natural environment, we ask if primary or secondary constituent elements included in the designation (if there are any) or physical, chemical, or biotic phenomena that give the designated area value for the conservation of listed species are likely to respond to that exposure. If primary or secondary constituent elements of designated critical habitat (or physical, chemical, or biotic phenomena that give the designated area value for the conservation of listed species) are likely to respond given exposure to the direct or indirect consequences of the proposed action on the natural environment, we ask if those responses are likely to be sufficient to reduce the quantity, quality, or availability of those constituent elements or physical, chemical, or biotic phenomena.

If the quantity, quality, or availability of the primary or secondary constituent elements of the area of designated critical habitat (or physical, chemical, or biotic phenomena) are reduced, we ask if those reductions are likely to be sufficient to reduce the conservation value of the designated critical habitat for listed species in the action area. In this step of our assessment, we combine information about the contribution of constituent elements of critical habitat (or of the physical, chemical, or biotic phenomena that give the designated area value for the conservation of listed species, particularly for older critical habitat designations that have no constituent elements) to the conservation value of those areas of critical habitat that occur in the action area, given the physical, chemical, biotic, and ecological processes that produce and maintain those constituent elements in the action area.

If the conservation value of designated critical habitat in an action area is reduced, the final step of our analyses asks if those reductions are likely to be sufficient to reduce the

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[4] We are aware that several courts have ruled that the definition of destruction or adverse modification that appears in the section 7 regulations at 50 CFR 402.02 is invalid and do not rely on that definition for the determinations we make in this Opinion. Instead, as we explain in the text, we use the "conservation value" of critical habitat for our determinations which focuses on the designated area's ability to contribute to the conservation or the species for which the area was designated.

conservation value of the entire critical habitat designation. In this step of our assessment, we combine information about the constituent elements of critical habitat (or of the physical, chemical, or biotic phenomena that give the designated area value for the conservation of listed species) that are likely to experience changes in quantity, quality, and availability given exposure to an action with information on the physical, chemical, biotic, and ecological processes that produce and maintain those constituent elements in the action area. We use the conservation value of the entire designated critical habitat as our point of reference for this comparison. For example, if the designated critical habitat has limited current value or potential value for the conservation of listed species that limited value is our point of reference for our assessment.

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 State or Tribal natural resource agencies, reports from non-governmental organizations involved in marine conservation issues, the information provided by the Permits and Conservation Division when it initiates formal consultation, and the general scientific literature. We supplement this evidence with reports and other documents – environmental assessments, environmental impact statements, and monitoring reports – prepared by other federal and state agencies whose operations extend into the marine environment.

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 as well as data that does not support that conclusion.

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. Finally, 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)], when data are equivocal, or in the face of substantial uncertainty, our decisions are designed to avoid the risks associated with incorrectly concluding an action has no adverse effect on a listed species when, in fact, such adverse effects are likely (i.e., avoiding Type II error).

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." Research efforts will be focused at the mouths of the Peace, Myakka, and Caloosahatchee rivers in the Charlotte Harbor estuarine system on the southwest coast of Florida although occasional sampling may occur in other areas from Texas to North Carolina if reliable and sufficient reports of smalltooth sawfish encounters warrant sampling in those areas. Thus, the action area for this proposed action is state and federal waters from Texas to North Carolina and extends inland at the Peace, Myakka, and Caloosatachee Rivers in southwest Florida.

STATUS OF THE SPECIES

The ESA Interagency Cooperation Division has determined that the following listed resources provided protection under the ESA or are proposed for listing occur within the action area and therefore may be affected by proposed action:

COMMON NAME	SCIENTIFIC NAME	LISTING STATUS
Cetaceans		
Blue Whale	*Balaenoptera musculus*	Endangered
Fin Whale	*Balaenoptera physalus*	Endangered
Humpback Whale	*Megaptera novaeangliae*	Endangered
Sei Whale	*Balaenoptera borealis*	Endangered
Sperm Whale	*Physeter macrocephalus*	Endangered
North Atlantic Right Whale	*Eubalaena glacialis*	Endangered
Sea Turtles		
Green Sea Turtle	*Chelonia mydas*	
-Florida and Mexico's Pacific Coast Breeding Colonies		Endangered[5]
-All other areas		Threatened
Loggerhead Sea Turtle	*Caretta caretta*	
-Northwest Atlantic Ocean DPS		Threatened
Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	Endangered
Marine and Anadromous Fish		
Atlantic Sturgeon	*Acipenser oxyrinchus oxyrinchus*	
-South Atlantic DPS		Endangered
-Carolina DPS		Endangered
Shortnose Sturgeon	*Acipenser brevirostrum*	Endangered

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[5] Green sea turtles in U.S. waters are listed as threatened except for the Florida and Mexico Pacific coast breeding colonies, which are listed as endangered. Due to difficulties in distinguishing between individuals from the Florida breeding population from other populations, green sea turtles are considered endangered wherever they occur in U.S. waters.

Gulf Sturgeon	*Acipenser oxyrinchus desotoi*	Threatened
Smalltooth Sawfish	*Pristis pectinata*	Endangered
-U.S. DPS		
Largetooth Sawfish	*Pristis perotteti*	Endangered

Marine Invertebrates

Elkhorn Coral	*Acropora palmata*	Threatened
Staghorn Coral	*Acropora cervicornis*	Threatened

Marine Plants

Johnson's Seagrass	*Halophila johnsonii*	Threatened

Critical Habitat

Smalltooth Sawfish Critical Habitat	Designated
Gulf Sturgeon Critical Habitat	Designated
Elkhorn Coral Critical Habitat	Designated
Staghorn Coral Critical Habitat	Designated
Johnson's Seagrass Critical Habitat	Designated
North Atlantic Right Whale Critical Habitat	Designated

<u>Listed Resources Not Likely to be Adversely Affected</u>

Cetaceans (Blue, Fin, Humpback, North Atlantic Right, Sei, and Sperm Whales)
Endangered blue, fin, humpback, North Atlantic right, sei, and sperm whales occur within the action area and could be subject to harassment and/or harm from boat strikes or entanglement in netting gear as a result of the proposed activities. However, these species are typically located further offshore in deeper waters than the areas targeted by the proposed research and would be highly unlikely to be encountered during sampling activities performed by the research applicants. These species are highly unlikely to be exposed to the effects of the proposed action and any potential threats are discountable. Therefore, the proposed action is not likely to adversely affect any listed cetaceans and these species will not be considered further in this Opinion.

North Atlantic Right Whale Critical Habitat
Critical habitat has been designated for the endangered North Atlantic right whale off the states of Georgia and Florida[6] (59 FR 28793). This portion of North Atlantic right whale critical habitat designation contains nursery habitat used by right whales during their annual migration. The physical, chemical, and biotic features that form right whale critical habitat in the southeast U.S. include water depth, water temperatures, and distance from shore for calving and nursery areas (59 FR 28793). NMFS believes that the proposed research activities will not affect oceanographic characteristics, water depth,

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6 Off the southeastern United States, right whale critical habitat is designated in waters between 31° 15' N and 30° 15' N (or approximately from the mouth of the Altamaha River in Georgia to Jacksonville, Florida) from the shoreline to 15 nautical miles offshore; as well as the waters between 30° 15' N and 28° 00' N (or Jacksonville south to Sebastian Inlet, Florida) from the shoreline out to 5 nautical miles.

water temperature, or distance of the critical habitat areas from shore. The majority of the sampling is expected to occur in nearshore areas and researchers do not intend to sample in areas designated as critical habitat for North Atlantic right whales. Therefore, the proposed action will not affect North Atlantic right whale critical habitat and this listed resource will not be considered further in this Opinion.

Atlantic Sturgeon (Carolina and South Atlantic DPSs)
Two endangered DPSs of Atlantic Sturgeon (Carolina and South Atlantic) occur within the action area (i.e., northeastern Florida to North Carolina) and therefore have the possibility of being present during research activities. While prior sampling of the St. Marys and St. Johns River in northeastern Florida failed to locate any reproducing Atlantic sturgeon suggesting the spawning population was extirpated from these river systems (Rogers and Weber, 1995; Kahnle et al., 1998), recent reports documented that 12 sturgeons, believed to be Atlantic sturgeon, were captured at the mouth of the St. Marys river in January 2010 during relocation trawling associated with a dredging project (J. Wilcox, FWC, pers. comm. *as cited in* 75 FR 61904). These were the first captures of Atlantic sturgeon in the St. Marys River in decades.

The majority of the research will occur in nearshore and estuarine areas off southwest Florida which is further south and west of the known range of these two DPSs. However, researchers may occasionally venture north into areas where this species occurs if reliable and sufficient reports of smalltooth sawfish encounters were received to warrant sampling in those areas. Researchers will suspend netting activities if Atlantic sturgeon are seen in the vicinity thereby minimizing the possibility of interacting with the species while sampling. Researchers did not report any sightings of Atlantic sturgeon in their monitoring reports submitted under their prior permit. Since a majority of the research effort is expected to be conducted in areas south and west of the known range of Atlantic sturgeon and since researchers are expected to cease survey activities if a this species is spotted, NMFS believes that Atlantic sturgeon are highly unlikely to be exposed to effects from the proposed action and any potential threats are discountable. For these reasons, NMFS believes this project is not likely to adversely affect the Carolina and South Atlantic DPS of Atlantic sturgeon and these species will not be considered further in this Opinion.

Shortnose Sturgeon
Shortnose sturgeon occur within the action area (i.e., northeastern Florida to South Carolina) and therefore have the possibility of being present during research activities. While shortnose sturgeon historically occupied the St. John’s and St. Mary’s rivers in northeastern Florida, Kahnle et al. (1998) and Rogers and Weber (1994) determined that shortnose sturgeon had been extirpated from those river systems systems. The majority of the research will occur in nearshore and estuarine areas off southwest Florida which is further south than the shortnose sturgeon’s known range. However, researchers may occasionally venture north into areas where this species occurs if reliable and sufficient reports of smalltooth sawfish encounters were received to warrant sampling in those areas. Researchers will suspend netting activities if a shortnose sturgeon is seen in the vicinity thereby minimizing the possibility of interacting with the species while sampling.

Researchers did not report any sightings of shortnose sturgeon in their monitoring reports submitted under their prior permit. Since a majority of the research effort is expected to be conducted in areas south and west of the known range of shortnose sturgeon and since researchers are expected to cease survey activities if a this species is spotted, NMFS believes that shortnose sturgeon are highly unlikely to be exposed to effects from the proposed action and any potential threats are discountable. For these reasons, NMFS believes this project is not likely to adversely affect shortnose sturgeon and this species will not be considered further in this Opinion.

Gulf Sturgeon

Gulf sturgeon occur within the action area (i.e., northern Gulf of Mexico) and therefore may be affected by the proposed research activities. The majority of the research will occur in nearshore and estuarine areas off southwest Florida which is further south than the gulf sturgeon's known range. However, researchers may occasionally venture north into areas where Gulf sturgeon occur if reliable and sufficient reports of smalltooth sawfish encounters were received to warrant sampling in those areas. Gulf sturgeon have the possibility of being incidentally caught as bycatch in nets used to capture targeted smalltooth sawfish (specifically gillnets). Researchers will suspend netting activities if a gulf sturgeon is seen in the vicinity thereby minimizing the possibility of interacting with the species while sampling. Also, the three to four inch mesh size used when targeting sawfish is significantly smaller than what would is typically used to capture Gulf sturgeon (i.e. normally six to twelve inch mesh). Also, researchers have not reported encountering a Gulf sturgeon in their monitoring reports submitted under their prior permit. Since a majority of the research effort is expected to be conducted in areas south of the known range of Gulf sturgeon and since researchers are expected to cease survey activities if a gulf sturgeon is spotted, NMFS believes that Gulf sturgeon are highly unlikely to be exposed to effects from the proposed action and any potential threats are discountable. For these reasons, NMFS believes this project is not likely to adversely affect gulf sturgeon and this species will not be considered further in this Opinion.

Gulf Sturgeon Critical Habitat

Critical habitat designated for Gulf sturgeon also occurs within the action area, specifically in Pensacola Bay, Santa Rosa Sound, Florida nearshore Gulf of Mexico, Choctawhatchee Bay, Apalachicola Bay, and Suwannee Sound (i.e., designated units 9 to 14). The primary constituent elements include: abundant prey items within riverine habitats for larval and juvenile life stages and within estuarine and marine habitats for juvenile, subadult, and adult life stages; riverine spawning sites with substrates suitable for egg deposition and development; riverine aggregation areas believed necessary for minimizing energy expenditures during fresh water residency and possibly for osmoregulatory functions; a flow regime necessary for normal behavior, growth, and survival of all life stages in the riverine environment and necessary for maintaining spawning sites in suitable condition for egg attachment, eggs sheltering, resting, and larvae staging; water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; and safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats.

The majority of the research will occur in nearshore and estuarine areas off southwest Florida which is further south than the gulf sturgeon's known range. Although researchers may occasionally venture north into areas designated as critical habitat for Gulf sturgeon if reliable and sufficient reports of smalltooth sawfish encounters warrant sampling in those areas, research activities are not expected to affect prey items, riverine spawning sites, flow regimes, water quality, sediment quality, or migratory pathways. Permit conditions require researchers to remove anchors and gear in a manner that avoids dragging them across the bottom to avoid disturbing sediments. The research team has experience performing similar types of surveys and would be expected to take all proper precautions to avoid any physical disturbance or minimizing the impact of an accidental fuel spill. NMFS believes that Gulf sturgeon critical habitat is highly unlikely to be exposed to effects from the proposed action and any potential threats are discountable. Therefore, the proposed action is not likely to adversely affect Gulf sturgeon critical habitat and this listed resource will not be considered further in this Opinion.

Largetooth Sawfish

Largetooth sawfish historically occupied waters within the action area for the proposed action and therefore have the possibility of being present during research activities. Largetooth sawfish were historically reported along the Texas coast and east into Florida waters. However, the most recent status review for largetooth sawfish reported the last sighting within Florida waters occurred in the year 1941 (NMFS, 2010a). Researchers did not report any sightings of largetooth sawfish in monitoring reports submitted since under their prior permit permit. While the possibility exists that transient fish may enter Florida's waters, NMFS believes it is highly unlikely that these species would be exposed to effects from the proposed action. Therefore, the proposed action is not likely to adversely affect largetooth sawfish and this species will not be considered further in this Opinion.

Smalltooth Sawfish Critical Habitat

Critical habitat designated for smalltooth sawfish exists in the action area and could be affected by the research activities during sampling activities. The two units of critical habitat designated for the smalltooth sawfish are the Charlotte Harbor Estuary Unit, which comprises approximately 221,459 acres of habitat, and the Ten Thousand Islands/Everglades Unit, which comprises approximately 619,013 acres of habitat. The two units are located along the southwestern coast of Florida between Charlotte Harbor and Florida Bay. These specific areas contain the following physical and biological features that are essential to the conservation of this species: red mangroves and shallow euryhaline habitats characterized by water depths between the Mean High Water Line and three feet (0.9 meters) measured at Mean Lower Low Water. These essential features are necessary to facilitate recruitment of juveniles into the adult population, because they provide for predator avoidance and habitat for prey in the areas currently being used as juvenile nursery areas. While research activities will occur in designated critical habitat for smalltooth sawfish, permit conditions require the researchers to avoid impacting bottom habitat including those occurring in nearshore waters. Research activities are not expected to impact red mangroves or shallow euryhaline habitats essential for juvenile smalltooth sawfish. The research team has experience performing similar types of surveys in these areas and would be expected to take all proper precautions to avoid any physical disturbance of bottom habitat and/or minimizing the impact of an accidental fuel spill. NMFS does not expect any measurable effect to occur to constituent elements of the critical habitat and any potential threats are discountable. Therefore, the proposed action is not likely to adversely affect designated critical habitat for the smalltooth sawfish and this listed resource will not be considered further in this Opinion.

Elkhorn and Staghorn Coral and their Joint Critical Habitat

Two listed invertebrate species (elkhorn and staghorn coral) and their joint critical habitat occur within the action area and could therefore be subjected to physical disturbance from vessels or nets used for smalltooth sawfish capture or from unexpected contaminant or fuel spill. Permit conditions will require the researchers to avoid impacting sediment or habitat for coral or other live bottom communities. Specific permit conditions include avoiding setting gear over such areas as well as taking steps to recover lost gear, avoiding anchoring in areas where these communities exist, and avoiding treading or trampling on these areas where in-water work does occur.

The research team has experience performing similar types of surveys in these areas and is expected to avoid live bottom areas containing listed corals or areas containing the essential features of elkhorn/staghorn coral critical habitat (i.e., natural consolidated hard substrate or dead coral skeleton that is free from fleshy or turf macroalgae cover and sediment cover). Researchers are also expected to take all proper precautions to avoid any physical disturbance or minimizing the impact of an accidental fuel spill. Also, no unexpected disturbance of these resources has been reported in monitoring reports submitted under the researcher's prior permit. NMFS believes that listed elkhorn and staghorn corals as well as their critical habitat are highly unlikely to be exposed to effects from the proposed action and any potential threats are discountable. Therefore, the proposed action is not likely to adversely affect elkhorn coral, staghorn coral, or their critical habitat and these listed resources will not be considered further in this Opinion.

Johnson's Seagrass and Johnson's Seagrass Critical Habitat

Johnson's seagrass and its critical habitat occur within the action area and could therefore be subjected to physical disturbance from vessels or nets used for smalltooth sawfish capture or from unexpected contaminant or fuel spill pollution similar to effects discussed for listed corals. However, permit conditions do not allow research activities to be conducted over, on, or immediately adjacent to Johnson's seagrass or within its critical habitat. Other specific permit conditions require researchers to avoid setting gear over areas containing any submerged aquatic vegetation and to remove anchors and gear in a manner that avoids dragging them across the sediment bottom. The research team has experience performing similar types of surveys and would be expected to take all proper precautions to avoid any physical disturbance or minimizing the impact of an accidental fuel spill. Also, no unexpected take has been reported in monitoring reports submitted since under the researcher's prior permit. NMFS believes that Johnson's seagrass and its critical habitat are highly unlikely to be exposed to effects from the proposed action and any potential threats are discountable. Therefore, the proposed action is not likely to adversely affect Johnson’s seagrass or its critical habitat and these listed resources will not be considered further in this Opinion.

Listed Resources Likely to be Adversely Affected

The sections below provide information on the status of listed resources likely to be adversely affected by the proposed action. The biology and ecology of these species as well as their global status and trends are described below, and inform the effects analysis for this Opinion.

Smalltooth Sawfish (U.S. DPS)

Species Description, Distribution, and Population Structure

The smalltooth sawfish is a tropical marine and estuarine elasmobranch fish species characterized by an extended snout with a long, narrow, flattened, rostral blade with a series of transverse teeth along either edge. The rostrum has a saw-like appearance, hence the name sawfish. Although they are rays, sawfish appear in some respects to be more shark-like than ray-like, with only the trunk and the head ventrally flattened. The smalltooth sawfish is distinguished from a similar listed species, the largetooth sawfish, by lacking a defined lower caudal lobe, by having the first dorsal fin origin located over the origin of the pelvic fins (versus considerably in front of the origin of pelvics in the largetooth sawfish) and by having 20-34 rostral teeth on each side of the rostrum (versus 14-23 teeth in largetooth sawfish) (Bigelow and Schroeder, 1953; Thorson, 1973; McEachran and Fechhelm, 1998; Compagno and Last, 1999). The rostrum of the smalltooth sawfish is also about a quarter of the total length of an adult specimen, somewhat longer than the rostrum of largetooth sawfish, which is about a fifth of its total length (Bigelow and Schroeder, 1953).

The smalltooth sawfish is reported to have a circumtropical distribution. In the western Atlantic, it has been reported from Brazil through the Caribbean and Central America, the Gulf of Mexico, and the Atlantic coast of the United States (Bigelow and Schroeder, 1953). Reports of fish resembling smalltooth sawfish have been reported from the eastern Atlantic in Europe and West Africa; the Mediterranean; South Africa; and the Indo-West Pacific, including the Red Sea, India, Burma, and the Philippines (Bigelow and Schroeder, 1953; Van der Elst, 1981; Compagno and Cook, 1995). However, whether populations outside the Atlantic are true smalltooth sawfish or closely related species is unknown (Bigelow and Schroeder, 1953; Adams and Wilson, 1995; Compagno and Cook, 1995). Sawfish in general inhabit shallow waters very close to shore in muddy and sandy bottoms, seldom descending to depths greater than 32 feet (10 meters). They are often found in sheltered bays, on shallow banks, and in estuaries or river mouths (NMFS, 2010b; Poulakis et al., 2010). Smalltooth sawfish are euryhaline, occurring in waters with a broad range of salinities from freshwater to full seawater (Simpfendorfer, 2001) and many encounters are reported at the mouths of rivers or other sources of freshwater inflows (Simpfendorfer and Wiley, 2004). Whether this observation represents a preference for river mouths because of physical characteristics (e.g., salinity) or habitat (e.g., mangroves or prey) factors or both is unclear (75 FR 61904).

Historic capture records of smalltooth sawfish within the U.S. range from Texas to New York, although peninsular Florida has historically been the U.S. region with the largest number of recorded captures and likely represents the core of the historic range (NMFS, 2000). Recent records indicate there is a resident reproducing population of smalltooth sawfish in south and southwest Florida from Charlotte Harbor through the Dry Tortugas which also serves as the last U.S. stronghold for the species (Seitz and Poulakis, 2002; Poulakis and Seitz, 2004; Simpfendorfer and Wiley, 2005). While sightings north of Florida are rare, the species is occasionally encountered further north during spring and summer periods (May-August) when inshore waters reach higher temperatures. Most specimens captured along the Atlantic coast north of Florida are large adults (over three meters) and likely represent seasonal migrants, wanderers, or colonizers from an historic Florida core population(s) to the south rather than representing members of a continuous, even-density population (Bigelow and Schroeder, 1953).

The coastal habitat of sawfish suggests that their biology may favor the isolation of populations that may be unable to traverse large expanses of deep water or otherwise unsuitable habitat (Faria, 2007). Faria (2007) investigated patterns of geographical structuring of the five most widespread sawfish species based on mitochondrial DNA sequences and rostral tooth counts. Two haplotypes were observed for 59 West Atlantic specimens, while the only haplotype observed for two East Atlantic specimens was common to the West Atlantic. Therefore, no geographical structure of sawfish populations was revealed in the study and West and East Atlantic populations of sawfish may represent separate units for conservation purposes.

Life History Information

Smalltooth sawfish are approximately 80 centimeters (31 inches) at birth (Simpfendorfer, 2002) and may grow to a length of 540 centimeters (18 feet) or greater during their lifetime (Bigelow and Schroeder, 1953). A more recent study conducted by Simpfendorfer et al. (2008) suggests rapid juvenile growth for smalltooth sawfish for the first two years after birth with stretched total length increasing by an average of 650–850 millimeters in the first year and an average of 480–680 millimeters in the second year. Using a demographic approach and life history data for smalltooth sawfish and similar species from the literature, Simpfendorfer (2000) estimated intrinsic rates of growth at 0.08-0.13 per year and estimated population doubling times at 5.4 years-8.5 years. These low intrinsic rates of growth suggests that the species is particularly vulnerable to excessive mortality and rapid declines due to stochastic events. Overall, much uncertainty still remains in estimating life history parameters for smalltooth sawfish since very little information exists on size classes other than juveniles.

Simpfendorfer (2000) estimated that smalltooth sawfish reach sexual maturity at 10-20 years of age, while Clark et al. (2004) estimated that males reach maturity at younger ages (around 19 years old) compared to females (around 33 years old). Fertilization is internal as with all elasmobranch species and development is believed to be ovoviviparous. Bigelow and Schroeder (1953) reported gravid females carry 15–20 embryos, although the source of their data is unclear and may represent an over-estimate of the true litter size. Studies of largetooth sawfish in Lake Nicaragua (Thorson, 1976) report brood sizes of 1–13 individuals, with a mean of 7.3 individuals. The gestation period for largetooth sawfish is approximately five months and females likely produce litters every second year. Although there are no studies on smalltooth sawfish reproductive traits, its similarity to the largetooth sawfish implies that their reproductive biology may be similar, but reproductive periodicity has yet to be verified for either sawfish species.

Acoustic tracking results for very small juveniles (100-200 centimeters long) indicate that they spend the vast majority of their time in very shallow water (less than one foot deep) associated with shallow mud or sand banks and within red mangrove root systems. It is hypothesized that by staying in these very shallow areas they are inaccessible to their predators (mostly sharks) and as a result increase their overall chances of survival (Simpfendorfer, 2003). Recent data suggests that sawfish less than a year old typically spend a majority of their time in backwater habitats and move upstream with increasing salinity while larger individuals are found within coastal waters and red mangrove habitats with overhanging vegetation (Poulakis et al., 2010). Acoustic monitoring studies have shown that juveniles have high levels of site fidelity for specific nursery areas for periods lasting up to almost three months (Wiley and Simpfendorfer, 2007).

Encounter data indicate there is a tendency for smalltooth sawfish to move offshore and into deeper water as they grow. An examination of the relationship between the depth at which sawfish occur and their estimated size indicates that large animals roam over a much larger depth range than juveniles with larger sawfish regularly occurring at depths greater than ten meters (Simpfendorfer, 2001; Poulakis and Seitz, 2004; Simpfendorfer and Wiley, 2004). Limited data are available on the site fidelity of adult sawfish although Seitz and Poulakis (2002) suggested that they may have some level of site fidelity for relatively short periods of time. Historic records of smalltooth sawfish indicate that some large mature individuals migrated north along the U.S. Atlantic coast as temperatures warmed in the summer and then south as temperatures cooled (Bigelow and Schroeder, 1953). However, given the very limited number of encounter reports from the east coast of Florida, Simpfendorfer and Wiley (2004) hypothesize the population previously undertaking the summer migration has declined to a point where the migration is currently undetectable or doesn’t occur at all.

Smalltooth sawfish feed primarily on small fish with mullet, jacks, and ladyfish believed to be their primary food resources (Simpfendorfer, 2001). By moving its saw rapidly from side to side through the water, the relatively slow-moving sawfish is able to strike at individual fish (Breder, 1952). The teeth on the saw stun, impale, injure, or kill the fish. Smalltooth sawfish then rub their saw against bottom substrate to remove the fish before ingesting it. In addition to fish, smalltooth sawfish are also known to prey on crustaceans (mostly shrimp and crabs) found along the sea bottom (Norman and Fraser, 1937; Bigelow and Schroeder, 1953).

Listing Status

The smalltooth sawfish U.S. DPS was listed as endangered under the ESA on April 1, 2003 (68 FR 15674). The species is also protected under the Convention on International Trade of Threatened and Endangered Species of Wild Fauna and Flora (CITES) and is classified as critically endangered on the International Union for Conservation of Nature's (IUCN) Red List of Threatened Species.

Critical habitat was designated for the smalltooth sawfish in September 2009 and is composed of two units in south and southwestern Florida: the Charlotte Harbor Estuary Unit, which comprises approximately 221,459 acres of habitat; and the Ten Thousand Islands/Everglades Unit, which comprises approximately 619,013 acres of habitat. These areas contain the following physical and biological features that are essential to the conservation of this species: red mangroves and shallow euryhaline habitats characterized by water depths between the Mean High Water Line and three feet (0.9 meters) measured at Mean Lower Low Water.

Abundance and Trends

Few long-term abundance data sets exist for the smalltooth sawfish, making it very difficult to estimate the current population size. However, Simpfendorfer (2001) estimated that the U.S. population size may number less than five percent of historic levels based on anecdotal data and the fact that the species range has contracted by nearly 90 percent, with south and southwest Florida the only areas known to currently support a reproducing population. Seitz and Poulakis (2002) and Poulakis and Seitz (2004) documented smalltooth sawfish occurrences during the period 1990-2002 along the southwest coast of Florida, and in Florida Bay and the Florida Keys, respectively. The studies reported a total of a total of 2,969 sawfish encounters during this period. In 2000, Mote Marine Laboratory also established a smalltooth sawfish public encounter database (now currently maintained by the Florida Museum of Natural History at the University of Florida) to compile information on the distribution and abundance of sawfish. A total of 3,205 sawfish encounters were reported from 1998-2011 (Florida Museum of Natural History, unpublished data[7]). Although encounter databases may provide a useful future means of measuring changes in the population and its distribution over time, accurate estimates concerning smalltooth sawfish abundance cannot be made at the current time because efforts are not expanded evenly across each study period.

Despite the lack of data on abundance, recent encounters with neonates (young-of-the-year), juveniles, and sexually mature sawfish indicate that the Florida population is currently reproducing (Seitz and Poulakis, 2002; Simpfendorfer, 2003). The abundance of juveniles encountered, including very small individuals, suggests that the population remains viable (Simpfendorfer and Wiley, 2004), and data analyzed from Everglades National Park as part of an established fisheries monitoring program indicate a slightly increasing trend in abundance within the park over the past decade (Carlson et al., 2007). While this data suggests that the species may be showing some signs of recovery in the region, encounters are still rare along much of their historical range beyond south and southwest Florida (Snelson and Williams, 1981; Simpfendorfer and Wiley, 2004).

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[7] Data is available at http://www.flmnh.ufl.edu/fish/sharks/sawfish/mapthree.html.

Current Threats

The primary reason for the decline in smalltooth sawfish abundance has been bycatch in various commercial and recreational fisheries, including gillnets, otter trawls, trammel nets, seines, and hook-and-line (NMFS, 2009a). While there never has been a large-scale directed fishery, smalltooth sawfish can easily become easily entangled in netting gear directed at other commercial species, often resulting in serious injury or death. Snelson and Williams (1981) attributed the extirpation of smalltooth sawfish from the Indian River Lagoon (IRL) off the east coast of Florida to heavy mortality associated with incidental captures by commercial fishermen. For instance, one fisherman interviewed by Evermann and Bean (1898) reported taking an estimated 300 smalltooth sawfish in just one netting season. Simpfendorfer (2002) extracted a data set from 1945–1978 of smalltooth sawfish landings by Louisiana shrimp trawlers containing both landings data and crude information on effort (number of vessels, vessel tonnage, number of gear units). The data from Lousiana show that smalltooth sawfish landings declined during that period from a high of 34,900 pounds in 1949 to less than 1,500 pounds in most years after 1967. In more recent years, the highest interaction with the species is reported for the Highly Migratory Species (HMS) Atlantic Shark, Gulf of Mexico Reef Fish, and the Gulf of Mexico and South Atlantic shrimp trawl fisheries. According to the biological opinions for these four fisheries, no more than seven lethal takes of smalltooth sawfish are exempted over a three year period for all these fisheries combined (see NMFS, 2005; NMFS, 2006a, NMFS, 2008a; NMFS, 2011a).

In addition to commercial fisheries, sawfish are also occasionally caught with recreational gear although the current threat associated with recreational fisheries is expected to be low given that possession of the species in Florida has been prohibited since 1992. Nevertheless, researchers under their previous permit reported around nine percent of the sawfish captured displayed evidence of previous hook and line capture (e.g., sawfish had a hook and leader present) (Poulakis et al., 2010) a portion of which may have been caught with recreational hook and line gear.

Another major factor in the historical decline of smalltooth sawfish is due to habitat modification, especially nursery habitat for juveniles. Activities such as agricultural and urban development, commercial activities, dredge and fill operations, boating, erosion, and diversions of freshwater runoff contribute to these losses (South Atlantic Fisheries Management Council [SAFMC], 1998). From 1943-1970, approximately 10,000 hectares of coastal wetlands were lost due to dredge fill and other activities including substantial losses of mangroves at specific locations throughout Florida (Odum et al., 1982). While modification of mangrove habitat is currently regulated, some permitted direct and/or indirect damage to mangrove habitat from increased urbanization still occurs and is expected to continue to threaten survival and recovery of the species in the future. For instance, many of the areas known to have been used historically by juveniles have already been drastically modified making it very difficult for the species to expand its current range (NMFS, 2009a).

Smalltooth sawfish may be especially vulnerable to coastal habitat degradation due to their affinity for shallow estuarine systems. In addition to mangroves, other riverine, nearshore, and offshore areas have been dredged for navigation, construction of infrastructure, and marine mining. An analysis of 18 major southeastern estuaries (Orlando et al., 1994) recorded over 703 miles of navigation channels and 9,844 miles of shoreline modifications. Habitat effects of dredging include the loss of submerged habitats by disposal of excavated materials, turbidity and siltation effects, contaminant release, alteration of hydrodynamic regimes, and fragmentation of physical habitats (SAFMC, 1998). Modifications of natural freshwater flows into estuarine and marine waters through construction of canals and other controlled devices have changed temperature, salinity, and nutrient regimes; reduced both wetlands and submerged aquatic vegetation; and degraded vast areas of coastal habitat utilized by smalltooth sawfish (Reddering, 1988; Whitfield and Bruton, 1989; Gilmore, 1995). Evidence from other elasmobranchs suggests that pollution disrupts endocrine systems and potentially leads to reproductive failure (Gelsleichter et al., 2006). Sawfish may also alter seasonal migration patterns in response to warm water discharges from power stations (Simpfendorfer and Wiley, 2005). Cumulatively, these effects have degraded habitat areas used by juvenile and adult smalltooth sawfish and continue to slow down recovery efforts.

Smalltooth sawfish is also limited by its life history characteristics as a slow growing, late maturing, and long-lived species making it particularly vulnerable to stochastic changes in its environment (NMFS, 2000). These combined characteristics result in a very low intrinsic rate of population increase (Musick, 1999) that also makes it slow to recover from any significant population decline (Simpfendorfer, 2000).

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 with a mean straight carapace length of 45 millimeters (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 aggregations 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.

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 (over 29^{o}C) generally produce more female hatchlings while incubation temperatures near the lower end of the tolerable range (under 29^{o}C) generally produce more male hatchlings (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 straight carapace length, 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 south to 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. On September 22, 2011, NMFS published a final rule to list nine separate DPSs under the ESA with 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., Mediterranean 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. The species is also protected by CITES and is classified as endangered on the IUCN’s Red List of Threatened Species. 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 1990s; 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 (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[8] 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, in turn, would indicate possible recruitment failure. However, the authors also stated these trends should be viewed with caution given the limited number and size of studies dedicated to assessing in-water abundance of loggerheads as well as the lack of longer term studies that could more adequately determine what impact, if any, these trends have on recruitment and/or survival rates for the population.

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

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[8] 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 South Carolina Marine Resources Research Institute (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.

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).

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 frequently 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.

While sea turtle bycatch varies depending on the fishery, the Southeast shrimp trawl fishery affects more sea turtles than all other activities combined [National Research Council (NRC), 1990]. Although participants in these fisheries are required to use Turtle Exclusion Devices (TEDs) that reduce the number of sea turtle captures by an estimated 97 percent, these fisheries are still expected to capture about 185,000 sea turtles each year, of which 5,000 end up dead (NMFS, 2002). Loggerhead and Kemp’s ridley sea turtles account for the majority of the annual take with 163,160 loggerheads (3,948 mortalities) and 155,503 Kemp's ridleys (4,208 mortalities) captured on an annual basis followed by 18,757 greens (514 mortalities) 3,090 leatherbacks (80 mortalities) and 640 hawksbills (all mortalities) (NMFS, 2002). In recent years, low shrimp prices, rising fuel costs, competition with imported products, and impacts from hurricanes in the Gulf of Mexico have all impacted shrimp fleets. As a result, interactions and mortalities in the Gulf of Mexico, notably for loggerheads and leatherbacks, have been substantially less than projected in the 2002 Opinion, with 61,299 loggerheads (1,451 mortalities) and 1001 leatherbacks (26 mortalities) reported taken during the 2009 fishing season (NMFS, 2011b). While the numbers reported by NMFS’ Southeast Fisheries Science Center (NMFS-SEFSC) appear to show decreased levels of interaction with sea turtles (notably loggerheads and leatherbacks), there is concern that many sea turtles that die from entanglement in commercial fishing gear tend to sink rather than strand ashore thus making it difficult to accurately determine the extent of such mortalities.

In the Caribbean region, sea turtles are impacted by the Atlantic pelagic longline, Carribbean reef fish, and spiny lobster fisheries in addition to various state and artisanal fisheries. The estimated number of loggerhead sea turtles caught by pelagic longline fisheries during the period 1992-2002 for all geographic areas was 10,034 individuals of which 81 were estimated to be dead when brought to the vessel (NMFS, 2004). Actual mortalities associated with pelagic longline were likely substantially higher given the fact that these numbers did not include post-release mortalities as a result of hooking injuries. The 3-year anticipated takes for the Caribbean reef fish fishery were 75 green (all lethal), 51 hawksbills (48 lethal), and 18 leatherbacks (all lethal) while the 3-year anticipated takes for the spiny lobster fishery were 3 loggerhead (lethal or non-lethal), 3 green (lethal or non-lethal), 1 hawksbill (lethal or non-lethal), and 1 leatherback (lethal or non-lethal) (NMFS, 2009b; NMFS, 2011c), respectively. Following a jeopardy biological opinion for the Atlantic pelagic longline fisheries issued by NMFS in 2004, NMFS published a final rule to implement management measures to reduce the impact of pelagic longlining on Atlantic sea turtles which included mandatory circle hook and bait requirements, and mandatory possession and use of sea turtle release equipment. While these measures are expected to reduce the population level impact of pelagic longlining on sea turtle populations in the Atlantic, pelagic longlining will continue to impact the ability of listed sea turtles to survive and recover given the large numbers of sea turtles caught each year.

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, 1997). 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). 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. 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).

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. At the time of this consultation, NMFS has reported that 481 Kemp's ridley, 67 loggerheads, 29 green, and 32 unspecified sea turtles have been found dead in the vicinity of the *Deepwater Horizon* spill event that occurred in the northcentral Gulf of Mexico from April-October, 2010, although the cause of death is not immediately certain for all caracasses recovered (NMFS, unpublished data[9]).

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9 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.

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). 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.

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.

Hawksbill Sea Turtle

Species Description, Distribution, and Population Structure

Hawksbill sea turtles are small to medium-sized (45 to 68 kilograms on average) although nesting females are known to weigh up to 80 kilograms in the Caribbean (Pritchard et al., 1983). The carapace is usually serrated and has a "tortoise-shell" coloring, ranging from dark to golden brown, with streaks of orange, red, and/or black. The plastron of a hawksbill turtle is typically yellow. The head is elongated and tapers to a point, with a beak-like mouth that gives the species its name. The shape of the mouth allows the hawksbill turtle to reach into holes and crevices of coral reefs to find sponges, their primary food source as adults, and other invertebrates. The shells of hatchlings are 42 millimeters long and are mostly brown and somewhat heart-shaped (Hillis and Mackay, 1989; van Dam and Sarti, 1989; Eckert, 1995).

Hawksbill turtles have a circumtropical distribution and usually occur between latitudes 30° N and 30° S in the Atlantic, Pacific, and Indian Oceans. In the western Atlantic, Hawksbills are widely distributed throughout the Caribbean Sea, off the coasts of Florida and Texas in the continental U.S., in the Greater and Lesser Antilles, and along the mainland of Central America south to Brazil (Lund, 1985; Plotkin and Amos, 1988; Amos, 1989; Groombridge and Luxmoore, 1989; Plotkin and Amos, 1990; NMFS and USFWS, 1998; Meylan and Donnelly, 1999). They are highly migratory and use a wide range of habitats during their lifetimes (Musick and Limpus, 1997; Plotkin, 2003). Adult hawksbill turtles are capable of migrating long distances between nesting beaches and foraging areas. For instance, a female hawksbill sea turtle tagged in Buck Island Reef

National Monument off St. Croix in the U.S. Virgina Islands (USVI) was later identified 1,160 miles (1,866 kilometers) away in the Miskito Cays in Nicaragua (Spotila, 2004).

Hawksbill sea turtles nest on insular and sandy beaches throughout the tropics and subtropics. Nesting occurs in at least 70 countries, although much of it now only occurs at low densities compared to other sea turtle species (NMFS and USFWS, 2007a). It is believed that the widely dispersed nesting areas as well as the often low densities seen on nesting beaches is likely a result of overexploitation of previously large colonies that have since been depleted over time (Meylan and Donnelly, 1999). The most significant nesting within the U.S. occurs in Puerto Rico and the USVI, specifically on Mona Island and Buck Island, respectively. Although nesting within the continental U.S. is typically rare, it can also occur along the southeast coast of Florida and the Florida Keys. In addition to nesting beaches in the U.S. Caribbean, the largest hawksbill nesting population in the Western Atlantic occurs in the Yucatán Península of Mexico, where several thousand nests are recorded annually in the states of Campeche, Yucatán, and Quintana Roo (Spotila, 2004; Garduño-Andrade et al., 1999). In the U.S. Pacific, hawksbills nest on main island beaches in Hawaii, primarily along the east coast of the island. Hawksbill nesting has also been documented in American Samoa and Guam. More information on nesting in other ocean basins may be found in the five year status review for the species (NMFS and USFWS, 2007a).

Mitochondrial DNA studies show that reproductive populations are effectively isolated over ecological time scales (Bass et al., 1996). Substantial efforts have been made to determine the nesting population origins of hawksbill sea turtles assembled in foraging grounds, and genetic research has shown that hawksbills of multiple nesting origins commonly mix in foraging areas (Bowen et al., 1996). The fact that hawksbills exhibit site fidelity to their natal beaches suggests that if subpopulations become extirpated they may not be replenished by recruitment from other nesting rookeries (Bass et al., 1996).

Life History Information

Hawksbill sea turtles exhibit slow growth rates although they are know to vary within and among populations from a low of 1-3 centimeters per year measured in the Indo-Pacific (Chaloupka and Limpus, 1997; Whiting, 2000; Mortimer et al., 2002; Mortimer et al., 2003) to a high of five centimers or more per year measured at some sites in the Caribbean (Leon and Diez, 1999; Diez and van Dam, 2002). Differences in growth rates are likely due to differences in diet and/or density of turtles at foraging sites and overall time spent foraging (Bjorndal et al, 2000; Chaloupka et al., 2004). Consistent with slow growth, age to maturity for the species is also long, taking between 20 and 40 years depending on the region (Chaloupka and Musick, 1997; Limpus and Miller, 2000). Hawksbills in the western Atlantic are known to mature faster (i.e., 20 more years) than turtles found in the Indo-Pacific (i.e. 30-40 years) based on studies performed in these areas (Boulon, 1983; Boulan, 1994; Limpus and Miller, 2000; Diez and van Dam, 2002). Males are typically mature when their length reaches 69 centimeters while females are typically mature at 75 centimeters (Limpus, 1992; Eckert, 1992). Female hawksbills return to their natal beaches every 2-3 years to nest (Witzell, 1983; van Dam et al., 1991) and generally lay 3-5 nests per season (Richardson et al., 1999). Compared with other sea turtles, clutch size for hawksbills can be quite high (e.g., up to 250 eggs per clutch) (Hirth, 1980).

Hawksbills may undertake developmental migrations (migrations as immatures) and reproductive migrations that involve travel over hundreds or thousands of kilometers (Meylan, 1999a). Post-hatchlings (oceanic stage juveniles) are believed to occupy the "pelagic" environment, taking shelter in floating algal mats and drift lines of flotsam and jetsam in the Atlantic and Pacific oceans (Musick and Limpus, 1997) before recruiting to more neritic, coastal foraging grounds. In the Caribbean, hawksbills are known to exclusively feed on sponges (Meylan, 1988; van Dam and Diez, 1997) although at times they have been seen foraging on other food items, notably corallimorphs and zooanthids (van Dam and Diez, 1997; Mayor et al., 1998; León and Diez, 2000).

Reproductive females undertake periodic (usually non-annual) migrations to their natal beach to nest and exhibit a high degree of fidelity to their nest sites. Movements of reproductive males are less certain, but are presumed to involve migrations to the nesting beach or to courtship stations along the migratory corridor. Hawksbills show a high fidelity to their foraging areas as well (van Dam and Diez, 1998). Foraging sites are typically areas associated with coral reefs although hawksbills are also found around rocky outcrops and high energy shoals which are optimum sites for sponge growth. They can also inhabit seagrass pastures in mangrove-fringed bays and estuaries, particularly along the eastern shore of continents where coral reefs are absent (Bjorndal, 1997; van Dam and Diez, 1998).

Listing Status

The hawksbill sea turtle was listed as endangered under the ESA on June 2, 1970 (35 FR 8491). The species is also protected by CITES and is classified as critically endangered on the IUCN's Red List of Threatened Species. Critical habitat was designated On June 2, 1998 in coastal waters surrounding Mona and Monito Islands in Puerto Rico (63 FR 46693) although no critical habitat exists within the action area for this consultation.

Abundance and Trends

There are currently no reliable estimates of population abundance and trends for non-nesting hawksbills at the time of this consultation; therefore, nesting beach data is currently the primary information source for evaluating trends in global abundance. Most hawksbill populations around the globe are either declining, depleted, and/or remnants of larger aggregations (NMFS and USFWS, 2007a). The largest nesting population of hawksbills appears to occur in Australia where approximately 2,000 hawksbills nest off the northwest coast and about 6,000 to 8,000 nest off the Great Barrier Reef each year (Spotila, 2004). Additionally, about 2,000 hawksbills nest each year in Indonesia and 1,000 nest in the Republic of Seychelles (Spotila, 2004). In the U.S., about 500-1,000 hawksbill nests are laid on Mona Island, Puerto Rico (Diez and van Dam, 2007) and another 56-150 nests are laid on Buck Island off St. Croix, USVI (Meylan, 1999b; Mortimer and Donnelly, 2008). Nesting also occurs to a lesser extent on other additional beaches on St. Croix, St. John, St. Thomas, Culebra Island, Vieques Island, and mainland Puerto Rico.

Mortimer and Donnelly (2008) reviewed nesting data for 83 nesting concentrations organized among 10 different ocean regions (i.e. Insular Caribbean, Western Caribbean Mainland, Southwestern Atlantic Ocean, Eastern Atlantic Ocean, Southwestern Indian Ocean, Northwestern Indian Ocean, Central Indian Ocean, Eastern Indian Ocean, Western Pacific Ocean, Central Pacific Ocean, and Eastern Pacific Ocean). Historic trends (i.e., 20-100 year time period) were determined for 58 of the 83 sites while recent abundance trends (i.e., within the past 20 years) were also determined for 42 of the 83 sites. Among the 58 sites where historic trends could be determined, all showed a declining trend during the long term period although among the 42 sites where recent trend data was available, 10 appeared to be increasing, 3 appeared to be stable, and 29 appeared to be decreasing. With respect to regional trends, nesting populations in the Atlantic (especially in the Insular Caribbean and Western Caribbean Mainland) are generally doing better than those in the Indo-Pacific regions. For instance, 9 of the 10 sites showing recent increases were all located in the Caribbean. Nesting concentrations in the Pacific Ocean appear to be performing the worst of all regions despite the fact that the region currently supports more nesting hawksbills than in either the Atlantic or Indian Oceans (Mortimer and Donnelly, 2008). More information about site specific trends for can be found in the most recent five year status review for the species (see NMFS and USFWS, 2007a).

Current Threats

The historical decline of the species is primarily attributed to centuries of exploitation for the beautifully patterned shell which made it a highly attractive species to target (Parsons, 1972). The fact that reproductive females exhibit a high fidelity for nest sites and the tendency of hawksbills to nest at regular intervals within a season made them an easy target for capture on nesting beaches. The tortoiseshell from hundreds of thousands of turtles in the western Caribbean region was imported into the United Kingdom and France during the 19th and early 20th centuries (Parsons, 1972) and additional hundreds of thousands of turtles contributed to the region’s trade with Japan prior to 1993 when a zero quota was imposed (Milliken and Tokunaga, 1987 *as cited in* Bräutigam and Eckert, 2006).

The continuing demand for the hawksbill's shell as well as other products (leather, oil, perfume, and cosmetics) represents an ongoing threat to recovery of the species. The British Virgin Islands, Cayman Islands, Cuba, Haiti, and the Turks and Caicos Islands (U.K.) all permit some form of legal take of hawksbill turtles. In the northern Caribbean, hawksbills continue to be harvested for their shells, which are often carved into hair clips, combs, jewelry, and other trinkets (Marquez, 1990; Stapleton and Stapleton, 2006). Additionally, hawksbills are harvested for their eggs and meat while whole stuffed turtles are sold as curios in the tourist trade. Also, hawksbill sea turtle products are openly available in the Dominican Republic and Jamaica despite a prohibition on harvesting hawksbills and their eggs (Fleming, 2001). In Cuba, 500 turtles are legally captured each year and while current nesting trends are unknown, the number of nesting females is suspected to be declining in some areas (Carrillo et al., 1999; Moncada et al., 1999). While the international trade in the shell of this species is prohibited by CITES, illegal trade is still occurring and remains an ongoing threat to hawksbill survival and recovery throughout its range.

Due to their preference to feed on sponges associated with coral reefs, hawksbill sea turtles are particularly sensitive to losses of coral reef communities. Coral reefs are vulnerable to destruction and degradation caused by human activities (e.g. nutrient pollution, sedimentation, contaminant spills, vessel groundings and anchoring, recreational uses, etc.) and are also highly sensitive to the effects of climate change (e.g. higher incidences of disease and coral bleaching) (Wilkinson, 2004; Crabbe, 2008). Continued loss of coral reef communities (especially in the greater Caribbean region) is expected to impact foraging and represents a major threat to recovery of the species.

Hawksbill sea turtles are also susceptible to capture in nearshore artisanal fishing gear such as drift-netting, long-lining, set-netting, and trawl fisheries with gill nets and artisanal hook and line representing the greatest impact to the species in the greater Caribbean region (NRC, 1990; Lutcavage et al., 1997; Epperly, 2003).

Hawksbills are also 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 federal and state fisheries, coastal construction, oil spills, climate change affecting sex ratios, etc.) as discussed in the loggerhead sea turtle status section above.

Green Sea Turtle

Species Description, Distribution, and Population Structure

Green sea turtles have a smooth carapace with four pairs of lateral (or costal) scutes and a single pair of elongated prefrontal scales between the eyes. They typically have a black dorsal surface and a white ventral surface although the carapace of green sea turtles in the Atlantic Ocean has been known to change in color from solid black to a variety of shades of grey, green, brown, and black in starburst or irregular patterns (Lagueux, 2001).

Green sea turtles are distributed circumglobally, mainly in waters between the northern and southern 20^o C isotherms (Hirth, 1971) and nesting occurs in more than 80 countries worldwide (Hirth, 1997). The two largest nesting populations are found at Tortuguero, on the Caribbean coast of Costa Rica, and Raine Island, on the Great Barrier Reef in Australia. The complete nesting range of green sea turtles within the southeastern U.S. includes sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands between Texas and North Carolina as well as the USVI and Puerto Rico (NMFS and USFWS, 1991; Dow et al., 2007). Principal U.S. nesting areas for green sea turtles are in eastern Florida, predominantly Brevard through Broward counties. For more information on green sea turtle nesting in other ocean basins, refer to the 1991 Recovery Plan for the Atlantic Green Turtle (NMFS and USFWS, 1991) or the 2007 Green Sea Turtle 5-Year Status Review (NMFS and USFWS, 2007b).

In U.S. Atlantic and Gulf of Mexico waters, green turtles are found in inshore and nearshore waters from Texas to Massachusetts. Important feeding areas in Florida include the Indian River Lagoon System, the Florida Keys, Florida Bay, Homosassa, Crystal River, Cedar Key, St. Joseph Bay, and the Atlantic Ocean off Florida from Brevard through Broward counties (Wershoven and Wershoven, 1992; Guseman and Ehrhart, 1992). Additional important foraging areas in the western Atlantic include the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean coast of Panama, scattered areas along Colombia and Brazil (Hirth, 1971), and the northwestern coast of the Yucatan Peninsula. Adults of both sexes are presumed to migrate between nesting and foraging habitats along corridors adjacent to coastlines and reefs (Hays et al., 2001) and, like loggerheads, are known to migrate from northern areas in the summer back to warmer southern waters to the south in the fall and winter to avoid seasonally cold seawater temperatures.

In terms of genetic structure, regional subpopulations show distinctive mitochondrial DNA properties for each nesting rookery (Bowen et al., 1992; Fitzsimmons et al., 2006). Despite the genetic differences, turtles from separate nesting origins are commonly found mixed together on foraging grounds throughout the species' range. However, such mixing occurs at extremely low levels in Hawaiian foraging areas, perhaps making this central Pacific population the most isolated of all green turtle populations occurring worldwide (Dutton et al., 2008).

Life History Information

Green sea turtles exhibit particularly slow growth rates [about 1-5 cenimeters per year (Green, 1993; McDonald-Dutton and Dutton, 1998)] and also have one of the longest age to maturity of any sea turtle species [i.e., 20-50 years (Chaloupka and Musick, 1997; Hirth, 1997)]. The slow growth rates are believed to be a consequence of their largely herbivorous, low-net energy diet (Bjorndal, 1982). Upon reaching sexual maturity, females begin returning to their natal beaches (i.e., the same beaches where they were born) to lay eggs (Balazs, 1982; Frazer and Ehrhart, 1985) and are capable of migrating significant distances (hundreds to thousands of kilometers) between foraging and nesting areas. While females lay eggs every 2-4 years, males are known to reproduce every year (Balazs, 1983).

In the southeastern U.S., females generally nest between June and September, while peak nesting occurs in June and July (Witherington and Ehrhart, 1989). During the nesting season, females nest at approximately two-week intervals, laying an average of 3-4 clutches (Johnson and Ehrhart, 1996). Clutch size often varies among subpopulations, but mean clutch size is around 110-115 eggs. In Florida, green sea turtle nests contain an average of 136 eggs (Witherington and Ehrhart, 1989), which will incubate for approximately two months before hatching. It is apparent that survivorship at any particular nesting site is greatly influenced by the level of anthropogenic stressors, with the more pristine and less disturbed nesting sites (e.g., Great Barrier Reef in Australia) showing higher survivorship values than nesting sites known to be highly disturbed (e.g., Nicarauga) (Campbell and Lagueux, 2005; Chaloupka and Limpus, 2005).

After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years, feeding close to the surface on a variety of marine algae associated with drift lines and other debris. This early oceanic phase remains one of the most poorly understood aspects of green turtle life history (NMFS and USFWS, 2007b). However, growth studies using skeletochronology indicate that green sea turtles in the Western Atlantic shift from this oceanic phase to nearshore development habitats (protected lagoons and open coastal areas rich in sea grass and marine algae) after approximately 5-6 years (Zug and Glor, 1998; Bresette et al., 2006). As adults, they feed almost exclusively on sea grasses and algae in shallow bays, lagoons, and reefs (Rebel, 1974) although some populations are known to also feed heavily on invertebrates (Carballo et al., 2002). While in coastal habitats, green sea turtles exhibit site fidelity to specific foraging and nesting grounds and it is clear they are capable of "homing in" on these sites if displaced (McMichael et al., 2003).

Reproductive migrations of Florida green turtles have been identified through flipper tagging and/or satellite telemetry. Based on these studies, the majority of adult female Florida green turtles are believed to reside in nearshore foraging areas throughout the Florida Keys from Key Largo to the Dry Tortugas and in the waters southwest of Cape Sable, Florida, with some post-nesting turtles also residing in Bahamian waters as well (NMFS and USFWS, 2007b).

Listing Status

The green sea turtle was listed as threatened under the ESA on July 28, 1978, except for the Florida and Pacific coast of Mexico breeding populations which were listed as endangered. Due to difficulties in distinguishing between individuals from the Florida breeding population from other populations, green sea turtles are considered endangered wherever they occur in U.S. waters and are treated as such in this Opinion. The species is also protected by CITES and is classified as endangered on the IUCN's Red List of Threatened Species. Critical habitat for the green sea turtle has been designated on September 2, 1998, for the waters surrounding Isla Culebra, Puerto Rico, and its associated keys although no critical habitat exists in the action area for this consultation.

Abundance and Trends

A summary of current nesting trends[10] is provided in the most recent status review for the species (i.e., NMFS and USFWS, 2007b) in which the authors collected and organized abundance data from 46 individual nesting concentrations organized by ocean region (i.e., Western Atlantic Ocean, Central Atlantic Ocean, Eastern Atlantic Ocean, Mediterranean Sea, Western Indian Ocean, Northern Indian Ocean, Eastern Indian Ocean, Southeast Asia, Western Pacific Ocean, Central Pacific Ocean, and Eastern Pacific Ocean). The authors found it was possible to determine trends at 23 of the 46 nesting sites and found that 10 appeared to be increasing, 9 appeared to be stable, and 4 appeared to be decreasing. With respect to regional trends, the Pacific, the Western Atlantic, and the Central Atlantic regions appeared to show more positive trends (i.e., more nesting sites increasing than decreasing) while the Southeast Asia, Eastern Indian Ocean, and possibly the Mediterranean Sea regions appeared to show more negative trends (i.e., more nesting sites decreasing than increasing). We must note that these

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[10] Estimates of abundance were largely based on annual numbers of nesting females or deposited nests at each site. In some cases, abundance was based on egg production or egg harvest rates (see NMFS and USFWS, 2007b).

regional determinations should be viewed with caution since trend data was only available for about half of the total nesting concentration sites examined in the review and that site specific data availability appeared to vary across all regions.

The western Atlantic region (focus of this Opinion) was one of the best performing in terms of abundance in the entire review as there were no sites that appeared to be decreasing based on the data collected. Positive trends were reported for the Florida nesting concentration in the U.S., Cuyo and Holbox nesting concentrations in Mexico, Tortuguero nesting concentration in Costa Rica, and Galibi Reserve nesting concentration in Suriname while the other two nesting concentrations included in the review (i.e., Aves Island off Venezuela and Isla Trindade off Brazil) were reported to be stable. More information about site specific trends for the other major ocean regions can be found in the most recent five year status review for the species (see NMFS and USFWS, 2007b).

By far, the largest known nesting assemblage in the western Atlantic region occurs at Tortuguero, Costa Rica. According to monitoring data on nest counts as well as documented emergences (both nesting and non-nesting events), there appears to be an increasing trend in this nesting assemblage since monitoring began in the early 1970's. For instance, from 1971-1975 there were approximately 41,250 average emergences documented per year and this number increased to an average of 72,200 emergences documented per year from 1992-1996 (Bjorndal et al., 1999). Troëng and Rankin (2005) collected nest counts from 1999-2003 and and also reported increasing trends in the population consistent with the earlier studies.

In the continental U.S., green turtle nesting occurs along the Atlantic coast, primarily along the central and southeast coast of Florida where an estimated 200-1,100 females nest each year (Meylan et al., 1995; Weishampel et al., 2003). Occasional nesting has also been documented along the Gulf coast of Florida as well as the beaches on the Florida Panhandle. According to data collected from Florida's Index Nesting Beach Survey from 1989-2011, green turtle nest counts across Florida have increased approximately tenfold from a low of 267 in the early 1990's to a high of 10,701 measured most recently in 2011 (FWC, 2011). While the increase in nest counts seen across Florida beaches is encouraging, these numbers only reflect one segment of the population (nesting females) and thus should not be taken to reflect the true population trend for the region.

Current Threats

The principal cause of the historical, worldwide decline of the green sea turtle was long-term harvest of eggs and adults on nesting beaches and juveniles and adults on feeding grounds. Egg removal and poaching of nesting females continues to be a problem for the greater threatened populations nesting throughout the South Pacific, Eastern Atlantic, Indian Ocean and some areas in the Caribbean (as summarized in Seminoff, 2004). Removal of eggs each nesting season can severely impact juvenile cohorts that would have recruited from the post-hatchling phase while poaching of nesting females reduces the abundance of reproductive adults as well as potential for annual egg production. Both these impacts led to declines in overall survival and reproduction for these respective populations. In addition to illegal poaching, direct harvest of adult and juveniles occurs heavily in the Caribbean Sea, Southeast Asia, Eastern Pacific, and Western Indian Ocean (NMFS and USFWS, 2007b). Despite substantial declines in the population of green sea turtles in these respective regions, intentional harvest remains legal in many countries and remains a threat to populations worldwide.

Green turtles depend on shallow foraging grounds with sufficient benthic vegetation. Therefore, direct destruction of foraging areas due to dredging, boat anchorage, deposition of spoil, and siltation may have considerable effects on the distribution of foraging green turtles (Coston-Clements and Hoss, 1983; Williams, 1988). Eutrophication, heavy metals, radioactive elements, and hydrocarbons all may reduce the extent, quality, and productivity of foraging grounds as well (Frazier, 1980; McKenzie et al., 1999; Storelli and Marcotrigiano, 2003). Various types of marine debries such as plastics, oil, and tar tends to collect on pelagic drift lines that young green turtles inhabit (Carr, 1987; Moore et al., 2001) and can lead to death through injestion (Balazs, 1985; Bjorndal et al., 1994). Another major threat from man-made debris is the entanglement of turtles in discarded monofilament fishing line and abandoned netting (Balazs, 1985).

Fibropapillomatosis, an epizootic disease producing lobe-shaped tumors on the soft portion of a turtle's body, has been found to infect green sea turtles, most commonly juveniles (Williams et al., 1994). The occurrence of fibropapilloma tumors may result in impaired foraging, breathing, or swimming ability possibly leading to death in some cases making it a serious threat to the survival and recovery of the species.

Another growing problem affecting green sea turtles is the increasing female bias in the sex ratio of green sea turtle hatchlings, likely related to global climate change and imperfect egg hatchery strategies (Tiwol and Cabanban, 2000; Hays et al., 2003a; Baker et al., 2006). Atleast one site (i.e. Ascension Island) has had an increase of mean sand temperature in recent years (Hays et al., 2003a). It is expected that similar rises in sand temperatures on nesting beaches may alter sex rations towards a highly female bias and significantly impact the ability of the species to survive and recover in the wild.

Green sea turtles are also 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 federal and state fisheries, coastal construction, oil spills, etc.) as discussed in the loggerhead sea turtle status section above.

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 straight carapace length 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 millimeter straight carapace length, and weigh between 15-20 grams (Chavez et al., 1967; Márquez, 1972; Pritchard and Márquez, 1973; Márquez, 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 Márquez, 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; Márquez, 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 centimeters 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 two years although intervals of one and three years have also been measured and are not uncommon (Márquez 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 (Márquez, 1994)

Studies have shown that the time spent in the post-hatchling pelagic stage can vary from 1-4 years, 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). Data 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

The Kemp's ridley sea turtle was listed as endangered under the ESA on December 2, 1970. The species is also protected by CITES and is classified as critically endangered on the IUCN's Red List of Threatened Species. No critical habitat has been designated for the species at the time of this consultation.

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 (notably 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, pers. comm., 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 centimeters 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 estimate for Kemp's ridley mortalities was significantly lower in 2009 (1,717 mortalities) than in the early part of the decade (NMFS et al., 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). According to the preliminary 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[11]). 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.

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). Since March 15, 2011, a notable increase in sea turtle strandings has occurred in the Gulf (primarily in Mississippi) according to data collected by the Sea Turtle Stranding and Salvage Network (NMFS, unpublished data[12]). As of October 6, 2011, 398 Kemp's ridleys (approximately 95 percent of the identified carcasses) have stranded along beaches off Alabama, Louisiana, and Mississippi. 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 of Mexico and other areas can significantly impact the ability of the species to recover given other stressors occurring as a result or in conjunction with strandings.

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[11] 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.

[12] Sea Turtle stranding data for the Gulf of Mexico is available at: http://www.nmfs.noaa.gov/pr/species/turtles/Gulfofmexico.htm

Leatherback Sea Turtle

Species Description, Distribution, and Population Structure

The leatherback sea turtle is the largest sea turtle and the largest living reptile in the world. Mature males and females can reach lengths of over two meters and weigh close to 900 kilograms (2,000 pounds). The leatherback is the only sea turtle that lacks a hard, bony shell. A leatherback's carapace is approximately four centimeters thick and consists of a leathery, oil-saturated connective tissue overlaying loosely interlocking dermal bones. The ridged carapace and large flippers are characteristics that make the leatherback uniquely equipped for long distance foraging migrations. Leatherbacks lack the crushing chewing plates characteristic of sea turtles that feed on hard-bodied prey (Pritchard, 1971). Instead, they have pointed tooth-like cusps and sharp edged jaws that are perfectly adapted for a diet of soft-bodied pelagic (open ocean) prey, such as jellyfish and salps. A leatherback's mouth and throat also have backward-pointing spines that help retain such gelatinous prey.

The leatherback sea turtle ranges farther than any other sea turtle species, exhibiting broad thermal tolerances and are widely distributed throughout the world's oceans (NMFS and USFWS, 1992). They forage in temperate and subpolar regions between latitudes 71º N and 47º S in all oceans and undergo extensive migrations to and from their tropical nesting beaches. In the Atlantic Ocean, leatherbacks have been recorded as far north as Newfoundland, Canada, and Norway, and as far south as Uruguay, Argentina, and South Africa. Female leatherbacks nest from the southeastern U.S. to southern Brazil in the western Atlantic and from Mauritania to Angola in the eastern Atlantic. The most significant nesting beaches in the Atlantic, and perhaps in the world, are located in French Guiana and Suriname (NMFS, 2001). Leatherbacks also occur in the Mediterranean Sea, although they are not known to nest there. Leatherback turtles are found on the western and eastern coasts of the Pacific Ocean, with nesting aggregations in Mexico and Costa Rica (eastern Pacific) and Malaysia, Indonesia, Australia, the Solomon Islands, Papua New Guinea, Thailand, and Fiji (western Pacific). In the Indian Ocean, leatherback nesting aggregations are reported in India and Sri Lanka (NMFS and USFWS, 2007c).

Leatherback turtles are uncommon in the insular Pacific Ocean, but individual leatherback turtles are sometimes encountered in deep water and prominent archipelagoes. To a large extent, the oceanic distribution of leatherback turtles may reflect the distribution and abundance of their macroplanktonic prey in temperate and boreal latitudes (NMFS and USFWS, 2007c).

Previous genetic analyses of leatherbacks using only mitochondrial DNA suggested that within the Atlantic basin there were at least three genetically distinct nesting populations: the St. Croix nesting population (U.S. Virgin Islands), the mainland nesting Caribbean population (Florida, Costa Rica, Suriname/French Guiana), and the Trinidad nesting population (Dutton et al., 1999). Further genetic analyses using microsatellite markers along with the mitochondrial DNA data and tagging data has resulted in Atlantic Ocean leatherbacks now being divided into seven groups or breeding populations: Florida, Northern Caribbean, Western Caribbean, Southern Caribbean/Guianas, West Africa, South Africa, and Brazil (TEWG, 2007).

Life History Information
Leatherbacks are a long-lived sea turtle species, with some individuals reaching 30 years of age or older. Past estimates showed that they reached sexual maturity faster than most other sea turtle species as Rhodin (1985) reported maturity for leatherbacks occurring at 3-6 years of age while Zug and Parham (1996) reported maturity occurring at 13-14 years of age. More recent research using sophisticated methods of analyzing leatherback ossicles has cast doubt on the previously accepted age to maturity figures, with leatherbacks in the western North Atlantic possibly not reaching sexual maturity until as late as 29 years of age (Avens and Goshe, 2007).

Female leatherbacks lay up to 10 nests during the nesting season (March through July in the U.S.) at 2-3 year intervals. They produce 100 eggs or more in each clutch and, thus, can produce 700 eggs or more per nesting season (Schultz, 1975). However, a significant portion (up to approximately 30 percent) of the eggs can be infertile. Thus, the actual proportion of eggs that can result in hatchlings is less than this seasonal estimate. After 60-65 days, leatherback hatchlings with white striping along the ridges of their backs and on the margins of the flippers emerge from the nest.

Leatherback sea turtles are highly migratory, exploiting convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Morreale and Standora, 1998; Eckert, 1999). In a single year, a leatherback may swim more than 10,000 kilometers (Eckert, 1999). In the North Atlantic Ocean, leatherback turtles regularly occur in deep waters (over 328 feet), and an aerial survey study in the north Atlantic sighted leatherback turtles in water depths ranging from 3-13,618 feet, with a median sighting depth of 131.6 feet [Cetacean and Turtle Assessment Program (CETAP), 1982]. Leatherbacks lead a completely pelagic existence, foraging widely in temperate waters except during the nesting season, when gravid females return to tropical beaches to lay eggs. Males are rarely observed near nesting areas, and it has been hypothesized that leatherback sea turtles probably mate outside of tropical waters, before females swim to their nesting beaches (Eckert et al., 1989).

Leatherbacks are known as prolific divers with some individuals diving deeper than 1,100 meters in the Caribbean (López-Mendilaharsu et al., 2008). Leatherbacks appear to spend almost the entire portion of each dive traveling to and from maximum depth, suggesting that maximum exploitation of the water column is essential for the species (Eckert et al., 1989).

Listing Status
The leatherback sea turtle was listed as endangered under the ESA throughout its range on June 2, 1970. The species is also protected by CITES and is classified as critically endangered on the IUCN's Red List of Threatened Species. Critical habitat was designated in 1998 in coastal waters adjacent to Sandy Point, St. Croix, U.S. Virgin Islands (44 FR 17710). On January 26, 2012, NMFS published a final rule to revise

critical habitat to include additional areas off of the U.S. west coast off California and Oregon (77 FR 4170). NMFS also received a petition on November 2, 2010 to further revise critical habitat to include additional areas off Puerto Rico. The petition was accepted by NMFS on May 5, 2011 although no proposed rule has been published to revise critical habitat to include these additional areas at the time of this consultation. No critical habitat for leatherbacks currently exists within the action area for this consultation.

Abundance and Trends

Leatherback sea turtle populations have seen dramatic declines worldwide, especially for nesting females where a majority of the data exists. For example, in the year 1980, the global leatherback population was estimated at approximately 115,000 adult females (Pritchard, 1982) which later declined to 34,500 by the year 1995 (Spotila et al., 1996). The most recent population estimate for leatherback sea turtles from the North Atlantic breeding groups is in the range of 34,000-90,000 adult individuals (20,000-56,000 of which are adult females) (TEWG, 2007). Increases in the number of nesting females have been noted at some sites in the Atlantic Ocean, but these are far outweighed by local extinctions (especially of island populations) and the demise of populations throughout the Pacific, such as in Malaysia and Mexico.

In the Atlantic and Caribbean, the largest nesting assemblages of leatherbacks are found in the USVI, Puerto Rico, and Florida. Populations in the eastern Atlantic (i.e., off Africa) and Caribbean appear to be stable; however, information regarding the status of the entire leatherback population in the Atlantic is lacking and it is certain that some nesting populations (e.g., St. John and St. Thomas, USVI) have been extirpated (NMFS and USFWS, 2007c). The TEWG (2007) reported that nesting populations appear to be increasing for Trinidad, Suriname, Guyana, and Puerto Rico while other colonies in the Caribbean, Costa Rica, Nicaragua, and Honduras may be stable or slightly declining. The Florida nesting stock appears to have grown from under 100 nests per year in the 1980s (Meylan et al., 1995) to over 1,000 nests per year on average in the first decade of the 21st century (FWC, 2009). Using data from the index nesting beach surveys, the TEWG (2007) estimated a significant annual nesting growth rate of 1.17 percent between 1989 and 2005 for the Florida nesting stock.

Based on published estimates of nesting female abundance, leatherback populations are declining at all major Pacific basin nesting beaches, particularly in the past two decades (Spotila et al., 1996; Spotila et al., 2000; NMFS and USFWS, 2007c). For example, the leatherback population nesting along the east Pacific Ocean dropped from an estimated 91,000 adults in the year 1980 (Spotila et al., 1996) to 3,000 total adults and subadults by the 1990's (Spotila et al., 2000). TEWG (2007) reported catastrophic collapse of the colonies in the South China Sea and East Pacific which contributed to these declines. It should be noted that these trends are for nesting females only which represent only one segment of the true leatherback abundance and should be taken with caution.

Current Threats

Leatherback sea turtles are threatened by several human activities, including entanglement in fishing gear (e.g., gillnets, longlines, lobster pots, weirs), direct harvest, egg collection, the destruction and degradation of nesting and coastal habitat, and ingestion of marine debris similar to other sea turtle species discussed in previous sections (NMFS and USFWS, 2007c).

Leatherbacks are more likely to become entangled in fishing gear because they are less maneuverable and larger than other sea turtle species (Davenport, 1987). NMFS-SEFSC reported that 1,001 leatherback sea turtles were captured in shrimp trawls in the Gulf of Mexico and Atlantic Ocean based on effort data gathered in 2009 (NMFS, 2011b) while an estimated 800 leatherbacks are captured in various other fisheries operating in the Atlantic (e.g. pelagic longline fisheries, bottom longline and drift gillnet fisheries for sharks as well as lobster, deep-sea red crab, Jonah crab, dolphin fish and wahoo, and Pamlico Sound gillnet fisheries). Leatherback entanglements in fishing gear are also common in Canadian waters where Goff and Lien (1988) reported that 14 of 20 leatherbacks encountered off the coast of Newfoundland and Labrador were entangled in fishing gear including salmon net, herring net, gillnet, trawl line and crab pot line. Leatherbacks are also reported taken by the many other nations that participate in Atlantic pelagic longline fisheries in addition to the U.S. and Canada.

The decline in the Mexican population of leatherbacks has been suggested to coincide with the growth of the longline and coastal gillnet fisheries in the Pacific (Eckert and Sarti, 1997). Lewison et al. (2004) reported that between 1,000 and 1,300 leatherback sea turtles are estimated to have been captured and killed in longline fisheries in the year 2000 alone. Between 2004 and 2008, shallow-set fisheries based out of Hawai'i are estimated to have captured about 19 leatherback sea turtles and leatherbacks continue to be captured and killed in the deep-set based longline fisheries based out of Hawai'i and American Samoa.

Leatherback sea turtles are also very susceptible to marine debris ingestion due to their predominantly pelagic existence and the tendency of floating debris to concentrate in convergence zones that adults and juveniles use for feeding and migratory purposes (Lutcavage et al., 1997; Shoop and Kenney, 1992). Investigations of the stomach contents of leatherback sea turtles revealed that a substantial percentage (44 percent of the 16 cases examined) contained some form of plastic debris (Mrosovsky, 1981). The presence of plastic in the digestive tract suggests that leatherbacks might not be able to distinguish between prey items and forms of debris such a plastic bags (Mrosovsky et al., 2009). Balazs (1985) speculated that the object might resemble a food item by its shape, color, and size (among others) which would induce a feeding response.

Global climate change is likely to influence the distribution and abundance of jellyfish, the primary prey item of leatherbacks (NMFS and USFWS, 2007c). Several studies have shown leatherback distribution is influenced by jellyfish abundance (e.g., Houghton et al., 2006; Witt et al., 2006; Witt et al., 2007); however, more studies need to be done to monitor how changes to prey items affect distribution and foraging success of leatherbacks so that population-level effects can be determined. Leatherback sea turtles are also threatened by domestic or domesticated animals that prey on their nests and artificial lighting that disorients adult female and hatchling sea turtles which can increase hatchling mortality.

ENVIRONMENTAL BASELINE

By regulation, environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR §402.02).

The purpose of the *Environmental Baseline* section is to step down from the species level discussion in the *Status of the Species* section and establish the current and projected viability or fitness of individuals and populations within the action area so that the effects of the proposed research activities can be measured and assessed. The following sections summarize the natural phenomena as well as the anthropogenic activities that have affected and continue to affect listed listed sea turtles within the action area.

Natural Sources of Stress and Mortality

Disease, Parasites, and Biotoxins

A variety of external parasites such as leeches (e.g., *Branchellion* spp.), copepod fin parasites, isopods, and monogenean worms (*Dermophthirioides pristidis*) have been found attached to sawfish claspers, skin, spiracles, gills, and fins although the significance that these parasites pose to sawfish populations appears to be minor (Poulakis et al., 2010).

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 1930s. 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). In Florida, many immature green turtles captured in the Indian River Lagoon are infected, and there are similar reports from other sites in Florida, including Florida Bay. More research needs to be done to determine the cause of the disease as well as the possibly long term effects to sea turtle populations.

Harmful algal blooms, such as a red tide, also impact 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). Sea turtles that washed ashore alive during these red tide events displayed symptoms that were consistent with acute brevitoxicosis (e.g., uncoordinated and lethargic but otherwise robust and healthy in appearance) and completely recovered within days of being removed from the area.

Predation

Known predators of juvenile sawfish include crocodiles (Thorburn et al., 2004), large sharks (Compagno, 1984; Thorburn et al., 2004), and marine mammals such as dolphins (Bigelow and Schroeder, 1953) which remove juveniles from the population. Current data from acoustic monitoring, public encounter database data, and satellite archival tagging data suggests that small juveniles use red mangrove prop root habitat, most likely to avoid predators. Therefore, habitat loss via natural (e.g., sea level rise and strong storm events, etc.), or anthropogenic stressors (e.g., coastal development and pollution, etc.) is likely to increase juvenile predation risk throughout the action area in the near future.

Predation of sea turtle eggs and hatchlings by native and introduced species occurs on almost all sea turtle nesting beaches throughout the Northwest Atlantic. 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 sea turtle eggs throughout the action area.

The invasive Australian pine (*Casuarina equisetifolia*) is also particularly harmful to sea turtles throughout the state of Florida because they outcompete 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 and affect reproduction (Marcus and Maley, 1987; Schmelz and Mezich, 1988; Hanson et al., 1998).

Hurricanes

Hurricanes and tropical storms are common for south and southwest Florida and have the potential to directly injure or kill marine fish and sea turtles or modify habitat in the action area. Degradation of the mangroves as a result of high hurricane activity may result in losses of habitat available to smalltooth sawfish 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 Pacific Decadal Oscillation and 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 habitat important to smalltooth sawfish. 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 is 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). Given that the south Florida nesting group is the largest loggerhead nesting group in the Atlantic (in terms of nests laid), a decline in the success of nesting as a result of global climate change could have profound effects on the abundance and distribution of loggerheads in the Atlantic, including those occurring within the action area (Hawkes et al., 2009*)*. It is expected that listed species will continue to be exposed to the effects of climate variability throughout the action area in the near future.

Anthropogenic Sources of Stress and Mortality

Fishery Interactions

Entrapment and entanglement in fishing gear is a frequently documented source of stress, injury, and/or mortality in listed species, especially sea turtles, within the action area (NMFS, 2001; Dietrich et al., 2007; NMFS, 2009a). Gillnet, longline, other types of hook-and-line gear, trawl gear, and pot fisheries all interact with sea turtles and marine fish throughout the action area at various degrees.

Sea turtles are frequently caught as bycatch in the following fisheries occurring atleast in part within the action area for the proposed action: Atlantic bluefish, Atlantic herring, Atlantic mackerel/squid/butterfish, Atlantic sea scallop, Atlantic swordfish/tuna/shark/ billfish, coastal migratory pelagic, dolphin-wahoo, Gulf of Mexico 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 fishery, Gulf of Mexico/South Atlantic spiny lobster, and Gulf of Mexico stone crab. While sea turtle bycatch varies depending on the fishery, the Southeast shrimp trawl fishery affects more sea turtles than all other activities combined (NRC, 1990). Although participants in these fisheries are required to use TEDs that reduce the number of sea turtle captures by an estimated 97 percent, these fisheries are still expected to capture about 185,000 sea turtles each year, of which 5,000 end up dead (NMFS, 2002).

As indicated in the *Status of the Species* section of this Opinion, loggerhead and Kemp's ridley sea turtles account for the majority of the annual take with 163,160 loggerheads (3,948 mortalities) and 155,503 Kemp's ridleys (4,208 mortalities) captured on an annual basis followed by 3,090 leatherbacks (80 mortalities), 18,757 greens (514 mortalities) and 640 hawksbills (all mortalities) (NMFS, 2002). In addition to direct mortality and serious injury, entanglements increase sea turtles' vulnerability to predation and ship strikes as well as increase their susceptibility to disease. In recent years, low shrimp prices, rising fuel costs, competition with imported products, and impacts from hurricanes in the Gulf of Mexico have all impacted the shrimp fleets; in some cases reducing fishing effort by as much as 50 percent for offshore waters [Gulf of Mexico Fishery Management Council (GMFMC), 2007]. As a result, sea turtle interactions and mortalities in the Gulf of Mexico, most notably for loggerheads and leatherbacks, have been substantially less than projected in the 2002 Opinion, with 61,299 loggerheads (1,451 mortalities) and 1,001 leatherbacks (26 mortalities) reported taken during the 2009 fishing season (NMFS, 2011b). While the numbers reported by NMFS-SEFSC appear to show decreased levels of interaction with these sea turtle species, there is concern that many sea turtles that die from entanglement in commercial fishing gear tend to sink rather than strand ashore thus making it difficult to accurately determine the extent of such mortalities.

Also, on August 16, 2010, NMFS reinitiated formal section 7 consultation on the shrimp trawl fishery in the southeastern U.S. to reanalyze its effects on sea turtles primarily due to the after-effects of the *Deepwater Horizon* oil spill event. NMFS has documented extraordinarily high numbers of sea turtle strandings in the Gulf of Mexico since the spill occurred and NMFS suspects that much of the increased level of strandings is attributable to shrimp fishing (NMFS, 2010c). It is expected that sea turtles will continue to be exposed to fishery interactions (including mortalities) in the action area so long as those fisheries remain viable.

Smalltooth sawfish occasionally are caught as bycatch in the following federally managed fisheries operating in and around the action area: HMS Atlantic Shark, Coastal Migratory Pelagics, Gulf of Mexico Reef Fish, South Atlantic Snapper-Grouper, Gulf of

Mexico stone crab, Gulf of Mexico/South Atlantic spiny lobster, and the Gulf of Mexico/South Atlantic shrimp trawl fisheries. The highest interaction with the species is reported for the HMS Atlantic Shark, Gulf of Mexico Reef Fish, and the Gulf of Mexico and South Atlantic shrimp trawl fisheries. According to the biological opinions for these four fisheries, no more than seven lethal takes of smalltooth sawfish are exempted over a three year period for all these fisheries combined (see NMFS, 2005; NMFS, 2006a, NMFS, 2008a; NMFS, 2011a)..

Sea turtles and marine fish are also caught as bycatch in other state-managed fisheries throughout the action area. While little is known about the level of take in fisheries that operate strictly in state waters, many state permit holders also hold federal licenses; therefore, ESA Section 7 consultations on federal action in those fisheries address some state-water activity. When this information becomes available, it can be used to refine take reduction plan measures in state waters.

Habitat Loss and Modification

Coastal habitat in the action area has already undergone extensive modification due to urbanization and it is expected that sea turtles and marine fish are going to continue to feel the effects as cities grow and the human population in the southeastern U.S. increases. Stedman and Dahl (2008) estimated that the Gulf of Mexico region of the U.S. lost an average of 60,000 acres of wetland habitat annually from 1998 to 2004. These losses have been attributed to commercial and residential development, port construction (dredging, blasting, and filling activities), construction of water control structures, modification to freshwater inflows, and oil and gas related activities (SAFMC, 1998). Riverine systems throughout the smalltooth sawfishes’ historical range have been altered or dammed thus limiting the species’ ability to expand its current range. Agricultural non-point discharges are responsible for the introduction of a wide range of toxic chemicals into habitats important to sawfish (Scott, 1997). For example, all of Florida Bay has undergone biological, chemical, and physical change due to large scale agricultural practices and hydrologic modifications in the Everglades (Fourqurean and Robblee, 1999).

Modifications of natural freshwater flows into estuarine and marine waters through construction of canals and other controlled devices have changed temperature, salinity, and nutrient regimes; reduced both wetlands and submerged aquatic vegetation; and degraded vast areas of coastal habitat important to smalltooth sawfish (Gilmore, 1995; Reddering, 1988; Whitfield and Bruton, 1989). In addition, seawalls and canals for waterfront homes have replaced marsh and mangrove intertidal shorelines and shallow estuarine waters, particularly within the IRL (Gilmore, 1995) where smalltooth sawfish were once abundant but now appear to have been extirpated (Snelson and Williams, 1981).

Sub-optimal sea turtle nesting habitat due to beach armoring (e.g., bulkheads, seawalls, soil retaining walls, rock revetments, sandbags, and geotextile tubes) and artificial lighting in the action area 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 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). 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 and Witherington, 1995).

Habitat in the action area may also be degraded by various sources of marine debris such as plastics, glass, metal, polystyrene foam, rubber, and derelict fishing gear. Marine debris is introduced into the marine environment through ocean dumping, littering, or hydrologic transport of these materials from land-based sources. 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). 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 (Seitz and Poulakis, 2006)

Oil Spills

Sea turtles and marine fish in the Gulf of Mexico are located in an area of high-density offshore oil extraction with chronic, low-level spills and occasional massive spills (such as the current *Deep Horizon* oil spill, *Ixtoc I* oil well blowout and fire in the Bay of Campeche in 1979, and the explosion and destruction of a loaded supertanker, the *Mega Borg*, near Galveston in 1990). Oil spills impact sea turtles and other wildlife directly through three primary pathways: ingestion – when animals swallow oil particles directly or consume prey items that have been exposed to oil, absorption – when animals come into direct contact with oil, and inhalation – when animals breath volatile organics released from oil or from “dispersants” applied by response teams in an effort to increase the rate of degradation of the oil in seawater. Several aspects of sea turtle biology and behavior place them at particular risk, including the lack of avoidance behavior, indiscriminate feeding in convergence zones, and large pre-dive inhalations (Milton et al., 2003).

At the time of this consultation, NMFS has reported that 481 Kemp’s ridley, 67 loggerheads, 29 green, and 32 unspecified sea turtles have been found dead in the vicinity of the *Deep Horizon* spill event that occurred in the northcentral Gulf of Mexico from April through October, 2010, although the cause of death is not immediately certain for all caracasses recovered (NMFS, unpublished data[13]). Kemp's Ridley sea turtles appear to be the most affected due to their high death totals since the blowout occurred, their low population numbers to begin with, and their limited range compared with other sea turtle species. Since March 15, 2011, a notable increase in sea turtle standings has occurred in the Northern Gulf of Mexico although the cause of this increase is unknown. The Sea Turtle Stranding and Salvage Network is currently investigating the cause of this increase in strandings although two primary considerations for the cause of death are forced submergence (fishing related) and acute toxicosis (from algal blooms or related to the oil spill) based on necropsies that have been performed thus far (NMFS, unpublished data[14]). More research needs to be done to determine the short and long term effects of the *Deepwater Horizon* oil spill event; however, the sections below provide a summary of the possible effects sea turtles and marine fish based on a review of the literature.

When large quantities of oil enter a body of water, chronic effects such as cancer, and direct mortality of wildlife becomes more likely (Lutcavage et al., 1997). Oil spills in the vicinity of nesting beaches just prior to or during the nesting season could place nesting females, incubating egg clutches, and hatchlings at significant risk (Fritts and McGehee, 1982; Lutcavage et al., 1997; Witherington, 1999). Continuous low-level exposure to oil in the form of tarballs, slicks, or elevated background concentrations also challenge animals facing other natural and anthropogenic stresses. Types of trauma can include skin irritation, altering of the immune system, reproductive or developmental damage, and liver disease (Keller et al., 2004; Keller et al., 2006). In addition, chronic exposure may impair a turtle's overall fitness so that it is less able to withstand other stressors throughout the species life history (Milton et al., 2003).

The earlier life stages are usually at greater risk from an oil spill than adults since they usually spend a greater portion of their time at the sea surface, thereby increasing their risk of exposure to floating oil slicks (Lutcavage et al., 1995). Most reports of oiled hatchlings originate from convergence zones where currents meet to form collection points for material at or near the surface of the water. For example, 65 of 103 post-hatchling loggerhead sea turtles in convergence zones off Florida's east coast were found with tar in the mouth, esophagus, or stomach (Loehefener et al., 1989). Thirty-four percent of post-hatchlings captured in *Sargassum* spp. off the Florida coast had tar in the mouth or esophagus and more than 50 percent had tar caked in their jaws (Witherington, 1994). Tarballs in a turtle's gut are likely to have a variety of effects – starvation from gut blockage, decreased absorption efficiency, absorption of toxins, effects of general intestinal blockage (such as local necrosis or ulceration), interference with fat metabolism, and buoyancy problems caused by the buildup of fermentation gases (floating prevents turtles from feeding and increases their vulnerability to predators and boats), among others. Lutz and Lutcavage (1989) reported hatchlings found with their beaks and esophagi blocked with tarballs, apparently dying of starvation.

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[13] 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.

[14] Sea Turtle stranding data for the Gulf of Mexico is available at: http://www.nmfs.noaa.gov/pr/species/turtles/Gulfofmexico.htm

Frazier (1980) suggested that olfactory impairment from chemical contamination could represent a substantial indirect effect in sea turtles, since a keen sense of smell apparently plays an important role in navigation and orientation. A related problem is the possibility that an oil spill impacting nesting beaches may affect the locational imprinting of hatchlings, and thus impair their ability to return to their natal beaches to breed and nest (Milton et al., 2003).

Oil cleanup activities, such as the use of dispersants, may also be harmful to sea turtles although such impacts are difficult to predict in the absence of direct testing. While inhaling petroleum vapors can irritate turtles' lungs, dispersants can interfere with lung function through their surfactant (detergent) effect. Dispersant components absorbed through the lungs or gut may affect multiple organ systems and interfere with digestion, respiration, excretion, and/or salt-gland function which can be similar to effects deriving from the oil itself (Hoff and Shigenaka, 2003). Other oil cleanup activities such as the use of earth-moving equipment on beaches can dissuade females from nesting and destroy nests while the use of containment booms has the possibly of entrapping young hatchlings (Witherington, 1999).

Smalltooth sawfish and other marine fish can be impacted by oil contamination directly through uptake by the gills, ingestion of oil or oiled prey, effects on eggs and larval survival, and through contamination of foraging and spawning sites. Studies after the Exxon Valdez oil spill demonstrated that fish embryos exposed to low levels of polycyclic aromatic hydrocarbon (PAH) compounds in weathered crude oil develop a syndrome of edema and craniofacial and body axis defects (Incardona et al., 2005). Crude oil can also impact survival, physiological, and haematological parameters of juvenile fish, although embryos are more severely affected than juveniles (Kazlauskiene et al., 2008).

Acoustic Stressors

Increases in underwater sound generated from various man-made sources such as on-shore construction, pile driving, and bridge construction have the potential to affect listed species in the action area at various times throughout the year. Acoustic impacts to sea turtles can include temporary or permanent injury, habitat exclusion, habituation, and disruption of other normal behavior patterns (NMFS, 2001). Short-term exposure to high-energy sound sources such as underwater explosions, pile driving, and other marine construction have the potential to result in direct injury or even death to listed species located near the sound source.

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

Recently, NMFS evaluated The U.S. Navy Atlantic Fleet's active sonar training along the Atlantic Coast of the United States and in the Gulf of Mexico from January 22, 2011 to January 21, 2012 as well as research, development, testing, and evaluation (RDT&E) activities in the Gulf of Mexico Range Complex from March 18, 2011 to March 17, 2012. Based on the biological opinions for the respective training activities, sea turtles are expected to be exposed to mid-frequency active sonar, vessel traffic, and explosions associated with the active sonar training although both opinions reached conclusions that the activities would not jeopardize the continued existence of any listed sea turtle species. 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 including any future operations occurring in the Gulf of Mexico.

Seismic surveys using towed airguns occur within the action area and are the primary exploration technique for oil and gas deposits and for fault structure and other geological hazards. Airguns generate intense low-frequency sound pressure waves capable of penetrating the seafloor and are fired repetitively at intervals of 10-20 seconds for extended periods (NRC, 2003). Most of the energy from the guns is directed vertically downward, but significant sound emission also extends horizontally. Very little data exists on the effects of seismic surveys on sea turtles and marine fish; however, NMFS anticipates incidental takes of sea turtles from vessel strikes, noise, marine debris, and the use of explosives during seismic surveys and during removal of oil and gas structures. Short-term exposure to high-energy sound sources such as underwater explosions, pile driving and other marine construction have the potential to result in direct injury or even death to listed species located near the sound source.

Ship Strikes and Other Vessel Interactions

In addition to noise effects described earlier, vessels operating in the action area adversely affect listed sea turtles and marine fish through direct ship strikes and/or other physical and behavioral disturbance. Turtles and marine fish swimming or feeding at or just beneath the surface of the water are vulnerable to boat and vessel strikes, potentially resulting in serious propeller injuries and even death (Hazel et al., 2007). Private vessels participate in high speed marine events concentrated in the southeastern United States and are a particular threat listed species in the action area. The magnitude of these marine events is not currently known. The Sea Turtle Stranding and Salvage Network also reports many records of vessel interaction (propeller injury) with sea turtles off coastal states such as Florida, where there are high levels of vessel traffic. Vessel avoidance may cause sea turtles and marine fish in the action area to move away from important feeding areas or potential mates, both of which can affect the ability of the species to recover. Boat registrations have increased dramatically in Florida in recent years, and new boat designs allow ever faster boats to use ever shallower waters which may increase interaction with smalltooth sawfish in the action area in the near future (NMFS, 2009a).

Scientific Research

Numerous scientific research activities are occurring throughout the action area that affect smalltooth sawfish and sea turtles either directly or indirectly, as authorized by NMFS permits. At the time of this consultation, there are currently 26 active research permits directed at sea turtles and two active research permits directed at smalltooth sawfish in the action area. Research activities directed at sea turtles include net and longline capture, photography, weighing, tagging, blood sampling, biopsy sampling, lavage, and performing laparoscopy. Research activities directed at smalltooth sawfish include net and longline capture, photographing, measuring, tagging, tracking, blood sampling, tissue sampling, and ultrasound examination. In addition, there are several other research permits directed at listed sturgeon that also incidentally interact with sea turtles through unintentional capture in longlines and net gear. A review of the biological opinions for these respective permits suggest that a majority of the species exposed to these types of scientific research activities undergo short term stress and discomfort with limited exemptions for unintentional mortalities (mostly loggerheads). However, for each biological opinion reviewed, the proposed takes and incidental takes exempted for listed species was not likely to jeopardize the continued existence of any listed species. Nevertheless, repeat disturbances of individuals are likely to occur each year as a result of these activities which may remove some individuals from the population (through unintentional mortality for sea turtles) and/or induce stress responses that impact an individuals time and energy budget that would otherwise be used for other essential behaviors (e.g., foraging, resting, migration, reproduction, etc.).

It is expected that smalltooth sawfish and sea turtles will continue to be exposed to similar types of research activities throughout the action area in the near future. The number of authorized takes varies widely depending on the research and species involved. However, 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 affected species. Currently, all permits affecting sea turtles and smalltooth sawfish contain conditions requiring the permit holders to coordinate their activities with the NMFS regional offices and other permit holders and, to the extent possible, share data to avoid unnecessary duplication of research. These measures help to minimize the cumulative impact to listed species although the point at which additional research would result in adverse effects at the population level would be evaluated as new permit applications are reviewed.

Conservation and Management Efforts

Several conservation and management efforts have been undertaken for listed sea turtles and marine fish to aid in recovery efforts and help mitigate some stressors acting on listed species within the action area. NMFS implements conservation and management activities for these species through its Regional Offices and Fishery Science Centers in cooperation with states, conservation groups, the public, and other federal agencies.

For smalltooth sawfish, NMFS developed *Sawfish Safe Handling and Release Guidelines* that are distributed to commercial fishers to minimize impacts to the species as a result of incidental bycatch. The Florida Museum of Natural History maintains The National Sawfish Encounter Database (formerly maintained by Mote Marine Laboratory) to track encounters throughout the state of Florida and efforts are ongoing to expand the questionnaire provided to recreational fishers to capture information on sawfish encounters from that sector as well. The Comprehensive Everglades Restoration Project is a major reconstruction project jointly led by the U.S. Army Corps of Engineers and the South Florida Water Management District, which has the potential to restore habitats and hydrological regimes in South Florida important for smalltooth sawfish.

NMFS has implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles from commercial fisheries in the action area. These include sea turtle release gear requirements for the Atlantic Highly Migratory Species Fishery, Gulf of Mexico reef fish, and South Atlantic snapper-grouper fishery, and TED requirements for the Southeast shrimp trawl fishery. NMFS published a final rule on July 6, 2004, to implement management measures to reduce bycatch and bycatch mortality of Atlantic sea turtles in the Atlantic pelagic longline fishery (69 FR 40734). The management measures include mandatory circle hook and bait requirements, and mandatory possession and use of sea turtle release equipment to reduce bycatch mortality. In the Hawaii-based longline swordfish fishery which required vessels to switch from using a J-shaped hook with squid bait to a wider circle-shaped hook with fish bait has reduced capture rates of leatherback and loggerhead turtles significantly by 83 and 90 percent, 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 (Watson et al., 2005; Read, 2007).

In March 2002, NMFS published new restrictions for the use of gillnets with larger than 8-inch stretched mesh operating 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. 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.

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

EFFECTS OF THE PROPOSED ACTION

Pursuant to Section 7(a)(2) of the ESA, federal agencies are directed to insure 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. 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, and the probable responses of those individuals (given probable exposures) based on the best scientific information available. 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. The purpose of this assessment is to determine if it is reasonable to expect the proposed research activities will have effects on listed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

For this consultation, we are particularly concerned about incidental mortality and/or behavioral disruptions that may result in animals that fail to feed or breed successfully or fail to complete their life history because these responses are likely to have population-level consequences. The proposed permits would authorize non-lethal "takes" by way of capture, wounding, and harrassment of listed smalltooth sawfish and five species of sea turtles (i.e., loggerhead Northwest Atlantic Ocean DPS, green, hawksbill, Kemp's ridley, and leatherback).

The ESA does not define harassment nor has NMFS defined the term pursuant to the ESA through regulation. However, the MMPA defines harassment as "any act of pursuit, torment, or annoyance which has the potential to injure or disturb a marine mammal or marine mammal population in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering" [16 U.S.C. 1362(18)(A)]. The latter portion of this definition (that is, "...causing disruption of behavioral patterns including...migration, breathing, nursing, breeding, feeding, or sheltering") is almost identical to the USFWS's regulatory definition of "harass"[15] pursuant to the ESA. For this Opinion, we define harassment similarly: an intentional or unintentional human act or omission that creates the probability of injury to an individual animal by disrupting one or more behavioral patterns that are essential to the animal's life history or its contribution to the population the animal represents.

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[15] An intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3)

Potential Stressors

Our effects analysis begins by identifying all possible stressors for which listed species would be exposed. During this consultation, we identified the following stressors associated with the proposed action:

- Ship strikes during vessel transit,
- Habitat contamination due to unexpected oil or fuel spill,
- Increased turbidity due to setting gillnets or from dragging seine nets in shallow water,
- Stress from net, longline, or hook and line capture,
- Injury due to net, longline, or hook and line capture,
- Forced submergence due to longline or gillnet capture,
- Stress from handling on board or alongside the boat,
- Stress from conducting ultrasound examinations,
- Wounding due to tag attachment (PIT tags, CTD and acoustic tags attached using either rototag or neoprene methods, and satellite tags using a harness),
- Increased drag from tag attachments,
- Wounding due to blood sampling,
- Wounding due to tissue and biopsy sampling.

Exposure Analysis

Exposure analyses identify the co-occurrence of ESA-listed species with the action's effects in space and time, and identify the nature of that co-occurrence. The exposure analysis identifies, as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the action's effects and the population(s) or subpopulation(s) those individuals represent. For the exposure analysis conducted for this consultation, we estimated the number of individuals likely to be exposed to the effects of the proposed research activities using the best information available to us including recent population or distribution estimates, expected growth rates over the life of the permits, the maximum survey effort expected from the researchers over the life of the permits, and past take numbers reported by the researcher under their previous permit (Permit No. 1475).

Ship strikes and/or propeller scarring during sampling is considered highly unlikely given that researchers will travel at slow speeds to and from sampling sites and have trained observers onboard to avoid direct hits to any listed species in the path of the vessel. Also, researchers have never reported a strike to a listed species in their past monitoring reports. Therefore, we do not anticipate exposure of listed smalltooth sawfish or sea turtles to ship strikes and the threats posed by this stressor are discountable.

We also don’t anticipate exposure of listed species to accidental fuel spills as researchers are expected to take all proper precautions to avoid a spill or minimize the impact of a spill if it were to occur thus preventing any type of widespread, high-dose contamination. Also, any increase in turbidity caused by the setting of gillnets or the dragging of seine nets in nearshore waters are expected to be minimal and temporary in nature and permit conditions require that researchers take great care to avoid damaging bottom habitat. Therefore, we consider the threats posed by these stressors to be discountable.

This consultation focused our assessment on the following stressors for which listed species are likely to be exposed and may have a measurable effect: stress/injury/forced submergence due to net, hook and line, and longline capture; forced submergence due to longline and net capture; stress from handling, measurements, and ultrasound examinations; wounding/stress/increased drag due to tag attachment (PIT tags, CTD and acoustic tags attached using either rototag or neoprene methods, and satellite tags using a harness); and stress/wounding due to blood, tissue, and biopsy sampling.

We evaluated the researcher’s previous catch numbers and accounted for the increase in effort anticipated under their proposed permit to evaluate exposure that is likely to occur over the five year permit duration. **Table 2** below displays the annual exposure of listed smalltooth sawfish to the anticipated stressors while **Table 3** displays the cumulative exposure of listed sea turtles over the life of the permit. We chose to evaluate sea turtle exposure cumulatively since we could not accurately estimate exposure likely to occur each year.

Table 2. Annual Exposure of Smalltooth Sawfish to Anticipated Stressors

Species (Life Stage)	Exposure to stress/ injury/ forced submergence from capture	Exposure to stress from handling and measuring	Exposure to stress from ultrasound examination	Exposure to wounding from tissue sampling (fin clips), biopsy sampling, and blood sampling	Exposure to stress/wounding/increased drag from attaching PIT tags and CTD/acoustic tags (attached using either rototag or neoprene methods)	Exposure to stress/wounding/ increased drag from attaching satellite tags using a harness
Smalltooth Sawfish (juveniles under 2 meters)	125	125	80*	80*	125	0
Smalltooth Sawfish (juveniles between 2 and 3 meters)	15	15	15	15	15	15
Smalltooth Sawfish (adults 3 meters or larger)	50	50	50	50	50	15

*Note: We anticipate that of the 125 juveniles captured, 45 (or 36 percent) will be recaptures and will not be exposed a second time to ultrasound, blood sampling, tissue sampling, or biopsy sampling. Therefore, we subtracted 45 from the total to get 80 total individuals that would be exposed to those activities each year.

Table 3. Cumulative Exposure of Sea Turtles to Anticipated Stressors Over the Five Year Permit Duration

Species (Life Stage)	Exposure to stress/injury/ forced submergence from capture	Exposure to stress from handling and measuring	Exposure to stress from ultrasound examination	Exposure to wounding from tissue sampling (fin clips), biopsy sampling, and blood sampling	Exposure to stress/wounding/increased drag from attaching PIT tags and CTD/acoustic tags (attached using either rototag or neoprene methods)	Exposure to stress/wounding/ increased drag from attaching satellite tags using a harness
Loggerhead sea turtle Northwest Atlantic Ocean DPS (all except hatchlings)	10	10	0	0	0	0
Green sea turtle (all except hatchlings)	6	6	0	0	0	0
Kemp's ridley sea turtle (all except hatchlings)	6	6	0	0	0	0
Hawksbill sea turtle (all except hatchlings)	6	6	0	0	0	0
Leatherback sea turtle (all except hatchlings)	6	6	0	0	0	0

To estimate probable exposure of smalltooth sawfish, we calculated the mean number of individuals captured each year from the monitoring reports submitted by the researchers and carried this mean level of exposure out to four standard deviations to account for variabilility in research effort from year to year as well as population growth over the life of the permit. We anticipate that up to 125 juveniles (under two meters TL) would be exposed to stress/injury/forced submergence from capture by way of longlines, gillnets, and/or seine nets; stress from handling and size measurements; and stress, wounding, and increased drag from attaching PIT tags and CTD/acoustic tags (attached using either rototag or neoprene methods). Based on recapture data we expect that of the 125 juveniles caught, a little over a third (i.e., 36 percent) would be recaptures. Researchers anticipate that recaptured individuals would only be handled, measured, and any lost tags would be reapplied. Therefore, of the total 125 juveniles, we anticipate that only 80 would be exposed to stress from ultrasound examinations as well as wounding from blood sampling, tissue sampling (fin clips), and biopsy sampling since recaptured individuals would not be exposed to these stressors a second time. We also anticipated an additional 15 larger juveniles (between two and three meters TL) would also be exposed to satellite tag attachment using a harness in addition to the other stressors. We could not separate anticipated recaptures for these larger juveniles so we are assuming that all 15 individuals would be exposed to all the anticipated stressors each year.

The researchers did not capture any adults (three meters or larger TL) in their previous monitoring reports; however, 13 adults were recently captured under another permit authorizing research within the same action area (i.e., Permit No. 13330, John Carlson). Therefore, we consider it likely that researchers may capture and satellite tag as many as 15 adults per year as was proposed by the Permits Division under this proposed action. It was difficult to accurately estimate recaptures for adults since so few data exists on both abundance and past take data. Therefore, we are provisionally accepting the total take numbers for adults that were proposed by the Permits Division (i.e., 50 total adults captured each year 15 of which would be exposed to all stressors including being fitted with satellite tags). Future monitoring reports submitted by the researchers will further inform this analysis.

To estimate probable exposure for sea turtles, we reviewed available monitoring reports submitted by smalltooth sawfish resarchers as well as recent opinions that evaluated “take” of sea turtles resulting from commercial fisheries operating in the action area. The updated review revealed that a total of three sea turtles (i.e., one green, one Kemp’s ridley, and one unidentified sea turtle) have been incidentally caught in gear directed at smalltooth sawfish since 2003 and that all turtles were released alive. We calculated the mean number of sea turtles captured each year from the various monitoring reports submitted since 2003 and carried this mean level of exposure out to four standard deviations to account for variabilility in research effort from year to year as well as population growth over the life of the permit. We also reviewed recent biological opinions submitted since 2004 for commercial fisheries operating in and around the action area that utilized gillnet, hook-and-line, and longline gear (i.e., HMS Atlantic Shark, Coastal Migratory Pelagics, South Atlantic Snapper-Grouper, Gulf of Mexico Reef Fish, and HMS Pelagic longline fisheries) and found that loggerheads made up the greatest proportion of the likely incidental take across all those respective fisheries over any three year period (51 percent of the total incidental take), followed by leatherbacks (40 percent of the total), greens (4 percent of the total), hawksbills (3 percent of the total), and Kemp's ridleys (2 percent of the total). Based on the numbers reported by these respective biological opinions, loggerheads were twice as likely to be caught as bycatch compared to all other species combined. While these estimated take numbers reflect a substantially higher level of effort compared to the research being evaluated in this consultation, they are still pertinent to our exposure analysis because they reflect the expected proportion of sea turtle species expected to be caught in the action area for similar gear types albeit on a much broader scale.

Based on this review, we anticipate that twice as many loggerheads would be captured each year compared with other species. Therefore, while we accepted the take numbers proposed for loggerheads (10 individuals over the life of the permit), hawksbills (6 individuals over the life of the permit), and leatherbacks (6 individuals over the life of the permit), we assessed exposure of green and Kemp's ridley sea turtles at lower levels than what was proposed by the Permits Division (6 individuals each over the life the permit rather than 10 individuals which was proposed). We feel these exposure estimates are more likely to occur based on the best available information at the time of this consultation. Future monitoring reports submitted by the researchers will further inform this analysis. All sea turtles would be exposed to stress/injury/forced submergence from capture in longlines, hook and line, or nets as well as stress from handling and measurements only. No sea turtles would be exposed to the other stressors evaluated in this Opinion.

Response Analysis

As discussed in the *Approach to the Assessment* section of this Opinion, response analyses determine how listed resources are likely to respond after being exposed to an action's effects on the environment or directly on listed animals themselves. For the purposes of consultation, our assessments try to detect potential lethal, sub-lethal, 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.

Responses to Longline, Hook and Line, Gillnet, and Seine Net Capture

Nets, rod-and-reel, and longline gear proposed can result in short term stress, injury or mortality to smalltooth sawfish (Musick et al., 2001; Simpfendorfer, 2006), and sea turtles (Hays et al., 2003b; Watson et al., 2005) based on years of data on incidental captures reported for commercial fisheries.

Once they are hooked, smalltooth sawfish are likely to slash back and forth as they try to free themselves from the hook. As the sawfish struggle, the gangion is likely to become wrapped around their saw or rostrum (NMFS, 2008a), increasing their degree of entanglement. Based on the researchers' prior experience and monitoring reports submitted under their prior permit (No. 1475), we do not expect any sawfish to be seriously injured during capture based on the specific mitigation measures and handling requirements to be followed by the researchers. However, sawfish are still likely to experience physiological stress responses as a result of being captured based on prior studies (Korte et al., 2005; Lankford et al., 2005; Moberg, 2000; Sapolsky et al., 2000). The consequences of those stress responses to each sawfish will depend on their condition prior to their capture, how long they remain entangled and hooked before they are released from the entangling gear, how long they are restrained and handled while the study protocols are completed, and their response to the study protocols. Depending on their prior state of health, we would expect smalltooth sawfish to experience any or all of these stress responses once they realize they cannot free themselves from being hooked. In addition to short term stress responses, smalltooth sawfish might be injured by the loss of individual rostral teeth during contact with the boat while they are handled and restrained. Researchers are proposing to use welding gloves to hold the rostra of captured sawfish as soon as possible after capture to minimize the threat of tooth loss. Loss of rostral teeth could affect the short term feeding success of the sawfish or its ability to defend itself after release although they are expected to eventually grow back after a short time thereby avoiding any long term adverse consequences for captured individuals.

Moser and Ross (1995) reported gill net mortalities for other species of marine fish (i.e., shortnose sturgeon) approached 25 percent when water temperatures exceeded 28ºC even though soak times were often less than four hours. Since 2006, more conservative mitigation measures implemented by NMFS and other researchers (e.g., reduced soak times at warmer temperatures or lower dissolved oxygen concentrations, and minimal holding or handling time, etc.), have reduced the effects of gillnetting on sturgeon species significantly, with very few documented mortalities reported in recent years. While researchers are targeting a different species (i.e., smalltooth sawfish rather than sturgeon), they are proposing to check nets more frequently (every 20 minutes) when water temperatures exceed 30ºC to help minimize the threat of unintentional mortality. Mitigation measures such as short sets and monitoring nets at all times while they are set reduces the chances of killing smalltooth sawfish individuals based on observations seen for other species marine fish. Also, we reviewed monitoring reports submitted by the researchers as well as others who have conducted research on the species since it was listed under the ESA in 2003 and did not find any mortalities attributed to the proposed capture methods. Therefore, based on the researchers prior data as well as those for other studies, we would expect smalltooth sawfish to undergo short term stress associated with net, rod-and-reel, and longline capture with no serious injury or mortality expected over the duration of the permit.

Capture of listed sea turtles by net or longline gear could result in responses ranging from very mild short term stress to serious injury or even mortality from drowning due to forced submergence or a hook-related injury (Ryder et al., 2006). Sea turtles are particularly prone to entanglement as a result of their body configuration and behavior. Records of stranded or entangled sea turtles reveal that fishing debris can wrap around the neck or flipper and severely restrict swimming or feeding. Sea turtles may also experience constriction of appendages as a result of the entanglement. Constriction may cut off blood flow, causing deep gashes, some severe enough to remove an appendage.

Injuries sustained as a result of the hooking incident, especially in incidents where the hook may have perforated an organ, may also result in death to a turtle.

Sea turtles that are forcibly submerged also 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. 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). Hoopes et al. (2000) found that entanglement netting produced notable changes in blood chemistry in wild Kemp's ridley sea turtles, with plasma lactate concentrations at capture elevated up to 6-fold above those measured 6-10 hours post capture. However, they note that the lactate response resulting from the stress of capture in entanglement netting was relatively slight compared with that reported for trawl capture.

Larger sea turtles are capable of longer voluntary dives than small turtles, so juveniles may be more vulnerable to the stress due to capture and handling than adults. With each forced submergence, lactate levels increase and require a long (as much as 20 hours) time to recover to normal levels. Therefore, sea turtles are likely 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 (Lutcavage and Lutz, 1997). Capture and handling activities may markedly affect metabolic rate (St. Aubin and Geraci, 1988) and hormone levels (Gregory et al., 1996). However, while net capture can result in temporary changes in blood chemistry of sea turtles, it appears that animals that are immediately placed back into a marine environment after removal from the gear can recover from the short-term stress of capture (Hoopes et al., 2000).

NMFS reviewed monitoring reports submitted by smalltooth sawfish researchers over the past eight years and found that of the three sea turtles encountered, all were released alive with no apparent long term fitness consequences as a result of the encounter. A majority of the research effort expected is to occur in nearshore and estuarine waters where shorter set lines are to be used compared to longer soak times practiced by commercial fisheries. NMFS believes that based on the types of equipment to be used in nearshore areas, the fact that no sea turtle mortalities have been reported to date from similar surveys, and the fact that permit conditions require researchers to follow de-hooking protocol as outlined in NMFS' *Careful Release Protocols for Sea Turtle Release with Minimal Injury* and to periodically check their nets for bycatch, we do not anticipate mortalities or serious injuries to occur to listed sea turtles. Sea turtles are expected to undergo short term stress or mild injury from incidental capture in these areas; however, all captured individuals would be expected to return to normal body chemistry shortly after release consistent with the literature (Hoopes et al., 2000).

Responses to Handling, Size Measurements, and Ultrasound Examinations

Handling and restraining smalltooth sawfish may cause short term stress responses similar to those expected during capture. Marine fish been shown to exhibit stronger or even lethal stress responses during handling when water temperatures are high or dissolved oxygen levels are sufficiently low (Moser et al., 2000; Kahn and Mohead, 2010). Signs of handling stress are redness around the neck and fins and soft fleshy areas, excess mucus production on the skin, and a rapid flaring of the gills. Mitigation measures such as checking nets more frequently in warm water conditions (i.e., over 30°C) and avoiding keeping any individual out of the water longer more than a minute without having water run through its mouth and over its gills should help minimize these stress responses and avoid any long term fitness consequences. Based on these measures, NMFS expects that individual sawfish handled for size measurements are expected to experience no more than short-term stress as a result of these activities with no long term fitness consequences anticipated.

Researchers will also perform ultrasound examinations to determine stomach contents, gonad size, and brood size (in the case of adult females). The time required for ultrasounds is around five minutes for juveniles and up to ten minutes for adults due to adults typically having more stomach contents. During the ultrasound procedure, the spiracles and gills will be kept in the water at all times. Also, researchers will not keep any captured individuals out of the water longer than one minute without having water run through its mouth and over its gills to minimize stress. Based on these measures, we expect smalltooth sawfish undergoing ultrasound examinations to undergo short term stress similar to capture and handling with no long term fitness consequences anticipated.

Handling can raise levels of stressor hormones in sea turtles even after they are removed from nets or de-hooked (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 onboard may result in heightened lactate production compared to if the individuals were immediately released from the gear and allowed to swim away freely. However, despite this threat, it is expected that any additional handling time will be kept at a minimum as researchers will only measure and photograph incidentally caught sea turtles before releasing them. Researchers are not proposing any prolonged holding or transporting of sea turtles so the additional stress response from handling and measuring is expected to be minimal compared to the response from capture. Therefore, NMFS expects that indicentally captured sea turtles will experience some additional short-term stress as a result of handling by researchers but that stress levels would return to normal soon after release with no long term fitness consequences expected for handled individuals.

Responses to Tissue, Biopsy, and Blood Sampling

Tissue samples will be clipped from dorsal fins of smalltooth sawfish and a biopsy sample would be collected from either the dorsal flank or from an external lesion on another part of the sawfish' body. Possible responses include short term injury or infection at the clipped or biopsied site; however, researchers are expected to disinfect all instruments prior to obtaining samples and researchers have never encountered problems with recaptured individuals from which a fin clip or biopsy sample was obtained. Researchers are also expected 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 sampling animals. Many researchers have removed tissue samples according to this same protocol with no observed mortalities (Wydoski and Emery, 1983); therefore, we do not anticipate any long-term adverse effects to smalltooth sawfish as a result of tissue or biopsy sampling as the affected area is expected to heal shortly after sampling.

In addition to tissue and biopsy samples, researchers would also obtain blood samples from captured smalltooth sawfish using caudal venipuncture with a syringe. As a general guideline, up to 10 percent of circulating blood volume can be collected from an animal in a single sampling without significant disturbance to the individual's normal physiology (Diehl et al., 2001). Given this, researchers will limit the amount of blood drawn to less than six percent of the total blood volume based on the weight of the sampled individual. Using these protocols typically results in one milliliter drawn from individuals under one kilogram, three milliliters for individuals between one and two kilograms, and five milliliters for individuals over two kilograms in weight. In order to ensure the samples are taken with minimal impact to the smalltooth sawfish, all staff listed on the permit to blood sample would be trained on blood draw procedures from experienced scientists and/or veterinarians and no recaptured individuals would have blood drawn a second time in any one year. If any sawfish is seriously injured during sampling, blood draws would be immediately suspended. Given these measures, NMFS expects that blood sampling would only result in short term stress to smalltooth sawfish similar to capture and handling with no long term fitness consequences since the affected area would be expected to heal shortly after sampling.

Responses to PIT Tagging

PIT tags have been extensively used in the past with a wide variety of animals including many fish species (Clugston, 1996; Skalski et al., 1998; Dare, 2003). When PIT tags are inserted into animals that have large body sizes relative to the size of the tag, empirical studies have generally demonstrated that the tags have no adverse effect on the growth, survival, reproductive success, or behavior of individual animals (Brännäs et al., 1994; Elbin and Burger, 1994; Keck, 1994; Jemison et al., 1995; Clugston, 1996; Skalski et al., 1998; Hockersmith et al., 2003). NMFS expects the relatively small sizes of the PIT tags (12 millimeters) relative to the expected sizes of smalltooth sawfish individuals to be fitted with tags would not reduce swimming ability or cause any detrimental effects. There is one record of a young sturgeon mortality within the first 24-48 hours of PIT tag insertion as a result of the tags being inserted too deeply. Henne et al. (2003) found 14 millimeter tags injected into smaller sturgeon caused mortality after 48 hours and later inferred from his results that either 11.5 or 14 millimeter PIT tags would not cause mortality in sturgeon equal to or longer than 330 millimeters. Researchers are expected to use 12 millimeter size PIT tags which should avoid this type of response and researchers have not reported any serious injuries or mortalities of sawfish from PIT tagging in monitoring reports submitted under their prior permit.

The effects of other types of invasive tags (i.e., dart tags) were analyzed by Heupel and Bennett (1997), who sampled the dermal and epidermal tissues of sharks and examined them histologically. Tissues from around tag sites were removed at time intervals ranging from 100 minutes to 284 days post-tagging. These samples showed acute and chronic responses to tagging consisting of localized tissue breakdown and hemorrhaging within the first few hours after tag insertion and then fibrous tissue formation 10-284 days after tagging in an effort to sequester the tag (Heupel and Bennett, 1997). However, tissue repair appeared to progress consistently in all specimens and no secondary infections at the tag site were seen. Tagging produced only localized tissue disruption and did not appear to be detrimental to the long term health of individual sharks in the study. Based on the measures proposed as well as the expected size-to-weight ratios expected, NMFS expects minor tissue damage and minimal discomfort due to the insertion of the tag but that the small wound resulting from the insertion of the tag would heal soon upon release with no long term fitness consequences expected for tagged individuals.

Responses to CTD and Acoustic Tagging using either Rototag or Neoprene Attachment Methods

All captured smalltooth sawfish will be fitted with CTD and acoustic tags using two different attachment methods depending on equipment availability. The first method being proposed is to attach a rototag base to the dorsal fin of the sawfish by punching a 3-5 millimeter hole and fastening two halves of the tag through the fin and then epoxying (or “gluing”) the CTD and acoustic tags to the rototag. The second method being proposed is to attach the tags using a neoprene clasp by creating two small 1-2 millimeter holes through the base of the dorsal fin, running antichaffing tubing through the holes, and epoxying the CTD and acoustic tags to the plastic backings and the clasp attached to either side of the fin (see **Figure 1** and **Figure 2** in the *Description of the Proposed Action* section of this Opinion for more details).

Manire and Gruber (1991) documented the effects of punching holes in the dorsal fins of elasmobranchs by taking five millimeter sized hole punches from the fin of lemon sharks. They found the holes were readily apparent for two to four weeks and became scars within a year of removing the punch from the dorsal fin. Heupel et al. (1998) monitored the effects of rototagging in carcharhinids and found that no infection was observed in tissues surrounding the wound. Disruption of the fin surface was observed due to abrasion by the tag, but did not appear to cause a severe tissue reaction. Past monitoring reports showed that some tags migrated through the fin, presumably from tags getting caught on debrise such as mangrove branches, etc. However, in all cases, the recaptured sawfish did not appear to be in poor health and no mortalities resulted (see Poulakis et al., 2010). A few sawfish have been recaptured with healed notches in the posterior margin of the fins where the dorsal fin tags were previously located showing evidence that the tagged area sufficiently healed once the tag migrated through the fin (see **Figure 4** below). It is expected that any short term injury sustained by attachment of the tags would eventually heal thereby preventing any type of long term adverse effects to tagged individuals.

Figure 4. Dorsal fins from recaptured sawfish (identified from PIT tags). The first photograph shows the dorsal fin of a sawfish that was originally tagged March 29, 2005 and recaptured on June 2, 2006 while the second photograph shows the dorsal fin of a sawfish originally tagged August 1, 2006 and recaptured on April 12, 2007. Source of Photographs: G.R. Poulakis, NMFS Permit No. 1475.

The neoprene clasp procedure also to be utilized by the researchers is expected to require a puncture wound much smaller (1-2 millimeter hole) compared those studied in Manire and Gruber (1991) and would also be smaller than those currently being employed by the researchers through attachment of rototags. The puncture wound produced with the neoprene clasp would be similar to inserting a PIT tag; however, it would be made through the anterior portion of the dorsal fin, a much more stable area consisting primarily of connective tissue. Simpfendorfer et al. (2010) observed no discomfort or bleeding while using this procedure and Wetherbee et al. (2007) indicated tag retention was excellent well after the study was completed. Therefore, NMFS expects stresses resulting from attachment of CTD and acoustic tags by the modified neoprene clasp technique to be short term in nature similar to responses seen for PIT tagging and that the small wound resulting from the insertion of the tag would heal soon upon release with no long term fitness consequences expected for tagged individuals similar to effects seen under the rototag attachment method.

Responses to Satellite Tagging using a Harness

Researchers are proposing to utilize a harness attachment method to attach satellite tags to large juveniles and adults (individuals over two meters TL). When attached, the satellite tag trails just behind the dorsal fin as the sawfish is released. The metal crimps will corrode over time and the tag will slip off the animal leaving only a small hole. Given the larger size of the animals to be tagged with this method (i.e., juveniles and adults over two meters TL), researchers anticipate that any rare snagging of the harness by mangroves or other underwater debris would result in the crimps breaking off and the tag floating free to minimize ripping of the dorsal tissue.

As with other tag attachments, the anterior section of the dorsal fin, through which the harness will be threaded, consists of connective tissue with very little vascularization; therefore the insertion of the harness cable would not expect to result in bleeding for those individuals fitted with satellite tags. The effects are expected to be similar to other types of tagging [i.e. localized tissue disruption but no long term detrimental health effects (Heupel and Bennett, 1997). The harness technique should help minimize the effects of the tag being ripped off the sawfish prematurely, thus minimizing the chance for lesions or other injuries to develop as have been observed under other techniques (i.e., use of an an umbrella dart). To be conservative and ensure the tag to animal weight ratio is not exceeded, satellite tags are used only on sawfish exceeding two meters TL. In all situations however, the researchers have established length standards to ensure that the size to weight ratio does not interrupt normal swimming behavior or result in detrimental health effects to sampled individuals. Therefore, while the attachment of tags may cause some minor drag effects after release, we expect these effects to be minimal given the relative size to weight ratios expected.

Another important consideration is whether the sounds emitted by the transmitters would attract potential predators, primarily sharks. Hearing data on sharks is limited. Casper and Mann (2004) examined the hearing abilities of the nurse shark (*Ginglymostoma cirratum*), and results showed that this species detects low-frequency sounds from 100 to 1,000 Hz, with best sensitivity from 100 to 400 Hz. Hueter et al. (2004) explained that audiograms have been published on elasmobranchs. Although we do not have hearing information for all the sharks that could potentially prey on smalltooth sawfish, estimates for hearing sensitivity in available studies provided ranges of 25 to 1,000 Hz. In general, these studies found that shark hearing is not as sensitive as in other tested fishes, and that sharks are most sensitive to low-frequency sounds (Kritzler and Wood, 1961; Banner, 1967; Casper et al., 2003). Thus, it appears that the acoustic and satellite transmitters will not attract potential shark predators to the sawfish, because the frequency of the sonic tags is well above the 1,000-Hz threshold.

Based on the effects seen for other types of tagging and given the expected size-to-weight ratios expected, NMFS expects stresses as a result of satellite tagging using the harness method to be minimal and short-term. Also, the signals emitted by the transmitters are not expected to be in the range heard by predators. Therefore, NMFS does not expect any long term fitness consequences as a result of proposed satellite tagging of larger juvenile and adult smalltooth sawfish.

Risk Analysis

Our risk analyses reflect 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 given their exposure to the action’s effects and the likely responses given that exposure. Ideally, risk analyses would consider and weigh evidence of adverse consequences as well as evidence suggesting the absence of such consequences. We then integrate those individual risks to identify consequences to the populations those individuals represent. Our analyses then determine the consequences those population-level risks have to the species as a whole. Our final jeopardy 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. For more information the specific parameters used to evaluate risk at each phase, please refer to the *Approach to the Assessment* section of this Opinion.

Smalltooth Sawfish (U.S. DPS)
The research activities to be authorized in permit No. 15802 are not expected to result in mortality or serious injury for listed smalltooth sawfish based on monitoring reports submitted over the past eight years by both the current researchers as well as others in their field. Based on observations from prior sampling efforts and in the literature on the expected responses of these species to capture, handling, tissue sampling, blood sampling, and tagging, NMFS expects that the proposed research activities are likely to result in short-term stress responses and minimal injury by way of localized tissue disruption with no long-term fitness consequences for sampled individuals. Based on the best scientific information available, we anticipate that research activities may result in short term fitness consequences for exposed individuals but are not likely to result in any long term consequences such as mortality, serious injury, or disruption of essential behaviors such as feeding, mating, or nursing, to a degree that the individual's likelihood of successfully reproducing or surviving in the wild is substantially reduced. Since we do not anticipate any long term fitness consequences for individuals, we do not, in turn, anticipate adverse consequences for the populations those individuals represent or the species for which those populations comprise.

Loggerhead (Northwest Atlantic Ocean DPS), Green (Florida Breeding Population and Rangewide Population), Kemp's Ridley, Hawksbill, and Leatherback Sea Turtles
The consequences of capturing sea turtles incidental to the proposed research can range from short term stress responses to serious injury or death as a result of forced submergence due to entanglement or hooking injuries (Ryder et al., 2006). Based on prior monitoring reports submitted by smalltooth sawfish researchers as well as the mitigation measures to be employed such as de-hooking procedures and short soak times, we expect that any sea turtles captured, measured, and handled would be expected to undergo short-term stress responses (manifested as a change in lactate acid levels) and/or minimal injury from capture. However, it is anticipated that all individuals will return to normal body chemistry and resume normal behaviors a short time after capture which should avoid any long term adverse fitness consequences for captured individuals. Since we do not anticipate any long term fitness consequences for individuals, we do not, in turn, anticipate adverse consequences for the populations those individuals represent or the species for which those populations comprise.

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 and marine fish 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 or degradation of rivers and estuarine areas utilized by smalltooth sawfish.

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 marine fish and 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). 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 marine fish and 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

The following text integrates and synthesizes the *Description of the Action, Status of the Species*, *Environmental Baseline*, *Effects of the Proposed Action, and Cumulative Effects* sections of this Biological Opinion. This information was used to assess the effects and subsequent risks the proposed action poses to ESA-listed smalltooth sawfish and sea turtles that may be adversely affected by the proposed action.

The Permits Division proposes to issue permit No. 15802 to FWC (Gregg Poulakis, responsible party) for direct "takes" to smalltooth sawfish and five species of sea turtles [i.e., loggerhead (Northwest Atlantic Ocean DPS), green (Florida Breeding Population and Rangewide Population), hawksbill, Kemp's ridley, and leatherback sea turtles for the purposes of scientific research, pursuant to section 10(a)(1)(A) of the ESA. The permit would be valid for five years from the date of issuance. The objective of the research is to obtain data on smalltooth sawfish movements and habitat use (juveniles and adults), relative abundance of juveniles, temporal and spatial distributions, and baseline assessments of health (e.g., toxicology). While sea turtles are not directly targeted, researchers do intend to measure and handle sea turtles before release and thus requested that takes to sea turtles be included in their permit. Takes are expected to be in the form of capture, wounding, and harassment for all sampled individuals.

Researchers propose to directly capture smalltooth sawfish and opportunistically capture sea turtles by way of longlines, hook and line, gill nets, and seine nets. Researchers will conduct both random sampling and directed sampling with defined areas at the mouths of the Peace, Myakka, and Caloosahatchee rivers in the Charlotte Harbor estuarine system on the southwest coast of Florida although additional areas will sampled if researchers receive reports of occurrences through the sawfish reporting network. In addition to capture, smalltooth sawfish and sea turtles will be exposed to handling and size measurements and sawfish will also undergo a short ultrasound examination. All captured sawfish will be fin clipped, biopsy sampled, blood sampled, PIT tagged, and be fitted with CTD and acoustic tags by either attaching a rototag base to the dorsal fin and epoxying the additional tags to the rototag or by attaching them to a neoprene clasp. In addition, larger juveniles and adults (individuals over two meters TL) will be fitted with satellite tags that would be attached using a harness and trail the dorsal fin of the sawfish after release.

Smalltooth sawfish have undergone severe declines in abundance due to various threats including bycatch in various commercial and recreational fisheries, habitat modification, water pollution, and modification of natural freshwater flows through construction of canals and other controlled devices (NMFS, 2009a). Activities such as agricultural and urban development, commercial activities, dredge and fill operations, boating, erosion, and diversions of freshwater runoff contribute to these effects (SAFMC, 1998). Smalltooth sawfish are also limited by certain life history characteristics as slow growing, late maturing, and long-lived species making them particularly vulnerable to stochastic changes as well as making them very slow to recover. Simpfendorfer (2001) estimated that the U.S. population of smalltooth sawfish may number less than five percent of historic levels.

Sea turtles have also been impacted historically by domestic and international fishery operations that often capture, injure, and even kill sea turtles at various life stages. The Southeast U.S. Shrimp Fishery (which uses otter trawl gear) has historically been one of the largest fishery threats to sea turtles in the southeastern U.S. (Murray, 2006) and continues to interact with (and kill) large numbers of turtles each year. There are also many non-fishery impacts affecting the status of sea turtle species, including entrainment in Hopper dredges, water pollution from coastal areas and oil spills, degradation of nesting beaches, and harassment and/or injury resulting from private and commercial vessel operations, military detonations and training exercises, and scientific research activities. Atmospheric warming creates habitat alteration which may change sex ratios and affect reproductive periodicity for nesting sea turtles in the years to come.

Taken together, the components of the environmental baseline for the action area include sources of natural mortality – such as predation, disease, and climate variability – as well as human activities resulting in disturbance, injury, or mortality of individuals. Stedman and Dahl (2008) estimated that the Gulf of Mexico region of the U.S. lost an average of 60,000 acres of wetland habitat annually from 1998 to 2004. These losses have been attributed to commercial and residential development, port construction (dredging, blasting, and filling activities), construction of water control structures, modification to freshwater inflows, and oil and gas related activities (SAFMC, 1998). Riverine systems throughout the smalltooth sawfish’s historical range has already been altered or dammed thus limiting the species’ ability to expand its current range.

Anthropogenic activities such as discharges from wastewater systems, dredging, ocean dumping and disposal, aquaculture, and additional impacts from coastal development are known to degrade coastal waters utilized by sea turtles in the action area. Also, 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 sea turtle adults as well as hatchlings in the action area. Since March 15, 2011, a notable increase in sea turtle standings has occurred in the Northern Gulf of Mexico although the cause of this increase is unknown. The Sea Turtle Stranding and Salvage Network is currently investigating the cause of this increase in strandings although two primary considerations for the cause of death are forced submergence (fishing related) and acute toxicosis (from algal blooms or related to the oil spill) based on necropsies that have been performed thus far. More research will need to be done to determine the short and long term effects that oil spills such as the *Deep Horizon* oil spill in the Gulf of Mexico has on Kemp's ridleys and other sea turtle populations in the action area in the coming years.

This consultation focused our assessment on the following stressors for which listed species are likely to be exposed and may have a measurable effect: stress/injury/forced submergence due to net, hook and line, and longline capture; forced submergence due to longline and net capture; stress from handling, measurements, and ultrasound examinations; wounding/stress/increased drag due to tag attachment (PIT tags, CTD and acoustic tags attached using either rototag or neoprene methods, and satellite tags using a harness); and stress/wounding due to blood, tissue, and biopsy sampling.

Summary of Effects to Smalltooth Sawfish

We evaluated the researcher's previous catch numbers and accounted for the increase in effort anticipated under their proposed permit to evaluate exposure that is likely to occur over the five year permit duration. We anticipate that up to 125 juveniles (under two meters TL) would be exposed to stress/injury/forced submergence from capture by way of longlines, gillnets, and/or seine nets; stress from handling and size measurements; and stress, wounding, and increased drag from attaching PIT tags and CTD/acoustic tags (attached using either rototag or neoprene methods). Based on recapture data we expect that of the 125 juveniles caught, a little over a third (i.e., 36 percent) would be recaptures. Researchers anticipate that recaptured individuals would only be handled, measured, and any lost tags would be reapplied. Therefore, of the total 125 juveniles, we anticipate that only 80 would be exposed to stress from ultrasound examinations as well as wounding from blood sampling, tissue sampling (fin clips), and biopsy sampling since recaptured individuals would not be exposed to these stressors a second time. An additional 15 larger juveniles (between two and three meters TL) would be exposed to satellite tag attachment using a harness in addition to the other stressors. We are also provisionally accepting the total take numbers for adults that were proposed by the Permits Division (i.e., 50 total adults captured each year 15 of which would be exposed to all stressors including being fitted with satellite tags) although future monitoring reports submitted by the researchers will further inform this analysis.

Nets, rod-and-reel, and longline gear proposed can result in short term stress, injury or mortality to smalltooth sawfish (Musick et al., 2001; Simpfendorfer, 2006) based on years of data on incidental captures reported for commercial fisheries. Based on the researchers prior experience and monitoring reports submitted under their prior permit

(No. 1475), we do not expect any sawfish to be seriously injured during capture based on the specific mitigation measures and handling requirements to be followed by the researchers. However, sawfish are still likely to experience physiological stress responses as a result of being captured based on prior studies (Korte et al., 2005; Lankford et al., 2005; Moberg, 2000; Sapolsky et al., 2000).

Signs of handling stress are redness around the neck and fins and soft fleshy areas, excess mucus production on the skin, and a rapid flaring of the gills. Mitigation measures such as checking nets more frequently in warm water conditions (i.e., over 30^{o}C) and avoiding keeping any individual out of the water longer more than a minute without having water run through its mouth and over its gills should help minimize these stress responses and avoid any long term fitness consequences. Based on these measures, NMFS expects that individual sawfish handled for size measurements are expected to experience no more than short-term stress as a result of these activities with no long term fitness consequences anticipated.

Possible responses from skin and blood sampling include short term injury or infection at the clipped or biopsied site; however, researchers are expected to disinfect all instruments prior to obtaining samples and researchers have never encountered problems with recaptured individuals from which a fin clip or biopsy sample was obtained. Many researchers have removed tissue samples according to this same protocol with no observed mortalities (Wydoski and Emery, 1983); therefore, we do not anticipate any long-term adverse effects to smalltooth sawfish as a result of tissue or biopsy sampling as the affected area is expected to heal shortly after sampling. Researchers will limit the amount of blood drawn to less than six percent of the total blood volume based on the weight of the sampled individual which should avoid adverse effects and result in only short term injury with the affected area expected to heal shortly after sampling.

When PIT tags are inserted into animals that have large body sizes relative to the size of the tag, empirical studies have generally demonstrated that the tags have no adverse effect on the growth, survival, reproductive success, or behavior of individual animals (Brännäs et al., 1994; Elbin and Burger, 1994; Keck, 1994, Jemison et al., 1995; Clugston, 1996, Skalski et al., 1998, Hockersmith et al., 2003). NMFS expects the relatively small sizes of the PIT tags (12 millimeters) relative to the expected sizes of smalltooth sawfish individuals to be fitted with tags would not reduce swimming ability or cause any detrimental effects. Based on the measures proposed as well as the expected size-to-weight ratios expected, NMFS expects minor tissue damage and minimal discomfort due to the insertion of the tag but that the small wound resulting from the insertion of the tag would heal soon upon release with no long term fitness consequences expected for tagged individuals.

All captured smalltooth sawfish will be fitted with CTD and acoustic tags using two different attachment methods depending on equipment availability. The first method being proposed is to attach a rototag base while the second method uses a neoprene clasp both of which would be attached to the dorsal fin of sampled sawfish. Manire and Gruber (1991) found holes punched in the dorsal fins of elasmobranchs were readily apparent for two to four weeks and became scars within a year of removing the punch from the dorsal fin. Heupel et al. (1998) monitored the effects of rototagging in carcharhinids and found that no infection was observed in tissues surrounding the wound. Disruption of the fin surface was observed due to abrasion by the tag, but did not appear to cause a severe tissue reaction. Past monitoring reports showed that some tags migrated through the fin, presumably from tags getting caught on debrise such as mangrove branches, etc. However, in all cases, the recaptured sawfish did not appear to be in poor health and no mortalities resulted (see Poulakis et al., 2010). A few sawfish have been recaptured with healed notches in the posterior margin of the fins where the dorsal fin tags were previously located showing evidence that the tagged area sufficiently healed once the tag migrated through the fin. It is expected that any short term injury sustained by attachment of the tags would eventually heal thereby preventing any type of long term adverse effects to tagged individuals.

Researchers are proposing to utilize a harness attachment method to attach satellite tags to large juveniles and adults (individuals over two meters TL). When attached, the satellite tag trails just behind the dorsal fin as the sawfish is released. The metal crimps will corrode over time and the tag will slip off the animal leaving only a small hole that should eventually heal over time. Given the larger size of the animals to be tagged with this method (i.e., juveniles and adults over two meters TL), researchers anticipate that any rare snagging of the harness by mangroves or other underwater debris would result in the crimps breaking off and the tag floating free to minimize ripping of the dorsal tissue. The researchers have established length standards to ensure that the size to weight ratio does not interrupt normal swimming behavior or result in detrimental health effects to sampled individuals. Therefore, while the attachment of tags may cause some minor drag effects after release, we expect these effects to be minimal given the relative size to weight ratios expected. Also, the signals emitted by the transmitters are not expected to be in the range heard by predators. Therefore, NMFS does not expect any long term fitness consequences as a result of proposed satellite tagging of larger juvenile and adult smalltooth sawfish.

The research activities to be authorized in permit No. 15802 are not expected to result in mortality or serious injury for listed smalltooth sawfish based on monitoring reports submitted over the past eight years by both the current researchers as well as others in their field. Based on the best scientific information available, we anticipate that research activities may result in short term fitness consequences for exposed individuals but are not likely to result in any long term consequences such as mortality, serious injury, or disruption of essential behaviors such as feeding, mating, or nursing, to a degree that the individual's likelihood of successfully reproducing or surviving in the wild would be substantially reduced. Since we do not anticipate any long term fitness consequences for individuals, we do not, in turn, anticipate adverse consequences for the populations those individuals represent or the species for which those populations comprise.

Summary of Effects to Sea Turtles

We anticipate that twice as many loggerheads will be captured each year compared with other species. Therefore, while we accepted the take numbers proposed for loggerheads

(10 individuals over the life of the permit), hawksbills (6 individuals over the life of the permit), and leatherbacks (6 individuals over the life of the permit), we assessed exposure of green and Kemp's ridley sea turtles at lower levels than what was proposed by the Permits Division (6 individuals each over the life the permit rather than 10 individuals which was proposed). We feel these exposure estimates are more likely to occur based on the best available information at the time of this consultation. All sea turtles would be exposed to stress/injury/forced submergence from capture in longlines, hook and line, or nets as well as stress from handling and measurements only. No sea turtles will be exposed to the other stressors evaluated in this Opinion.

Based on a review of the literature as well as recent monitoring reports submitted by researchers, sea turtles are expected to respond to net, hook-and-line, and nearshore and offshore longline capture with varying degrees of responses ranging from short term stress to serious injury or even death due to continued forced submergence or injury from being hooked. Sea turtles that are forcibly submerged also undergo respiratory and metabolic stress that can lead to severe disturbance of their acid-base balance which is particularly concerning for juveniles undergoing multiple captures over a short period of time. NMFS reviewed monitoring reports submitted by smalltooth sawfish researchers over the past eight years and found that of the three sea turtles encountered, all were released alive with no apparent long term fitness consequences as a result of the encounter. A majority of the research effort expected is to occur in nearshore and estuarine waters where shorter set lines are to be used compared to longer soak times practiced by commercial fisheries.

NMFS believes that based on the types of equipment to be used in nearshore areas, the fact that no sea turtle mortalities have been reported to date from similar surveys, and the fact that permit conditions require researchers to follow de-hooking protocol as outlined in NMFS' *Careful Release Protocols for Sea Turtle Release with Minimal Injury* and to periodically check their nets for bycatch, we do not anticipate mortalities or serious injuries to occur to listed sea turtles. Sea turtles are expected to undergo short term stress or mild injury from incidental capture in these areas; however, all captured individuals would be expected to return to normal body chemistry shortly after release consistent with the literature (Hoopes et al., 2000).

Based on the best scientific information available, we anticipate that research activities may result in short term fitness consequences for exposed individuals but are not likely to result in any long term consequences such as mortality, serious injury, or disruption of essential behaviors such as feeding, mating, or nursing, to a degree that the individual's likelihood of successfully reproducing or surviving in the wild would be substantially reduced. Since we do not anticipate any long term fitness consequences for individuals, we do not, in turn, anticipate adverse consequences for the populations those individuals represent or the species for which those populations comprise.

Summary of Cumulative Effects

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. Climatic variability has the potential to affect listed species in the action area through 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. 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 or degradation of rivers and estuarine areas utilized by smalltooth sawfish.

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. For sea turtle species in the Atlantic, international activities, particularly fisheries, are significant factors impacting populations. As the size of human communities increase, there is also 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. 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 the 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 have on the survival and recovery of these species.

CONCLUSION

After reviewing the current status of listed species affected by the proposed action, the environmental baseline for the action area, the anticipated effects of the proposed research activities and the possible cumulative effects, it is the ESA Interagency Cooperation Division's opinion that the Permits Division's proposed action of issuing permit No. 15802, as proposed, is not likely to jeopardize the continued existence of ESA-listed smalltooth sawfish, loggerhead sea turtles (Northwest Atlantic Ocean DPS), green sea turtles (Florida Breeding Population and Rangewide Population), Kemp's ridley sea turtles, hawksbill sea turtles, and leatherback sea turtles under NMFS' authority.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and federal regulation pursuant to section 4(d) of the ESA prohibit the "take" of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the NMFS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Sections 7(b)(4) and 7(o)(2), taking that is incidental and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

However, as discussed in the accompanying Opinion, only the species targeted by the proposed research activities will be taken by way of capture, wounding, and harassment as part of the intended purpose of the proposed action. Therefore, NMFS does not expect the proposed action will incidentally take any threatened or endangered species.

CONSERVATION RECOMMENDATIONS

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

We recommend the following conservation recommendation, which would provide information for future consultations involving the issuance of permits that may affect listed smalltooth sawfish as well as reduce harassment related to the authorized activities:

1. *Reporting Survey Days in Annual Reports*. The Permits Division should encourage researchers to log the actual number of survey days completed each sampling season and include this information in the annual reports submitted to NMFS' Office of Protected Resources. Knowing the number of survey days in addition to the number of takes improves our ability to estimate exposure of listed species for a given level of effort and would help NMFS' Office of Protected Resources determine the appropriate level of take to authorize in future permits.

2. *Cumulative Impact Analysis*. The Permits Division should work with the smalltooth sawfish recovery team and the research community to identify a research program with sufficient scope and depth to determine cumulative impacts of existing levels of research on smalltooth sawfish and other listed species. This includes the cumulative sub-lethal and behavioral impacts of research permits.

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

REINITIATION NOTICE

This concludes formal consultation on the proposal to issue scientific research permit No. 15802. 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 proposed take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of authorized take is exceeded, the Permits Division must immediately request reinitiation of section 7 consultation.

LITERATURE CITED

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.

Adams, W.F. and C. Wilson. 1995. The status of the smalltooth sawfish, *Pristis pectinata* Latham 1794 (Pristiformes: Pristidae) in the United States. Chondros 6(4):1-5.

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.

Amos, A.F. 1989. The occurrence of hawksbills Eretmochelys imbricata along the Texas coast. Pages 9-11 in S.A. Eckert, K.L. Eckert, and T.H. Richardson, compilers. Proceedings of the ninth annual workshop on sea turtle conservation and biology. NOAA technical memorandum NMFS/SEFC-232

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

Avens, L. and L.R. Goshe. 2007. Comparative skeletochronological analysis of Kemp's ridley (Lepidochelys kempii) and loggerhead (Caretta caretta) humeri and scleral ossicles. Mar Biol 152:1309–1317.

Baker, J.D., C.L. Littnan, and D.W. Johnston. 2006. Potential effects of sea level rise on the terrestrial habitats of endangered and endemic megafauna in the Northwestern Hawaiian Islands. Endangered Species Research 2: 21-30.

Balazs, G.H. 1982. Growth rates of immature green turtles in the Hawaiian Archipelago. In: Bjorndal, K.A. (Ed.), Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C., pp. 117-125.

Balazs, G.H. 1983. Recovery records of adult green turtles observed or originally tagged at French Frigate Shoals, northwestern Hawaiian Islands. p. 47 pp.

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.

Banner, A. 1967. Evidence of sensitivity to acoustic displacements in the lemon shark, Negaprion brevirostris (Poey). pp. 265–273. In: P.H. Cahn (ed.) Lateral Line Detectors, Indiana University Press, Bloomington, Indiana.

Bass, A.L., D.A. Good, K.A. Bjorndal, J.I. Richardson, Z.M. Hillis, J.A. Horrocks, and B.W. Bown. 1996. Testing models of female reproductive migratory behaviour and population structure in the Caribbean hawksbill turtle, *Eretmochelys imbricata*, with mtDNA sequences. Molecular Ecology 5: 321-328.

Beamish, R.J., Noakes, D.J., McFarlane, G.A., Klyashtorin, L., Ivanov, V.V., Kurashov, V. 1999. The regime concept and natural trends in the production of Pacific salmon. Can. J. Fish. Aquat. Sci., 56: 516-526.

Benson, A.J. and A.W. Trites. 2002. Ecological effects of regime shifts in the Bering Sea and eastern North Pacific Ocean. Fish and Fisheries, 9: 95-113.

Bigelow, H.B. and W.C. Schroeder. 1953. Sawfishes, guitarfishes, skates and rays. Pages 1-514 in: Tee-Van, J., C.M. Breder, A.E. Parr, W.C. Schroeder, and L.P. Schultz (eds.), Fishes of the Western North Atlantic, Part Two. Memoir, Sears Foundation for Marine Research.

Bjorndal, K.A. 1982. The consequences of herbivory for the life history pattern of the Caribbean green turtle, *Chelonia mydas*. Pages 111-116 *In:* Bjorndal, K.A. (editor). Biology and Conservation of Sea Turtles. Smithsonian Institution Press. Washington, D.C.

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. 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 pp.

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., J.A. Wetherall, A.B. Bolten, and J.A. Mortimer. 1999. Twenty-Six Years of Green Turtle Nesting at Tortuguero, Costa Rica: An Encouraging Trend. Conservation Biology 13, 126-134.

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

Bleakney, J.S. 1955. Four records of the Atlantic ridley turtle, *Lepidochelys kempi*, from Nova Scotia. Copeia 2:137.

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. and H.R. Martins. 1990. Kemp's ridley captured in the Azores. Marine Turtle Newsletter 48:23.

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.

Bolten, A.B., K.A. Bjorndal, H.R. Martins, T. Dellinger, M.J. Biscoito, S.E. Encalada, and B.W. Bowen. 1998. Transatlantic developmental migrations of loggerhead sea turtles demonstrated by mtDNA sequence analysis. Ecol. Appl., 8, 1–7.

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

Boulan, R.H., Jr. 1983. Some notes on the population biology of green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles in the northern U.S. Virgin Islands: 1981-1983. Report to the National Marine Fisheries Service, Grant No. NA82-GA-A-00044. 18pp.

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

Bowen, B.W., A.B. Meylan, J.P. Ross, C.J. Limpus, G.H. Balazs, and J.C. Avise. 1992. Global Population Structure and Natural History of the Green Turtle (Chelonia mydas) in Terms of Matriarchal Phylogeny. Evolution 46, 865-881.

Bowen, B.W., A.L. Bass, A. Garcia-Rodriguez, C.E. Diez, R. van Dam, A. Bolten, K.A. Bjorndal, M.M. Miyamoto, and R.J. Ferl. 1996. Origin of hawksbill turtles in a

Caribbean feeding area as indicated by genetic markers. Ecological Applications 6(2): 566-572.

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

Bräutigram, 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. 547pp.

Brännäs, E., H. Lundqvist, E. Prentice, M. Schmitz, K. Brännäs, and B. Wiklund. 1994. Use of the passive integrated transponder (PIT) in a fish identification and monitoring system for fish behavioral studies. Transactions of the American Fisheries Society Symposium 123:395-401.

Breder, C.M. 1952. On the utility of the saw of the sawfish. Copeia 1952(2):90-91.

Bresette, M.J., R.M. Herrin, D.A. Singewald. 2003. Sea turtle captures at the St. Lucie nuclear power plant: A 25 year synopsis, p. 46. In: J. Seminoff (compiler). Proceedings of the twenty-second annual symposium on sea turtle biology and conservation. NOAA Technical Memorandum, NMFS-SEFSC-53. 336pp.

Bresette, M.J., D. Singewald, and E. De Maye. 2006. Recruitment of post-pelagic green turtles (*Chelonia mydas*) to nearshore reefs on Florida's east coast. Page 288 *In:* Frick, M., A. Panagopoulou, A.F. Rees, and K. Williams (compilers). Book of Abstracts. Twenty-sixth annual symposium on sea turtle biology and conservation. International Sea Turtle Society, Athens, Greece.

Brongersma, L.D. 1972. European Atlantic Turtles. Zoologische Verhandelingen 121:318.

Brongersma, L. and A. Carr. 1983. *Lepidochelys kempii* (Garman) from Malta. Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen (Series C). 86(4):445-454.

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

Butler, P. J., W.K. Milsom, and A.J. Woakes. 1984. Respiratory, cardiovascular and metabolic adjustments during steady state swimming in the green turtle, Chelonia mydas. J. comp. Phvsiol. 154B: 167-174.

Caldwell, S. 1990. Texas sawfish: Which way did they go? Tide (Jan.-Feb.):16–19.

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

Carballo, A.Y., C. Olabarria, and T. Garza Osuna. 2002. Analysis of four macroalgal assemblages along the Pacific Mexican coast during and after the 1997-98 El Niño. Ecosystems 5(8): 749-760.

Carlson, J.K. J. Osbourne and T.W. Schmidt. 2007. Monitoring the recovery of smalltooth sawfish, *Pristis pectinata*, using standardized relative indices of abundance. Biological Conservation 136:195–202.

Carr, A. 1963. Panspecific reproductive convergence in *Lepidochelys kempii*. Ergebnisse der Biologie 26:298-303.

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.

Carrillo, E., G.J.W. Webb, and S.C. Manolis. 1999. Hawksbill turtles (*Eretmochelys imbricata*) in Cuba: An assessment of the historical harvest and its impacts. Chelonian Conservation and Biology 3(2): 264-280.

Casper B.M., P.S. Lobel, H.Y. Yan. 2003. The Hearing Sensitivity of the Little Skate, *Raja erinacea*: A Comparison of Two Methods. Environmental Biology of Fishes, vol. 68, no. 4, pp. 371-379 (9).

Cetacean and Turtle Assessment Program (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 to the U.S. Dept. of Interior under Contract No. AA551-CT8-48.

Chaloupka, M.Y. and C.J. Limpus. 1997. Robust statistical modeling of hawksbill sea turtle growth rates (southern Great Barrier Reef). Marine Ecology Progress Series 146: 1-8.

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

Chaloupka, M.Y. and J.A. Musick. 1997. Age, growth, and population dynamics. Pages 233-273 *In:* Lutz, P.L. and J.A. Musick (editors). The Biology of Sea Turtles. CRC Press, Boca Raton, Florida.

Chaloupka, M. and G.R. Zug. 1997. A polyphasic growth function for endangered Kemp’s ridley sea turtle, *Lepidochelys kempii*. Fishery Bulletin 95:849-856.

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

Chavez, H., M. Contreras, and D. Hernandez. 1967. Aspectos biologicos y proteccion de la tortuga lora, *Lepidochelys kempii* (Garman), en la costa de Tamaulipas, Mexico., I.N.I.B.P., Publication 17.

Clark, S., Violetta, G. Henningsen, A., Reischuck, V., Mohan, P., Keyon, J. and Kelly, G. 2004. Growth in captive smalltooth sawfish, *Pristis pectinata*. Presentation to the Smalltooth Sawfish Recovery Team, October 2004.

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.

Collard, S.B. and L.H. Ogren. 1990. Dispersal scenarios for pelagic post-hatchling sea turtles. Bulletin of Marine Science 47(1):233-243.

Compagno, L.J.V. 1984. FAO Species Catalogue. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. II Carcharhiniformes. Rome, Italy, FAO Fisheries Synopsis.

Compagno, L.J.V. and S.F. Cook. 1995. The exploitation and conservation of freshwater elasmobranches: status of taxa and prospects for the future. The Journal of Aquariculture and Aquatic Science 7:62-90.

Compagno, L.J.V. and P.R. Last. 1999. Pristidae. Sawfishes. Pp. 1410–1417. In: Carpenter, K.E. and V. Niem (eds.), FAO Identification Guide for Fishery Purposes. The Living Marine Resources of the Western Central Pacific. FAO, Rome, Italy.

Conant, T. 2010. Personal communication. NMFS Office of Protected Resources, Silver Spring, MD.

Conant, T.A., P.H. Dutton, T. Eguchi, S.P. Epperly, C.C. Fahy, M.H. Godfrey, S.L. MacPherson, E.E. Possardt, B.A. Schroeder, J.A. Seminoff, M.L. Snover, C.M. Upite, and B.E. Witherington. 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, August 2009. 222 pp.

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

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.

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.

Deraniyagala, P.E.P. 1938. The Mexican loggerhead turtle in Europe. Nature 142:540.

Diehl, K.H., R. Hull, D. Morton, R. Pfister, Y. Rabemampianina, D. Smith, J.M. Vidal and C. van de Vorstenbosch. 2001. A good practice guide to the asministration of substances and removal of blood, including routes and volumes. Journal of Applied Toxicology 21: 15-23.

Dietrich, K.S., V.R. Cornish, K.S. Rivera, and T.A. Conant. 2007. Best practices for the collection of longline data to facilitate research and analysis to reduce bycatch of protected species. NOAA Technical Memorandum NMFS-OPR-35. 101p. Report of a workshop held at the International Fisheries Observer Conference Sydney, Australia.

Diez, C.E. and R.P. van Dam. 2002. Habitat effect on hawksbill sea turtle growth rates on feeding grounds at Mona and Monita Islands, Puerto Rico. Marine Ecology Progress Series 234: 301-309.

Diez, C.E., and R.P. van Dam. 2007. In-water surveys for marine turtles at foraging grounds of Culebra Archipelago, Puerto Rico Progress Report: FY 2006-2007.

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.

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 pp.

Dutton, P.H., B.W. Bowen, D.W. Owens, A. Barragán, and S.K. Davis. 1999. Global phylogeography of the leatherback turtles (Dermochelys coriacea). J. Zool. London, 248:397-409.

Dutton, P., V. Pease, and D. Shaver. 2006. Characterization of MtDNA variation among Kemp’s ridleys nesting on Padre Island with reference to Rancho Nuevo genetic stock. Proceedings of the 26th Annual Symposium on Sea Turtle Biology and Conservation: Book of Abstracts:189.

Dutton, P.H., G.H. Balazs, R.A. LeRoux, S.K.K. Murakawa, P. Zarate, and L.S. Martínez. 2008. Composition of Hawaiian green turtle foraging aggregations: mtDNA evidence for a distinct regional population. Endang. Species Res., 5: 37-44.

Eckert, K.A. 1992. Five year status reviews of sea turtles listed under the Endangered Species Act of 1973: hawksbill sea turtle Eretmochelys imbricata. U.S. Fish and Wildlife Service P.O. No. 20181-1-0060.

Eckert, K.A. 1995. Hawksbill sea turtle (Eretmochelys imbricata). In: Plotkin, P.T. (Ed.). National Marine Fisheries Service and U.S. Fish and Wildlife Service Status Reviews for Sea Turtles Listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland, pp. 76-108.

Eckert, S.A. and L.M. Sarti. 1997. Distant Fisheries implicated in the loss of the worlds largest leatherback nesting population. Marine Turtle Newsletter 78:2-7.

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

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

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

Ehrhart, L.M., W.E. Redfoot, and D.A. Bagley. 2007. Marine turtles of the central region of the Indian River Lagoon System, Florida. Florida Scientist 70: 415-434.

Elbin, S.B. and J. Burger. 1994. Implantable microchips for individual identification in wild and captive populations. Wildlife Society Bulletin 22:677-683.

Epperly, S.P. 2003. Fisheries-related mortality and turtle excluder devices (TEDS). Pages 339-353 *In:* Lutz, P.L., J.A. Musick, and J. Wyneken (editors). Biology of Sea Turtles, Volume II. CRC Press, Boca Raton, Florida.

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

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

Epperly, S.P., J. Braun, and P.M. Richards. 2007. Trends in catch rates of sea turtle in North Carolina, U.S.A. Endangered Species Research 3:283-293.

Evermann, B.W. and B.A. Bean. 1898. Indian River and its fishes. U.S. Commission of Fish and Fisheries 22:227-248.

Faria, V.V. 2007. Taxonomic review, phylogeny, and geographical population structure of the sawfishes (Chondrichthyes, Pristiformes). Ph.D. dissertation. Iowa State University, Ames, Iowa. 219 p.

Fitzsimmons, N.N., L.W. Farrington, M.J. McCann, C.J. Limpus, and C. Moritz. 2006. Green turtle populations in the Indo-Pacific: a (genetic) view from microsatellites. Page 111 in Pilcher, N. (compiler). Proceedings of the twenty-third annual symposium on sea turtle biology and conservation. NOAA Technical Memorandum NMFS-SEFSC-536.

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.

Florida Fish and Wildlife Conservation Commission (FWC). 2011. Index Nesting Beach Survey Totals (1989-2011). Available online at: http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/ Accessed October 11, 2011.

FWC. 2009. Statewide nesting beach survey program: Leatherback (Dermochelys coriacea), nesting data, 2005-2009. FWC Fish and Wildlife Research Institute. <http://research.myfwc.com/images/articles/2479/leatherback_nesting_data__2005-2009.pdf>

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

Fontaine, C.T., S.A. Manzella, T.D. Williams, R.M. Harris, and W.J. Browning. 1989. Distribution, growth and survival of head started, tagged and released Kemp's ridley sea turtle, (*Lepidochelys kempii* from year-classes 1978-1983, p. 124-144. *In*: C.W. Caillouet, Jr. and A.M. Landry Jr. (editorss), Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management. TAMU-SG: 89-105.

Fourqurean, J.W. and M.B. Robblee. 1999. Florida Bay: a history of recent ecological changes. Estuaries 22:345–357.

Francis, R.C., S.R. Hare, A.B. Hollowed, and W.S. Wooster. 1998. Effects of interdecadal climate variability on the oceanic ecosystems of the NE Pacific. Fisheries Oceanography, 7: 1-21.

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

Frazier, J. 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.

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 pp.

Garduño-Andrade, M., V. Guzmán, E. Miranda, R. Briseno-Duenas, and A. Abreu. 1999. Increases in hawksbill turtle (Eretmochelys imbricata) nestings in the Yucatán Peninsula, Mexico (1977-1996): data in support of successful conservation? Chelonian Conservation and Biology 3: 286-295.

Garrett, C. 2004. Priority Substances of Interest in the Georgia Basin - Profiles and background information on current toxics issues. Technical Supporting Document. Canadian Toxics Work Group Puget Sound/Georgia Basin International Task Force: 402.

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.

Gelsleichter, J., Walsh, C.J., Szabo, N.J., and Rasmussen, L.E.L. 2006. Organochlorine concentrations, reproductive physiology, and immune function in unique populations of freshwater Atlantic stingrays (*Dasyatis sabina*) from Florida's St. Johns River. Chemosphere. 63: 1506-1522.

Geraci, J.R. 1990. Physiological and toxic effects on cetaceans. Pp. 167-197 In: Geraci, J.R. and D.J. St. Aubin (eds), Sea Mammals and Oil: Confronting the Risks. Academic Press, Inc.

Geraci, J.R. and D.J. St. Aubin. 1980. Offshore petroleum resource development and marine mammals: A review and research recommendations. Mar. Fish. Rev., 42: 11:1-12.

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

Gilmore, R.G. 1995. Environmental and biogeographic factors influencing ichthyofaunal diversity: Indian River Lagoon. Bull. Mar. Sci. 57:153–170.

Glen, F., AC. Broderick, BJ. Godley, and G.C. Hays. 2003. Incubation environment affects phenotype of naturally incubated green turtle hatchlings. Journal of the Marine Biological Association of the United Kingdom 83(5): 1183-1186.

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

Goldenberg, S.B., C.W. Landsea, AM. Mestas-Nunez, W.M. Gray. 2001. The recent increase in Atlantic hurricane activity: causes and implications. Science 293:474-479.

Grant, S.C.H. and P.S. Ross. 2002. Southern Resident killer whales at risk: toxic chemicals in the British Columbia and Washington environment. Canadian Technical Report of Fisheries and Aquatic Sciences 2412. Fisheries and Oceans Canada., Sidney, B.C.: 124.

Green, D. 1993. Growth rates of wild immature green turtles in the Galapagos Islands, Ecuador. Journal of Herpetology, 27(3): 338-341.

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

Groombridge, B., and R. Luxmoore. 1989. The green turtle and hawksbill (Reptilia: Cheloniidae): world status, exploitation and trade. CITES Secretariat; Lausanne, Switzerland.

Gulf of Mexico Fishery Management Council (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.

Guseman, J.L. and L.M. Ehrhart. 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.

Hamann, M., C.J. Limpus, and M.A Read. 2007. Chapter 15 Vulnerability of marine reptiles in the Great Barrier Reef to climate change. *In:* Johnson JE, Marshall PA (eds) Climate change and the Great Barrier Reef: a vulnerability assessment, Great Barrier Reef Marine Park Authority and Australia Greenhouse Office, Hobart, p 465-496.

Hanson, J., T. Wibbels, and R.E. Martin. 1998. Predicted female bias in sex ratios of hatchling loggerhead sea turtles from a Florida nesting beach. Canadian Journal of Zoology 76(10):1850-1861.

Hare, S.R., N.J. Mantua, and R.C. Francis. 1999. Inverse production regimes: Alaskan and west coast salmon. Fisheries, 24: 6-14.

Hartwell, S.I. 2004. Distribution of DDT in sediments off the central California coast. Marine Pollution Bulletin, 49: 299-305.

Hawkes L.A., A.C. Broderick, M.H. Godfrey, and B.J. Godley. 2007. Investigating the potential impacts of climate change on a marine turtle population. Global Change Biology 13:923-932.

Hawkes, L.A, AC. Broderick, M.H. Godfrey, and B.J. Godley. 2009. Climate change and marine turtles. Endangered Species Research 7: 137-159.

Hays, G.C., S. Akesson, A.C. Broderick, F. Glen, B.J. Godley, P. Luschi, C. Martin, J.D. Metcalfe, and F. Papi. 2001. The diving behaviour of green turtles undertaking oceanic migration to and from Ascension Island: dive durations, dive profiles and depth distribution. J Exp Biol 204, 4093-4098.

Hays, G.C., A.C. Broderick, F. Glen, and B.J. Godley. 2003a. Climate change and sea turtles: a 150 year reconstruction of incubation temperatures at a major marine turtle rookery. Global Change Biology 9:642-646.

Hays, G.C., A.C. Broderick, B.J. Godley, P. Luschi, and W.J. Nichols. 2003b. Satellite telemetry suggests high levels of fishing-induced mortality in marine turtles. Marine Ecology Progress Series 262:305-309.

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

Henne, J.P., R.L. Crumpton, J. Fleming, and R. Martin. 2003. Preliminary development of guidelines for administering PIT tags in juvenile shortnose sturgeon, *Acipenser brevirostrum*. 6pp.,U.S. Fish and Wildlife Service, Report to NMFS.

Henwood, T. A. and L.H. Ogren. 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.

Heppell, S.S., L.B. Crowder, D.T. Crouse, S.P. Epperly, and N.B. Frazer. 2003. Population models for Atlantic loggerheads: past, present, and future. In Bolten, A.B. and B.E. Witherington (Eds.) Loggerhead Sea Turtles. Smithsonian Institution Press, Washington, D.C.

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

Heupel, M.R. and B.A. Bennett. 1997. Histology of dart tag insertion sites in the epaulette shark. Journal of Fish Biology 50:1034-1041.

Heupel, M.R., C. A. Simpfendorfer, and B.A. Bennett. 1998. Analysis of tissue responses to fin tagging in Australian carcharhinids. Journal of Fish Biology 52:610-620.

Hildebrand, H.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(4):105-112.

Hillis, Z. and A.L. Mackay. 1989. Research report on nesting and tagging of hawksbill sea turtles Eretmocheys imbricata at Buck Island Reef National Monument, U.S. Virgin Islands, 1987-88. pp. 52 pp.

Hirth, H. F. 1971. Synopsis of biological data on the green sea turtle, Chelonia mydas. FAO Fisheries Synopsis 85: 1-77.

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

Hirth, H.F. 1997. Synopsis of the biological data on the green turtle Chelonia mydas (Linnaeus 1758). p. 120 pp.

Hoff, R.Z. and G. Shigenaka. 2003. Response considerations for sea turtles. In: G. Shigenaka (editor), Oil and Sea Turtles: Biology, Planning, and Response. NOAA National Ocean Service. p: 49-68.

Hockersmith, E.E., W.D. Muir, S.G. Smith, B.P. Sandford, R.W. Perry, N.S. Adams, and D.W. Rondorf. 2003. Comparison of Migration Rate and Survival between Radio-Tagged and PIT-Tagged Migrant Yearling Chinook Salmon in the Snake and Columbia Rivers. North American Journal of Fisheries Management 23: 404-413.

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.

Houghton, J.D.R., T.K. Doyle, M.W. Wilson, J. Davenport, and G.C. Hays. 2006. Jellyfish aggregations and leatherback turtle foraging patterns in a temperate coastal environment. Ecology, 87(8):1967-1972.

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.

Hueter, R., D. Mann, K. Maruska, J. Sisneros, and L. Demski. 2004. Sensory Biology of Elasmobranchs. In J. Carrier, J. Musick and M. Heithaus (editors). Biology of Sharks and Their Relatives. CRC Press, Washington, D.C. 325-335.

Hurrell, J.W. 1995. Decadal trends in the North Atlantic Oscillation: regional temperatures and precipitation. Science, 269: 676-679.

Incardona, J.P., M.G. Carls, H. Teraoka, C.A. Sloan, T.K. Collier, and N.L. Scholz. 2005. Aryl hydrocarbon receptor-independent toxicity of weathered crude oil during fish development. Environmental Health Perspectives 113(12): 1755-1762.

Insacco, G. and F. Spadola. 2010. First record of Kemp’s ridley sea turtle, *Lepidocheyls kempii* (Garman 1880)(Cheloniidae), from the Italian waters (Mediterranean Sea). Acta Herpetologica 5(1):113-117.

Intergovernmental Panel on Climate Change (IPCC). 2007. Summary for Policymakers. Cambridge University Press, Cambridge.

Iwata, H., S. Tanabe, N. Sakai, and R. Tatsukawa. 1993. Distribution of persistent organochlorines in the oceanic air and surface seawater and the role of ocean on their global transport and fate. Environmental Science and Technology, 27: 1080-1098.

Jemison, S.C., L.A. Bishop, P.G. May, and T.M. Farrell. 1995. The impact of PIT-tags on growth and movement of the rattlesnake, Sistrurus miliarus. Journal of Herpetology 29(1):129-132.

Jimenez, M.C., A. Filonov, I. Tereshchenko, and R.M. Marquez. 2005. Time-series analyses of the relationship between nesting frequency of the Kemp’s ridley sea turtle and meteorological conditions. Chelonian Conservantion and Biology 4(4):774-780.

Johnson, S.A. and L.M. Ehrhart. 1996. Reproductive Ecology of the Florida Green Turtle: Clutch Frequency. Journal of Herpetology 30: 407-410.

Kahn, J. A. and M.C. Mohead. 2010. A Protocol for Use of Shortnose, Atlantic, Gulf, and Green Sturgeons. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-OPR-45, 62 pp.

Kahnle, A. W., K. A. Hattala, K. A. McKown, C. A. Shirey, M. R. Collins, T. S. Squiers, Jr., and T. Savoy. 1998. Stock status of Atlantic sturgeon of Atlantic Coast estuaries. Report for the Atlantic States Marine Fisheries Commission. Draft III.

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.

Kazlauskiene, N., M.Z. Vosyliene, E. Ratkelyte. 2008. The comparative study of the overall effect of crude oil on fish in early stages of development. In: Dangerous Pollutants (Xenobiotics) in Urban Water Cycle. NATO Science for Peace and Security Series C.

Keck, M.B. 1994. Test for detrimental effects of PIT tags in neonatal snakes. Copeia 1994:226-228.

Keinath, J.A. 1993. Movements and behavior of wild head-stated sea turtles. Ph.D. Dissertation. College of William and Mary, Gloucester Point, Virginia. 206pp.

Keller, J.M., J.R. Kucklick, M.A. Stamper, C.A. Harms, and P.D. McClellan-Green. 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., P.D. McClellan-Green, J.R. Kucklick, D.E. Keil, and M.M. Peden-Adams. 2006. Effects of organochlorine contaminants on loggerhead sea turtle immunity: Comparison of a correlative field study and in vitro exposure experiments. Environmental Health Perspectives 114(1):70-76.

Korte, S. M., J. M. Koolhaas, J. C. Wingfield and B. S. McEwen. 2005. The Darwinian concept of stress: benefits of allostasis and costs of allostatic load and the trade-offs in health and disease. Neuroscience and Biobehavioral Reviews. 29:3-38.

Kritzler, H. and L. Wood. 1961. Provisional audiogram for the shark, *Carcharhinus leucas*. Science 133: 1480–1482.

Lagueux, C. 2001. Status and distribution of the green turtle, Chelonia mydas, in the Wider Caribbean Region, pp. 32-35. In: K. L. Eckert and F. A. Abreu Grobois (eds.), 2001 Proceedings of the Regional Meeting: Marine Turtle Conservation in the Wider Caribbean Region: A Dialogue for Effective Regional Management. Santo Domingo, 16-18 November 1999. WIDECAST, IUCN-MTSG, WWF, and UNEP-CEP.

Landry, A.M. Jr. and E.E. Seney. 2008. Movements and behavior of Kemp's ridley sea turtles in the Northwestern Gulf of Mexico during 2006 and 2007. TAMU Final Report to the Schlumberger Excellence in Educational Development Program, Sugar Land, Texas.

Lankford, S. E., T. E. Adams, R. A. Miller and J. J. J. Cech. 2005. The cost of chronic stress: Impacts of a nonhabituating stress response on metabolic variables and swimming performance in sturgeon. Physiological and Biochemical Zoology. 78:599-609.

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., C.F. Fileman, A.D. Hopkins, J.R. Baker, J. Harwood, D.B. Jackson, S. Kennedy, A.R. Martin, 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.

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

León, Y.M. and C.E. Diez. 2000. Ecology and population biology of hawksbill turtles at a Caribbean feeding ground. Pp. 32-33 in Proceedings of the 18th International Sea Turtle Symposium, Abreu-Grobois, F.A., Briseno-Duenas, R. ,Marquez, R., and Sarti, L., Compilers. NOAA Technical Memorandum NMFS-SEFSC.

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.

Lewison, R.L., S.A. Freeman, and L.B. Crowder. 2004. Quantifying the effects of fisheries on threatened species: the impact of pelagic longlines on loggerhead and leatherback sea turtles. Ecology Letters 7: 221-231.

Limpus, C.J. 1992. The hawksbill turtle, Eretmochelys imbricata, in Queensland: population structure within a southern Great Barrier Reef feeding ground. Wildlife Research 19: 489-506.

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.

Limpus, C.J. and J.D. Miller. 2000. Final report for Australian hawksbill turtle population dynamics project. A project funded by the Japan Bekko Association to Queensland Parks and Wildlife Service. 147pp.

Limpus, C.J., P. Reed, and J.D. Miller. 1983. Islands and turtles: the influence of choice of nesting beach on sex ratio. Pages 397-402 *in* Baker, J.T., R.M. Carter, P.W. Sammarco, and K.P. Stark (editors). Proceedings of the Inaugural Great Barrier Reef Conference, James Cook University Press, Townsville, Queensland, Australia.

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.

López-Mendilaharsu, M., C.F.D. Rocha, A. Domingo, B.P. Wallace, P. Miller. 2008. Prolonged deep dives by the leatherback turtle Dermochelys coriacea, pushing their aerobic dive limits. JMBA2-Biodiversity Records No. 6274, pp. 1–3.

Lund, P. F. 1985. Hawksbill turtle Eretmochelys imbricata nesting on the east coast of Florida. Journal of Herpetology 19: 164-166.

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

Lutcavage, M. E. and P.L. Lutz. 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.): 387-432. CRC Press, Boca Raton, Florida.

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

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.

Magnuson, J.J., K.A. Bjorndal, W.D. DuPaul, G.L. Graham, D.W. Owens, C.H. Peterson, P.C.H. Pritchard, J.I. Richardson, G.E. Saul, and C.W. West. 1990. Decline of the sea turtles: causes and prevention. National Research Council, National Academy Press, Washington, DC.

Manire, C.A. and S.H. Gruber. 1991. Effect of M-type dart tags on field growth of juvenile lemon sharks. Transactions of the American Fisheries Society 120(6):776-780.

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.

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society, 78: 1069-1079.

Marcovaldi, M.A., M.H. Godfrey, and N. Mrosovsky. 1997. Estimating sex ratios of loggerhead turtles in Brazil from pivotal incubation durations. Canadian Journal of Zoology 75:755-770.

Marcus, S.J. and C.G. Maley. 1987. Comparison of sand temperatures between a shaded and unshaded turtle nesting beach in south Florida. (abstract) Seventh Annual Workshop on Sea Turtle Biology and Conservation, February 1987, Wekiva Springs State Park, Florida.

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. 1972. Resultados prelimiares sobre edad y crecimiento de la tortuga lora, *Lepidochelys kempii* (Garman). Mem. IV Congr. Nac. Ocean. 1969., Mexico. p. 419-427.

Márquez, M.R. 1990. Sea turtles of the world. An annotated, and illustrated catalogue of sea turtle species known to date. FAO Species Catalogue, FAO Fisheries Synopsis No. 125, Volume 11. Available: ftp://ftp.fao.org/docrep/fao/009/t0244e/t0244e00.pdf (March 2008).

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

Márquez, M.R., A. Villanueva O., and M. Sánchez P. 1982. The population of the Kemp's ridley sea turtle in the Gulf of Mexico – *Lepidochelys kempii*. p. 159-164 *In:* K.A. Bjorndal (editor), Biology and Conservation of Sea Turtles. Washington, D.C. Smithsonian Institue Press.

Martin, R.E. 1996. Storm impacts on loggerhead turtle reproductive success. Marine Turtle Newsletter. 73:10-12.

Matkin, C.O. and E. Saulitis. 1997. Restoration notebook: killer whale (Orcinus orca). Exxon Valdez Oil Spill Trustee Council, Anchorage, Alaska.

Mayor, P., B. Phillips, and Z. Hillis-Starr. 1998. Results of stomach content analysis on the juvenile hawksbill turtles of Buck Island Reef National Monument, U.S.V.I. In: Proceedings of the 17th Annual Sea Turtle Symposium, Vol. 415 (Epperly, S. and Braun, J., eds.). pp. 230-232. U.S. Department of Commerce NOAA Technical Memorandum, NMFS-SEFSC.

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

McDonald-Dutton, D. and P.H. Dutton. 1998. Accelerated growth in San Diego Bay green turtles? Pages 175-176 *In:* Epperly, S.P. and J. Braun (compilers). Proceedings of the seventeenth annual symposium on sea turtle biology and conservation. NOAA Technical Memorandum NMFS-SEFSC-415.

McEachran, J.D., and J.D. Fechhelm. 1998. Fishes of the Gulf of Mexico. Volume 1: Myxiniformes to Gasterosteiformes. University of Texas Press, Austin, TX. 1112 pp.

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

McMichael, E., R.R. Carthy, and J.A. Seminoff. 2003. Evidence of homing behavior in juvenile green turtles in the northeastern Gulf of Mexico. Pages 223-224 *In:* Seminoff, J.A. (compiler). Proceedings of the twenty-second annual symposium on sea turtle biology and conservation. NOAA Technical Memorandum NMFS-

SEFSC-503.

Mearns, A.J. 2001. Long-term contaminant trends and patterns in Puget Sound, the Straits of Juan de Fuca, and the Pacific Coast. In: Droscher, T. (Ed.), 2001 Puget Sound Research Conference. Puget Sound Action Team, Olympia, Washington.

Meylan, A. 1988. Spongivory in hawksbill turtles: a diet of glass. Science 239:393-395.

Meylan, A. B. 1999a. International movements of immature and adult hawksbill turtles (Eretmochelys imbricata) in the Caribbean region. Chelonian Conservation and Biology 3: 189-194.

Meylan, A. B. 1999b. The status of the hawksbill turtle (Eretmochelys imbricata) in the Caribbean Region. Chelonian Conservation and Biology 3: 177-184.

Meylan, A. and M. Donnelly. 1999. Status Justification for Listing the Hawksbill Turtle (Eretmochelys imbricata) as Critically Endangered on the 1996 IUCN Red List of Threatened Animals. Chelonian Conservation and Biology 3: 200-224.

Meylan, A., Schroeder B., and A. Mosier. 1995. Sea turtle nesting activity in the state of Florida 1979-1992. State of Florida Department of Environmental Protection Florida Marine Research Institute. Florida marine research publications (52): 57pp.

Milliken, T. and H. Tokunaga. 1987. The Japanese sea turtle trade 1970-1986. A special report prepared by TRAFFIC (Japan). Center for Environmental Education. Washington, D.C. 171pp.

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.

Moberg, G. P. 2000. Biological response to stress: implications for animal welfare. pp. 1-21. *in* G. P. Moberg and J. A. Mench, eds. The biology of animal stress. Basic principles and implications for animal welfare, Oxford, United Kingdom, Oxford University Press.

Moncado, F., E. Carrillo, A. Saenz, and G. Nodarse. 1999. Reproduction and nesting of the hawksbill turtle, *Eretmochelys imbricata*, in the Cuban archipelago. Chelonian Conservation and Biology 3(2): 257-263.

Moore, C.J., S.L. Moore, M.K. Leecaster, and S.B. Weisberg. 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 pp.

Morreale, S.J., C.F. Smith, K. Durham, and R.A. DiJiovanni, Jr. 2005. Assessing heath, status, and trends in northeastern sea turtle populations. Department of Natural

Resources, Cornell University. Interim report to the National Marine Fisheries Service, Northeast Regional Office. Contract No. EA133F-02-SE-0191. 42pp.

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.

Mortimer, J.A. and M. Donnelly. 2008. Hawksbill turtle (*Eretmochelys imbricata*). Marine Turtle Specialist Group 2008 IUCN Red List Status Assessment. 112pp.

Mortimer, J.A., M. Day, and D. Broderick. 2002. Sea turtle populations of the Chagos Archipelago, British Indian Ocean Territory. Pages 47-49 *In*: Mosier, A., A. Foley, and B. Brost (editors). Proceedings of the twentieth annual symposium on sea turtle biology and conservation. NOAA Technical Memorandum NMFS-SEFSC-477.

Mortimer, J.A., J. Collie, T. Jupiter, R. Chapman, A. Liljevik, and B. Betsy. 2003. Growth rates of immature hawksbills (Eretmochelys imbricata) at Aldabra Atoll, Seychelles (Western Indian Ocean). Pages 247-248 *In:* Seminoff, J.A. (compiler). Proceedings of the twenty-second annual symposium on sea turtle biology and conservation. NOAA Technical Memorandum NMFS-SEFSC-503.

Moser, M. L. and S. W. Ross. 1995. Habitat use and movements of shortnose and Atlantic sturgeon in the lower Cape Fear River, North Carolina. Transactions of the American Fisheries Society 124: 225-234.

Moser, M. L., M. Bain, M. R. Collins, N. Haley, B. Kynard, J. C. O'Herron II, G. Rogers and T.S. Squiers. 2000. A Protocol for Use of Shortnose and Atlantic Sturgeons. pp. U.S. Department of Commerce NOAA Technical Memorandum, NMFS-OPR-18.

Mosier, A. 1998. The impact of coastal armoring structures on sea turtle nesting behavior at three beaches on the East Coast of Florida. Unpublished Master of Science thesis. University of South Florida, Tampa, Florida. 112 pages.

Mrosovsky, N. 1981. Plastic jellyfish. Marine Turtle Newsletter 17:5-6. (http://www.seaturtle.org/mtn/archives/mtn17/mtn17p5.shtml?nocount).

Mrosovsky, N. 1988. Pivotal temperatures for loggerhead turtles from northern and southern nesting beaches. Canadian Journal of Zoology 66:661-669.

Mrosovsky, N. and C.L. Yntema. 1980. Temperature dependence of sexual differentiation in sea turtles: implications for conservation practices. Biological Conservation 18:271-280.

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

Murphy, T. M. and S.R. Hopkins. 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. 1999. Life in the slow lane: ecology and conservation of long-lived marine animals. American Fisheries Society Symposium 23, 265 pp.

Musick, J. A. and C.J. Limpus. 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.): 137-164. CRC Press, Boca Raton, Florida.

Musick, J.A., M.M. Harbin, S.A. Berkeley, G.H. Burgess, A.M. Eklund, L. Findley, R.G. Gilmore, J.T. Golden, D.S. Ha, G.R. Huntsman, J.C. McGovern, S.J. Parker, S.G. Poss, E. Sala, T.W. Schmidt, G.R. Sedberry, H. Weeks, and S.G. Wright. 2001. Marine, Estuarine, and Diadromous Fish Stocks at Risk of Extinction in North America (Exclusive of Pacific Salmonids). Fisheries 25(11):6-30.

National Marine Fisheries Service (NMFS). 1997. Biological opinion 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. 2000. Status review of smalltooth sawfish (Pristis pectinata). National Marine Fisheries Service. 73pp.

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. 226 pp.

NMFS. 2002. Biological opinion 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. National Marine Fisheries Service, Southeast Region. St. Petersburg, FL. 94pp.

NMFS. 2004. Biological opinion on the reinitiation of consultation on the Atlantic pelagic longline fishery for highly migratory species. National Marine Fisheries Service, St. Petersburg, Florida, June 1, 2004.

NMFS. 2005. Biological opinion on the continued authorization of shrimp trawling as managed under the Fishery Management Plan (FMP) for the shrimp fishery of the South Atlantic region, including proposed Amendment 6 to that FMP. National Marine Fisheries Service Southeast Regional Office, St. Petersburg, FL. 32pp.

NMFS. 2006a. Biological opinion 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). National Marine Fisheries Service Southeast Regional Office. St. Petersburg, FL. 23pp.

NMFS. 2008a. Biological opinion 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 (F/SERJ2007/05044). National Marine Fisheries Service Southeast

Regional Office. St. Petersburg, FL. 170pp.

NMFS. 2009a. Smalltooth sawfish recovery plan (*Pristis pectinata*). Prepared by the Smalltooth Sawfish Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland.

NMFS. 2009b. Biological opinion on the continued authorization of fishing under the Fishery Management Plan (FMP) for Spiny Lobster in the South Atlantic and Gulf of Mexico (F/SERl2005/07518). National Marine Fisheries Service Southeast Regional Office. St. Petersburg, FL. 219pp.

NMFS. 2010a. Status review of the largetooth sawfish (*Pristis perotteti*). National Marine Fisheries Service. 57pp.

NMFS. 2010b. Smalltooth sawfish (*Pristis pectinata* Latham) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Protected Resources Division. St. Petersburg, FL. 51pp.

NMFS. 2010c. Biological opinion on the authorization of fisheries under the Northeast Multispecies Fishery Management Plan [Consultation No. FINER/2008/01755]. National Marine Fisheries Service Northeast Regional Office, Gloucester, MA. 210pp.

NMFS. 2011a. Biological opinion on the continued authorization of reef fish fishing under the Gulf of Mexico (Gulf) Reef Fish Fishery Management Plan (RFFMP). NMFS, Southeast Regional Office. St. Petersburg, FL. 216pp.

NMFS. 2011b. Update of turtle bycatch in the Gulf of Mexico and southeastern Atlantic shrimp fisheries. Memorandum from Bonnie Ponwith, SEFSC Director, to Roy Crabtree, SERO Regional Administrator, January 5, 2011, 10p.

NMFS. 2011c. Biological opinion on the continued authorization of reef fish fishing managed under the Reef Fish Fishery Management Plan (FMP) of Puerto Rico and the U.S. Virgin Islands (CRFFMP) (Consultation Number F/SER/2010/06680). National Marine Fisheries Service Southeast Regional Office. St. Petersburg, FL. 260pp.

NMFS and United States Fish and Wildlife Service (USFWS). 1991. Recovery Plan for U.S. Population of Atlantic Green Turtle. National Marine Fisheries Service, Washington, D.C.

NMFS and USFWS 1992. Recovery Plan for Leatherback Turtles in the U.S. Caribbean, Atlantic, and Gulf of Mexico. National Marine Fisheries Service, Washington, D.C.

NMFS and USFWS. 1998. Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle (Eretmochelys imbricata). National Marine Fisheries Service, Silver Spring, MD.

NMFS and USFWS. 2007a. Hawksbill sea turtle (Eretmochelys imbricata). 5-year review: summary and evaluation. Washington, D.C.

NMFS and USFWS. 2007b. Green sea turtle (Chelonia mydas) 5-year review: summary and evaluation. Washington, D.C.

NMFS and USFWS. 2007c. Leatherback sea turtle (Dermochelys coriacea) 5-year review: Summary and evaluation. National Marine Fisheries Service, Silver Spring, MD. 79 pp.

NMFS and USFWS. 2008. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (*Caretta caretta*), Second Revision. National Marine Fisheries Service, Silver Spring, Maryland. 325pp.

NMFS, USFWS, and SEMARNAT. 2011. Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*), Second Revision. National Marine Fisheries Service. Silver Spring, Maryland 156 pp. + appendices.

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

NRC. 2003. National Research Council: Ocean noise and marine mammals. National Academies Press, Washington, D.C. 192 pp.

Norman, J.R. and F.C. Fraser. 1937. Giant fishes, whales and dolphins. Putman and Company, Limited., London.

Odum, W.E., C.C. McIvor, and T. J. Smith. 1982. The ecology of the mangroves of south Florida: a community profile. U.S. Fish and Wildl. Serv., Office of Biological Services, Wash. D.C. FWS/OBS-8124 144 p.

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.): 116-123. Texas A&M University.

Orlando, S.P, Jr., P.H. Wendt, C.J. Klein, M.E. Pattillo, K.C. Dennis, and G.H. Ward. 1994. Salinity characteristics of the south Atlantic estuaries. Silver Springs, MD: National Oceanic and Atmospheric Administration, Office of Ocean Resources Conservation and Assessment 117 p.

Parsons, J.J. 1972. The hawksbill turtle and the tortoise shell trade. In: Études de géographie tropicale offertes a Pierre Gourou, Vol.: 45-60. Paris: Mouton.

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

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

Pike, D.A and J.C. Stiner. 2007. Sea turtle species vary in their susceptibility to tropical cyclones. Oecologia 153: 471-478.

Plotkin, P. 2003. Adult migrations and habitat use. Pages 225-241 *In:* Lutz, P.L., J.A. Musick, and J. Wyneken (editors). Biology of Sea Turtles, Volume II. CRC Press, Boca Raton, Florida.

Plotkin, P. 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.

Poulakis, G.R. and J.C. Seitz. 2004. Recent occurrence of the smalltooth sawfish, Pristis pectinata (Elasmobranchiomorphi: Pristidae), in Florida Bay and the Florida Keys, with comments on sawfish ecology. Florida Scientist 67:227-35.

Poulakis, G.R., P.W. Stevens, A.A. Timmers, C.J. Stafford, C. Curtis, M.D. Tringali, and M.D. Bakenhaster. 2010. Distribution, habitat use, and movements of juvenile smalltooth sawfish, *Pristis pectinata*, in the Charlotte Harbor estuarine system, Florida. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Charlotte Harbor Field Laboratory. Final Report, February 2010. Award Number: NA06NMF4720032. 92pp.

Pritchard, P.C.H. 1971. The leatherback or leathery turtle, Dermochelys coriacea. International Union for the Conservation of Nature, Monograph Number 1. 39p.

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

Pritchard, P.C.H. and R. Márquez. 1973. Kemp’s ridley or Atlantic ridley *Lepidochelys kempii*. IUCN Monograph No. 2., (Marine Turtle Series).

Pritchard, P.C.H., P. Bacon, F. Berry, A. Carr, J. Fletemeyer, R. Gallagher, S. Hopkins, R. Lankford, M.R. Marquez, L. Ogren, W. Pringle Jr., H. Reichart, and R. Witham. 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. 125pp.

Prusty, G., S. Dash, and M.P. Singh. 2007. Spatio-temporal analysis of multi-date IRS imageries for turtle habitat dynamics characterisation at Gahirmatha coast, India. Int J Remote Sens 28: 871-883

Putman, N.F., T.J. Shay, and K.J. Lohmann. 2010. Is the geographic distribution of nesting in the Kemp’s ridley turtle shaped by the migratory needs of offspring? Integrative and Comparative Biology, a symposium presented at the annual meeting of the Society for Integrative and Comparative Biology, Seattle, WA. p. 1-10.

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.

Reddering, J.S.V. 1988. Prediction of the effects of reduced river discharge on estuaries of the south-eastern Cape Province, South Africa. S. Afr. J. Sci. 84:726–730.

Redlow, T., A. Foley, and K. Singel. 2003. Sea turtle mortality associated with red tide events in Florida. Page 272 *in* Seminoff, J.A. (compiler). Proceedings of the Twenty-second Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-503.

Renaud, M.L. and J.A. Williams. 2005. Kemp's ridley sea turtle movements and migrations. Chelonian Conservation and Biology 4(4):808-816.

Rhodin, A.G.J. 1985. Comparative Chondro-Osseous Development and Growth of Marine Turtles. Copeia 1985: 752-771.

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. 21pp.

Richardson, J. I., R. Bell, and T.H. Richardson. 1999. Population ecology and demographic implications drawn from an 11-year study of nesting hawksbill turtles, Eretmochelys imbricata, at Jumby Bay, Long Island, Antigua, West Indies. Chelonian Conservation and Biology 3: 244-250.

Rogers, S. G., and W. Weber. 1995. Status and restoration of Atlantic and shortnose sturgeons in Georgia. Final report to NMFS for grant NA46FA102-01.

Ross. J.P. 2005. Hurricane effects on nesting *Caretta caretta.* Mar Turtle News. 108:13-14.

Ryder, C. E., T. A. Conant and B. A. Schroeder. 2006. Report of the Workshop on Marine Turtle Longline Post-Interaction Mortality. U.S. Department of Commerce NOAA Technical Memorandum, NMFS-F/OPR-29:36 pp.

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

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

Schmelz, G.W. and R.R. Mezich. 1988. A preliminary investigation of the potential impact of Australian pines on the nesting activities of the loggerhead turtle. Pages 63-66 *in* Schroeder, B.A. (compiler). Proceedings of the Eighth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFSC-214.

Schmid, J.R. 1998. Marine turtle populations on the west-central coast of Florida: results of tagging studies at Cedar Keys, Florida, 1986-1995. Fishery Bulletin 96(3):589-602.

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

Schmid, J.R. and A. Woodhead. 2000. Von Bertalanffy growth models for wild Kemp's ridley turtles: analysis of the NMFS Miami Laboratory tagging database. In: Turtle Expert Working Group Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. NOAA Technical Memorandum. NMFS-SEFSC-444: 94-102.

Schultz, J.P. 1975. Sea turtles nesting in Surinam. Zoologische Verhandelingen (Leiden), Number 143: 172 pp.

Scott, G.I. 1997. Assessment of risk reduction strategies for the management of agricultural non-point-source runoff in estuarine ecosystems of the southeastern U.S. Unpublished report of the National Marine Fisheries Service, Charleston Laboratory. 5 pp.

Seitz, J.C. and G.R. Poulakis. 2002. Recent occurrences of sawfishes (Elasmobranchiomorphi: Pristidae) along the southwest coast of Florida (USA). Florida Scientist 65:256–266.

Seitz, J.C. and G.R. Poulakis. 2006. Anthropogenic effects on the smalltooth sawfish (*Pristis pectinata*) in the United States. Marine Pollution Bulletin 52:1533–1540.

Seminoff, J.A. 2004. 2004 global assessment: Green turtle (*Chelonia mydas*). IUCN Marine Turtle Specialist Group Review. 71pp.

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. 2002. Research in support of the restoration of sea turtles and their habitat in national seashores and areas along the Texas coast, including the Laguna Madre. Final NRPP Report. U.S. Geological Survey, Department of the Interior.

Shaver, D.J. 2005. Analysis of the Kemp's ridley imprinting and headstart project at Padre Island National Seashore, Texas, 1978-88, with subsequent nesting and stranding records on the Texas coast. Chelonian Conservation and Biology 4(4):846-859.

Shaver, D.J. and C.W. Caillouet, Jr. 1998. More Kemp's ridley turtles return to south Texas to nest. Marine Turtle Newsletter 82:1-5.

Shaver, D.J. and P.T. Plotkin. 1998. Marine debris ingestion by sea turtles in south Texas: preand post-MARPOL Annex V. *In:* R. Byles and Y. Fernandez (compilers), Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum. NMFS-SEFSC-412:124.

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. Herpetol. Monogr, 6:43-67.

Simpfendorfer, C.A. 2000. Predicting recovery rates for endangered western Atlantic sawfishes using demographic analysis. Environmental Biology of Fishes 58:371-377.

Simpfendorfer, C. 2001. Essential habitat of smalltooth sawfish (Pristis pectinata).

Mote Marine Library Technical Report 786. Mote Marine Laboratory, Sarasota, Florida.

Simpfendorfer, C.A. 2002. Smalltooth sawfish: the USA's first endangered elasmobranch? Endangered Species Update 19:45–49.

Simpfendorfer, C. 2003. Abundance, movement and habitat use of the smalltooth sawfish. Final Report to the National Marine Fisheries Service, Grant number WC133F-02-SE-0247. Mote Marine Laboratory, Sarasota, Florida. Mote Marine Laboratory Technical Report 929.

Simpfendorfer, C.A. 2006. Final report: movement and habitat use of smalltooth sawfish. Final Report to the National Marine Fisheries Service, Grant number WC133F-04-SE-1543. Mote Marine Laboratory, Sarasota, Florida. Mote Marine Laboratory Technical Report 1070.

Simpfendorfer, C.A. and T.R. Wiley. 2004. Determination of the distribution of Florida's remnant sawfish population, and identification of areas critical to their conservation. Mote Marine Laboratory Technical Report. Mote Marine Laboratory, Sarasota, Florida.

Simpfendorfer, C.A. and T.R. Wiley. 2005. Determination of the distribution of Florida's remnant sawfish population and identification of areas critical to their conservation. Final Report. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

Simpfendorfer, C.A., G.R. Poulakis, P.M. O'Donnell, and T.R. Wiley. 2008. Growth rates of juvenile smalltooth sawfish (*Pristis pectinata*) in the western Atlantic. Journal of Fish Biology 72: pp. 711-723.

Simpfendorfer, C.A. T.R. Wiley and B.G. Yeiser, 2010. Improving conservation planning for an endangered sawfish using data from acoustic telemetry, Biological Conservation, 143: 1460-1469.

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.

Snelson, F.F. and S.E. Williams. 1981. Notes on the occurrence, distribution, and biology of elasmobranch fishes in the Indian River lagoon system, Florida. Estuaries 4:110–120.

Snover, M.L. 2002. Growth and ontogeny of sea turtles using skeletochronology: methods, validation and application to conservation. Unpublished Ph.D. dissertation. Duke University, Durham, North Carolina. 144 pages.

Snover, M.L. and S.S. Heppell. 2009. Application of diffusion approximation for risk assessments of sea turtle populations. Ecological Applications 19(3): 774-785.

South Atlantic Fishery Management Council (SAFMC). 1998. Final Plan for the South Atlantic Region; Essential Fish Habitat Requirements for the Fishery Management Plan of the South Atlantic Fishery Management Council. Prepared by the South Atlantic Fishery Management Council, October 1998. Available from: SAFMC, 1 Southpark Circle, Suite 306, Charleston, SC 29407.

South Carolina Marine Resources Research Institute (SCMRI). 2000. SEAMAP-South Atlantic 10-year trawl report. Atlantic States Marine Fisheries Commission Special Report No. 71. 143pp.

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

Spotila, J. R., A. E. Dunham, A. J. Leslie, A. C. Steyermark, P. T. Plotkin and F. V. Paladino 1996. Worldwide population decline of Dermochelys coriacea: Are leatherback turtles going extinct? Chelonian Conservation and Biology 2(2):209-222.

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

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

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

Stancyk, S.E. 1982. Non-human predators of sea turtles and their control. Pages 139-152 *in* Bjorndal, K.A. (editor). Biology and Conservation of Sea Turtles. Smithsonian Institution Press. Washington, D.C.

Stapleton, S.P. and C.J.G. Stapleton. 2006. Tagging and Nesting Research on Hawksbill Turtles (Eretmochelys imbricata) at Jumby Bay, Long Island, Antigua, West Indies: 2005 Annual Report. Wider Caribbean Sea Turtle Conservation Network. Antigua, W.I. 26 pp.

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

Stedman, S. and T.E. Dahl. 2008. Status and trends of wetlands in the coastal watersheds of the Eastern United States 1998 to 2004. National Oceanic and Atmospheric Administration, National Marine Fisheries Service and U.S. Department of the Interior, Fish and Wildlife Service. 32pp.

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

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

908-913.

Taylor, A.H., M.B. Jordan, and J.A. Stephens. 1998. Gulf Stream shifts following ENSO events. Nature, 393: 638.

Thorburn, D., Morgan, D., and Gill, H. 2004. Biology and cultural significance of the freshwater sawfish (Pristis microdon) in the Fitzroy River Kimberley, Western Australia. Freshwater Fish Group at the Centre for Fish & Fisheries Research 57 pp.

Thorson, T.B. 1973. Sexual dimorphism in number of rostral teeth of the sawfish, *Pristis perotteti* Müller and Henle, 1841. Transactions of the American Fisheries Society 103:612–614.

Thorson, T.B. 1976. Observations on the reproduction of sawfish, Pristis perotteti, in Lake Nicaragua, with recommendations for its conservation. Pages 641-650 in: Thorson, T.B. (Ed.), Investigations of the ichthyofauna of Nicaraguan lakes. University of Nebraska, Lincoln, Nebraska.

Tiwol, C.M. and A.S. Cabanban. 2000. All female hatchlings from the open-beach hatchery at Gulisaan Island, Turtles Islands Park, Sabah. Pages 218-227 *In:* Pilcher, N.J. and M.G. Ismail (editors). Sea turtles of the Indo-Pacific: Research, management, and conservation. ASEAN academic press, London.

Tomas, J. and J.A. Raga. 2007. Occurrence of Kemp's ridley sea turtle (*Lepidochelys kempii*) in the Mediterranean. Journal of the Marine Biological Association of the United Kingdom. p 1-3. Document is available at: http://www.mba.ac.uk/jmba/pdf/5640.pdf

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

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.

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

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

TEWG. 2007. An Assessment of the Leatherback Turtle Population in the Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-555, 116p.

TEWG. 2009. An assessment of the loggerhead turtle population in the western North Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-575. 131pp.

U.S. Navy. 2008. USS Nassau Expeditionary Strike Group Composite Training Unit

Exercise 08-01 (ESG COMPTUEX 08-01): after action report for the exercise occurring 28 November to 14 December 2007. U.S. Department of the Navy, Fleet Forces Command, Norfolk, Virginia.

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

van Dam, R. and C. Diez. 1998. Home range of immature hawksbill turtles (Eretmochelys imbricata) at two Caribbean islands. Journal of Experimental Marine Biology and Ecology 220: 15-24.

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

van Dam, R., L. Sarti, and D. Pares. 1991. The hawksbills of Mona Island, Puerto Rico. Page 187 in M. Salmon and J. Wyneken, compilers. Proceedings of the eleventh annual workshop on sea turtle biology and conservation. NOAA Technical Memorandum NMFS/SEFC-302.

Van der Elst, R. 1981. A guide to the common sea fisheries of southern Africa. C. Struik (ed.). Cape Town, South Africa.

Van Houton, K.S. and O.L. Bass. 2007. Stormy oceans are associated with declines in sea turtle hatching. Curr BioI 17: R590.

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, 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 pp.

Webster, P.J., GJ. Holland, J.A Curry, H.R. Chang. 2005. Changes in tropical cyclone number, duration, and intensity in a warming environment. Science 309: 1844-1846.

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

Wershoven, J. L. and R.W. Wershoven. 1992. Juvenile green turtles in their nearshore habitat of Broward County, Florida: a five year review. In: Proceedings of the 11th Annual Workshop on Sea Turtle Biology and Conservation, Vol. 302 (Salmon, M. and Wyneken, J., eds.): 121-123. U.S. Department of Commerce NOAA Technical Memorandum, NMFS-SEFSC.

Wetherbee, B. M. S.H. Gruber, R.S. Rosa. 2007. Movement patterns of juvenile lemon sharks Negaprion brevirostris; in Atol das Rocas, Brazil: a nursery characterized by tidal extremes. Marine Ecology Progress Series 343: 283-293.

Whitfield, A.K. and M.N. Bruton. 1989. Some biological implications of reduced freshwater inflow into eastern Cape estuaries: a preliminary assessment. South African Journal of Science 85:691–694.

Whiting, S. D. 2000. The foraging ecology of juvenile green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) sea turtles in north-western Australia. Unpublished Ph.D thesis. Northern Territory University. Darwin, Australia.

Wiley, T.R. and Simpfendorfer, C.A. 2007. Site fidelity/residency patterns/habitat modeling. Final Report to the National Marine Fisheries Service, Grant number WC133F-06-SE-2976. Mote Marine Laboratory Technical Report (1223).

Wilkinson, C.R. (ed). 2004. Status of Coral Reefs of the World: 2004. Australian Institute of Marine Science. 572 p.

Williams, S.L. 1988. Thalassia testudinum productivity and grazing by green turtles in a highly disturbed seagrass bed. Marine Biology 98: 447-455.

Williams, E.H., L. Bunkley-Williams, E.C. Peters, B. Pinto-Rodriguez, R. Matos-Morales, A.A. Mignucci-Giannoni, K.V. Hall, J.V. Rueda-Almonacid, J. Sybesma, I.B. De Calventi, and R.H. Boulon. 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.

Williams, R., R.W. Trites, and D.E. Bain. 2002. Behavioural responses of killer whales (Orcinus orca) to whale-watching boats: Opportunistic observations and experimental approaches. Journal of Zoology, 256: 255-270.

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

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. 166pp.

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. 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.E., and L.M. Ehrhart. 1989. Status, and reproductive characteristics of green turtles (Chelonia mydas) nesting in Florida. Pages 351-352 *In:* Ogren, L., F. Berry, K. Bjorndal, H. Kumpf, R. Mast, G. Medina, H. Reichart, and R. Witham (eds.), Proceedings of the Second Western Atlantic Turtle Symposium. NOAA Technical Memorandum NMFS-SEFSC-226.

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. 26pp.

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. 11pp.

Witherington, B., P. Kubilis, B. Brost, and A. Meylan. 2009. Decreasing annual nest counts in a globally important loggerhead sea turtle population. Ecological Applications 19:30-54.

Witt, M.J., B.J. Godley, A.C. Broderick, R. Penrose, and C.S. Martin. 2006. Leatherback turtles, jellyfish and climate change in the northwest Atlantic: current situation and possible future scenarios. Pp. 3556-357 In: Frick, M., A. Panagopoulou, A.F. Rees, and K. Williams (compilers). Book of Abstracts. Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.

Witt, M.J., A.C. Broderick, D.J. Johns, C. Martin, R. Penrose, M.S. Hoogmoed, and B.J. Godley. 2007. Prey landscapes help identify foraging habitats for leatherback turtles in the NE Atlantic. Marine Ecological Progress Series 337: 231-243.

Witzell,W.N. 1983. Synopsis of the biological data on the hawksbill turtle Eretmochelys imbricata (Linnaeus, 1766). FAO Fisheries Synopsis 137:78.

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

Wydoski, R. and L. Emery. 1983. Tagging and marking. Pages 215-237 in: L.A. Nielson and D.L. Johnson (Eds.) Fisheries Techniques. American Fisheries Society, Bethesda, Maryland.

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

Zug, G.R. and R.E. Glor. 1998. Estimates of age and growth in a population of green sea turtles (*Chelonia mydas*) in the Indian River Lagoon system, Florida: a skeletochronological analysis. Canadian Journal of Zoology 76: 1497-1506.

Zug, G.R., H.J. Kalb, and S.J. Luzar. 1997. Age and growth in wild Kemp's ridley sea turtlesn *Lepidochelys kempii* from skeletochronological data. Biological Conservation 80: 261-268.