

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

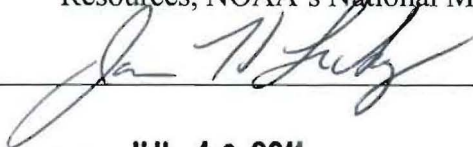
Biological and Conference Opinion

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

Activity Considered: The Proposal to Issue Permit Modification No. 13330-01 to
NMFS' Southeast Fisheries Science Center for Research on
the Biology, Distribution, and Abundance of Smalltooth
Sawfish along the Coast of Florida

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

Approved by:



Date:

JUL 18 2011

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 of 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 NOAA's 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]).

For the actions described in this document, the action agency is NMFS' Office of Protected Resources – Permits, Conservation, and Education Division (Permits Division). The consulting agency is NMFS' Office of Protected Resources – Endangered Species Division (Endangered Species Division). This document represents NMFS' Biological and Conference Opinion (Opinion) of the effects of the proposed research activities on listed and proposed threatened and endangered species and designated critical habitat in accordance with section 7 of the ESA. This Opinion is based on information submitted by the Permits Division as part of their initiation package, published and unpublished scientific information on the biology and ecology of the listed species affected, and other relevant sources of information.

CONSULTATION HISTORY

On October 1, 2008, the Permits Division issued a permit to NMFS' Southeast Fisheries Science Center (NMFS-SEFSC) to capture and tag smalltooth sawfish off the coast of Florida after consulting with the Endangered Species Division. The permits, as issued, are valid for five years and are set to expire October 31, 2013.

On March 28, 2011, the Permits Division requested consultation with the Endangered Species Division to modify the existing permit to replace two tagging methods while excluding another in order to increase tag retention and provide less invasive means for tagging. The timeframe for the original permit would remain in effect. The initiation package included the permit applications from the respective applicants, discussion of the effects of the research on the target species, the original 2008 biological opinion, and drafts of the proposed permits.

Upon reviewing the initiation package, the Endangered Species Division requested additional information regarding the locations of tagging in relation to designated critical habitat for smalltooth sawfish as well as any possible effects to designated critical habitat. Upon receiving the additional information, the Endangered Species Division initiated formal consultation on April 6th, 2011.

BIOLOGICAL AND CONFERENCE OPINION

DESCRIPTION OF THE PROPOSED ACTION

The Permits Division proposes to issue permit modification No. 13330-01 to NMFS-SEFSC for harassment of listed smalltooth sawfish (*Pristis pectinata*) off the coast of mainland Florida and the Florida Keys during capture and tagging activities pursuant to section 10(a)(1)(A) of the ESA. These actions may result in direct "takes"¹ of listed smalltooth sawfish as well as incidental "take" of loggerhead sea turtles (*Caretta caretta*) [including members of the proposed Northwest Atlantic Ocean distinct population segment (DPS)], green sea turtles (*Chelonia mydas*), hawksbill sea turtles (*Eretmochelys imbricata*), Kemp's ridley sea turtles (*Lepidochelys kempii*), leatherback sea turtles (*Dermochelys coriacea*), and members of the proposed South Atlantic DPS of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). This ESA Section 7 consultation considers the effects of the proposed research studies on listed species and designated critical habitat occurring within the action area.

The objective of the permitted activity is to collect data on the biology, distribution and abundance of the endangered smalltooth sawfish to facilitate the recovery of the species. Sampling will occur primarily off the Florida coast from Naples to Key West encompassing the Ten Thousand Islands region and Everglades National Park. While

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

researchers intend to focus their sampling efforts in these regions, additional sampling may occur in other areas off Florida (both Gulf and Atlantic sides) if reliable and sufficient reports of smalltooth sawfish encounters are received to warrant sampling in those areas. This permit modification authorizes two new tagging methods while excluding another that was authorized in the previous permit. More information on the current research activities as well as the additional tagging methods to be authorized is provided in the sections below.

Researchers are currently authorized to capture and sample up to 45 smalltooth sawfish annually by way of longline, gillnet, seine net, drum (set) lines, or rod and reel throughout Florida's coastal waters. All captured sawfish are to be handled, measured, tagged, sampled, and released alive. Dead sawfish acquired through strandings or from law enforcement confiscations are also measured and sampled for scientific purposes. **Table 1** below provides the proposed "take" of smalltooth sawfish associated with the proposed permit modification including both annual "take" as well as cumulative "take" expected over the remaining permit duration. The original permit was authorized October 1, 2008 and was set to expire October 31, 2013; therefore, this permit modification would remain in effect until the that latter date upon issuance.

Table 1. Additional Research Activities and Proposed Takes of Listed Species for Permit Modification No. 13330-01

SPECIES	LIFE STAGE (EITHER SEX)	ACTIVITY*	INDIVIDUALS PROPOSED TO BE TAKEN ANNUALLY	INDIVIDUALS PROPOSED TO BE TAKEN OVER REMAINING PERMIT DURATION
Smalltooth Sawfish	Neonate/ Young-of-the-Year (less than 150 centimeters stretched total length)	Capture by longline, gillnet, seine, drum (set) lines, and rod and reel; weigh, measure; genetic sample; blood draw**; neoprene clasp (with sonic tag) ; dart tag; PIT tag; release; track and monitor	15	45
Smalltooth Sawfish	Juvenile (150-350 centimeters stretched total length)	Capture by longline, gillnet, seine, drum (set) lines, and rod and reel; weigh, measure; genetic sample; blood draw**; dart tag; PIT tag; neoprene clasp (with sonic tag) ; or PAT tag (with harness attachment) ; release; track and monitor	15	45
Smalltooth Sawfish	Adult (greater than 350 centimeters stretched total length)	Capture by longline, gillnet, seine, drum (set) lines, and rod and reel; weigh, measure; genetic sample; blood draw**; dart tag; PIT tag; neoprene clasp (with sonic tag) ; or PAT tag (with harness attachment) ; release; track and monitor	15	45

*Activities in **bold** represent new tagging methods to be authorized in the modified permit.

**Researchers shall not draw blood from animals weighing less than 360 grams. Researchers may blood sample up to 15 neonate/young-of-the-year smalltooth sawfish a year, until a total 25 of each sex is sampled. However, researchers may not exceed the limit of blood sampling 75 animals of both sexes combined for the entire period of the permit

Activities Continued from the Original Permit:

The following is a summary of the research activities authorized under the current permit that will continue through the duration of the proposed permit modification:

Capture

Capture of smalltooth sawfish is conducted using longlines, gill nets, seines nets, drum (set) lines, and rod and reel. Two types of longlines are currently utilized depending on the sampling location. The more routine longlines used for sawfish sampling under the current research activities as authorized consist of a 1,312 to 1,624 foot bottom set mainline of 0.315 inch braided nylon rope anchored at both ends. Gangions are constructed of 39 inches of 0.196 inch braided nylon cord and 39 inches of stainless steel wire leader and are spaced 10 meters apart along the mainline. Mustad tuna circle hooks ranging in size from 10/0 to 16/0 are used in association with longlines. These hook sizes are necessary to successfully sample the entire size range of sawfish. Small hooks (10/0 and 12/0) are required to fish for juvenile sawfish, given the small size of their mouth. Larger hooks (14/0 and 16/0) are required to fish for adult sawfish to prevent breaking or straightening of the hook. These longlines are generally set in open water coastal areas, passes, Florida Bay, and the Florida Keys as opposed to estuaries or river mouths. Hooks are baited with frozen mullet and fresh catfish, pinfish, crevalle jack, or ladyfish when available. Size 10/0 hooks are also baited with frozen shrimp when available. These longlines are deployed for three to four hours before they are retrieved.

A second offshore type of longline is only used in offshore areas to the East, West, and South of the Florida peninsula using a 46-foot research vessel. This type of longline consists of one mile of 0.25 inch diameter braided tarred line with a three strand core. This type of longline would have a Danforth anchor at each end to hold the line in place and a commercial grade high flyer equipped with strobes and radar reflectors to mark the ends of the line. Gangions with 16/0-18/0 Mustad tuna circle hooks would be spaced approximately every 50 feet and a float would be attached to the line after every tenth hook to suspend the line to fish the entire water column. The hooks closest to the anchors would be placed at a distance 1.5 times the depth of the water from the anchor to allow any air breathing animals to surface. These longlines are deployed for three to four hours and then retrieved.

Gill nets consist of up to 328 feet of three or four inch stretch mesh monofilament anchored at both ends. The float line contains a foam core and the lead line contains a lead core. Surface buoys are used to mark the location of the net every 33 feet. Gill nets are monitored continuously to allow removal of animals as they are captured. Gill nets are most often set in waters less than one meter deep over sand and mud banks.

Rod and reel fishing equipment utilize Penn 7500SS reels and Star ST 15/30 rods with 40 pound monofilament line and a 10/0 Mustad tuna circle hook with approximately 19 inches of plastic coated wire leader. Hooks are baited with the same baits used on the longlines.

Seine nets consist of 200 feet by eight feet of nylon with two inch stretched mesh. While seine nets are rarely used by researchers, there are occasions when the seine net would be used to encircle a sawfish which is observed swimming along a sand bar or shallow flat.

Drumlines consist of a cement block anchor with a monofilament leader (or baitline), a 14/0-18/0 circle hook, and a surface float. The bait line would be at least 1.5 times the water depth in length to allow for any captured air-breathing animals to surface. This would allow for these animals to be removed from the gear soon after capture. Drum lines would only be used when targeting adult sawfish.

Handling and Size Measurements

Smalltooth sawfish captured are identified and sexed. Four measurements of straight line length are taken when possible: precaudal length (PCL), fork length (FL), total length (TL) and stretched total length (STL). Rostral tooth counts (left, right and total) and rostral length (RL) are also taken for all captured sawfish individuals. Smaller individuals would be measured aboard the vessel or in the water using a measuring board while larger individuals would be left in the water and measured using a fiberglass measuring tape. Small individuals would also be weighed using a mesh bag suspended from a spring scale. Occasional recaptures may be measured, weighed, re-tagged if necessary, re-sampled, and then released. No sawfish are authorized to be out of the water longer than one minute without having water run through its mouth and over its gills.

Genetic Tissue Sampling

Small tissue samples are clipped with disinfected scissors from the dorsal fin of captured sawfish individuals for genetic analysis. Similar samples would also be obtained on an opportunistic basis for any Atlantic sturgeon incidentally captured.

Blood Sampling

Blood samples from captive smalltooth sawfish from Sea World Orlando are used in validating commercially available hormone assays for testosterone and estradiol, following the manufacturer's instructions. Blood samples are regularly obtained from Sea World's captive sawfish in the fall, as part of routine veterinary physicals. Additional blood samples for use in validating hormone assays are obtained from wild sawfish. To draw blood, researchers use a sterile, disposable one to 1.5 inch, 20 to 24 gauge needle and syringe. The caudal vein lies ventral to the caudal artery, with both vessels encased in the hemal arch of the caudal vertebrae. All sawfish are restrained with the ventral side up by securing the saw and caudal tail. Small sawfish (about 4 feet or less) would be handled on the boat and secured by personnel holding the saw and caudal tail. Larger sawfish would be secured with ropes wrapped around the rostrum, mid-section and caudal tail which are secured to the boat or held by personnel. The needle enters the tail at the ventral midline and remains as close to the midline position as possible during penetration of the muscle until the vertebral column is reached. Slight penetration of the caudal vertebrae allows access to the caudal vein. No swabbing of the area prior to penetration is used as the effects of alcohol or betadine on the skin of sawfish is currently unknown. Dermatitis has been reported in some other elasmobranchs

from the swabbing of the skin. Therefore, swabbing is not generally used unless the animal is going to be sampled numerous times and the effects of the agent applied to the skin can be observed in a controlled setting.

After the draw, blood is transferred to heparinized vacutainers, and stored on ice until samples are returned to the laboratory. Blood samples are centrifuged to separate plasma, and stored in aliquots at -80°C until used in hormone assays. Plasma hormone concentrations are grouped by sex and compared by animal size and month (season) of capture to discern hormone patterns and to make inferences about the reproductive cycle including size-at-maturity, reproductive stage, and reproductive seasonality. These methods are consistent with earlier studies on the reproductive endocrinology of sharks and their relatives (Gelsleichter, 2004).

The amount of blood drawn depends on the size of the sawfish sampled. A recent review on body fluid volume regulation in elasmobranchs reported that total blood volume ranged between 5.2-8.0 milliliters per 100 gram body weight in shark species that have been directly tested (Anderson, 2007). Using a conservative estimate of five milliliters per kilogram of body weight, researchers estimate that the smallest smalltooth sawfish sampled had a total blood volume of no less than 18 milliliters. Larger juveniles (two to four pounds), which are more commonly sampled by the program, are estimated to have total blood volumes ranging from 50 to 100 milliliters. 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 limit the amount of blood drawn to 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. Using these protocols, researchers sample less than six percent of total blood volume from any individual sawfish and still obtain sufficient material for conducting hormone assays. Blood from juvenile sawfish will also be used to provide a baseline for hormones levels to compare with adults, while still allowing for the one milliliter minimum amount necessary for radio immunoassay.

Tagging

Tagging methods authorized to continue include attachment of acoustic transmitter tags, plastic headed dart tags, Pop-Up Archival Transmitting (PAT) tags, and Passive Integrated Transponder (PIT) tags. Every sampled smalltooth sawfish is currently being fitted with acoustic transmitter tags, plastic headed dart tags, and PIT tags, while PAT tags are only fitted on individuals over 150 centimeters long (i.e. juveniles and adults).

Acoustic transmitters are attached to the sawfish's dorsal fin although the method of attachment is being modified under this proposed permit modification (see next section for details). Acoustic tags transmit a coded pulse stream at 50 to 69 kilohertz and are 7 centimeters long and 1.6 centimeters in diameter. Two styles of acoustic tags would be used: (1) active tracking tags where the pulse stream is repeated every three seconds allowing the animal to be followed, and (2) monitoring tags which produce a pulse stream every 45 to 75 seconds. The monitoring tags are used in conjunction with moored

acoustic monitors that record when the tag is within its range. Plastic headed dart tags are applied to sawfish at the base of the first dorsal fin using an applicator needle to position the barbed head behind the cartilaginous rays supporting the fin.

PAT tags are data-logging tags that detach from the host animal at a pre-assigned date (generally three to six months after release), float to the surface, and download data summaries via the ARGOS satellite system. Depth, temperature, and light level are all logged by the tag. A geolocating algorithm utilizes the light data to provide an estimate of daily location of the animal. These tags are 14 centimeters long, 2.1 centimeters in diameter, have a four centimeter diameter float, and a 12 centimeter antenna. The tag is streamlined and is easily towed by an animal that is longer than 150 centimeters. While PAT tags would continue to be utilized, the method of attachment has been modified (see next section for details).

PIT tags are small (12 millimeters in length and 1.5 millimeters in diameter), implantable tags that can remain in the animal throughout their lifetime. These tags are inserted using a 12 gauge 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 would have a PIT tag implanted unless scanning the animal reveals that an implantable tag already exists. If an Atlantic sturgeon, prior to its proposed ESA listing, is incidentally captured, researchers will also PIT tag these individuals prior to release.

Activities Modified under the Proposed Permit:

The following are research activities to be added or modified as part of the proposed permit modification:

Attaching Acoustic Transmitters with Neoprene Clasp Tags

As part of the original permit, acoustic transmitters were authorized to be attached to smalltooth sawfish by epoxying the transmitter to a swivel ear tag also referred to as a “rototag”. These tags were attached to the first dorsal fin of a smalltooth sawfish by punching a 3-5 millimeter hole through the fin with a leather hole-punch, and then fastening the two halves of the tag together through the fin. However, after using this tagging method, the applicant found that some of the transmitters eventually migrated through the fin and fell out which has greatly limited the long-term data collection of habitat use and movements.

To address these issues, the researchers are proposing to modify their attachment methods by utilizing a neoprene clasp which has proven to increase tag retention on other elasmobranch species (Wetherbee et al., 2007). In the modified tagging procedure, a small 1-2 millimeter hole would be created through the anterior base of the first dorsal fin using a 20-gauge, four centimeter long surgical needle. The front of the clasp is positioned at the anterior of the dorsal fin where it would be anchored through thick connective tissue. A second attachment point is created 30 to 36 millimeters posterior of the first attachment point at the base of the dorsal fin. Before the neoprene clasp is fastened, a small piece of anti-chaffing tubing is inserted through the anterior hole, and

80 pound test monofilament line is threaded through the tubing. The monofilament is then 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 tag would be fastened with epoxy to the plastic backings and the clasp attached to either side of the fin. The monofilament would then be threaded through holes in the two types of backings and through the attachment holding the tagging apparatus taut against the animal and minimizing drag. After the tags are secure, metal (nickel plated brass) crimps would be used to secure the monofilament loops. The metal crimps would corrode over time releasing the tag, leaving two small holes. The proposed procedure would be performed in less than five minutes without anesthesia with the animal remaining in the water.

Attaching PAT Tags Using a Harness

As part of the original permit, PAT tags were authorized to be attached using nylon umbrella darts connecting the tag with 136 kilogram monofilament leaders that were designed to detach from the host animal in a predictable time period (generally three to six months after release), float to the surface, and then download data summaries via the ARGOS satellite system. However, researchers found that tag retention by this method was significantly less than the programmed data collection period (63 days on average before release compared to the 90-180 days for which the tag is programmed to obtain data before release) thereby limiting the long term data collection on sawfish movements. Researchers also found that lesions were sometimes evident on recaptured sawfish where the tag had been ripped off, presumably from the tag getting caught on mangrove branches or other structures in nearshore areas.

To address these issues, the researchers are proposing to utilize a harness attachment method rather than nylon umbrella dart. The structural base of the proposed satellite tag attachment is a 75 centimeter section of 1.8 millimeter, stainless steel (49 strand) cable. One end of this cable is attached to the satellite tag using two 1.8 millimeter double copperlock crimps. Onto the free end of the of the steel cable, the following items are threaded: two double copperlock crimps, a 5.0 centimeter section of 3.2 millimeter polyolefin heat-shrinkable tubing, a 30-50 centimeter (depending on sawfish size) section of 2.0 millimeter nylon chafe tubing, and finally a second 5.0 centimeter section of 3.2 millimeter polyolefin heat-shrinkable tubing. 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. Internally, this region primarily consists of connective tissue with very little vascularization, therefore the insertion results in no bleeding. 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.

The cable is pulled through the crimps to decrease the loop in the harness until the crimps rest just under the free rear tip of the dorsal fin. The crimps are then closed to secure the harness in place and the excess steel cable is removed with wire cutters. 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. Also, given the larger size of the animals to be tagged with this method (i.e. juveniles and adults over 150 centimeters), 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.

Excluding SPOT tags from All Research Activities

Researchers also will no longer use Smart Position Only Transmitting (SPOT) tags as part of the research activities to be authorized in the proposed permit modification. SPOT tags transmit signals to the ARGOS satellite system to estimate the location of the animal whenever they break the surface of the water. The researcher is no longer using SPOT tags because the dorsal fins of sampled sawfish were found to be too flexible to maintain the SPOT tag antennae vertically to send signals. Like rototags, SPOT tags have also been found to migrate their way through the dorsal fin, releasing the tag prematurely and causing torn fins in sampled individuals.

Mitigation Measures

The following section summarizes the mitigation measures associated with permit modification No. 13330-01 to mitigate effects to targeted and any 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 proposed permit modification:

1. In the event a serious injury or mortality² of a protected species occurs, the Researchers must suspend permitted activities and contact the Chief, NMFS Permits, Conservation, and Education 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 take³ is exceeded, the Researchers must cease all permitted activities and notify the Chief, NMFS Permits, Conservation, and Education 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 include a complete description of the events and

² 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.

³ Under the ESA, a take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to do any of the preceding.

identification of steps that will be taken to reduce the potential for additional exceedance of authorized take.

3. Accidental Mortality or Serious Injury of Smalltooth Sawfish: This permit does not authorize the serious injury or mortality of smalltooth sawfish. In the event that this species is killed or seriously harmed the research must be immediately suspended and the Permits Division contacted as described in Section III.A of the the permit. Any deaths or serious injuries that could have been caused by the presence or actions of the researchers, regardless of whether the animal was in hand at the time of death, shall be reported. This includes, but is not limited to, deaths resulting from infections related to intrusive procedures or injuries sustained by animals attempting to evade capture or restraint. If researchers are uncertain about whether a death was related to the research, they should consult with the Permits Division.
4. All co-investigators shall receive training from the Principal Investigator to learn sawfish and sea turtle handling procedures 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.
5. 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.
6. 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.
7. For satellite transmitters: Total weight of transmitter attachments for any one sawfish must not exceed 2% 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.
8. 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 PI or qualified co-investigators (CIs) unless a qualified research associate (RA) is supervised by the PI or CI.
9. During release from boats, animals shall be lowered as close to the water's surface as possible to prevent potential injuries.
 10. 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.
 11. Capture of Sea Turtles: If a sea turtle is captured and is seriously injured or dies, the Permit Holder must notify the Permits Division by phone ((301)713-2289) or fax ((301)713-0376) as soon as possible after completing a research trip and supply the details.
 12. Sea Turtle Handling: 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.

In the case of a sea turtle hooking event, researchers shall be trained in and follow the NOAA de-hooking protocol as outlined in "Careful Release Protocols for Sea Turtle Release With Minimal Injury." Copies of this memo can be obtained at <http://www.sefsc.noaa.gov/seaturtletechmemos.jsp>. Researchers must have appropriate equipment to allow them to follow the protocol. Resuscitation shall be attempted on sea turtles that are comatose or inactive by:

- a. Placing the sea turtle on its bottom shell (plastron) in the upright position and elevating its hindquarters at least 6 inches (15.2 cm) for a period up to 24 hours. The elevation depends on the size of the sea turtle; greater elevations are needed for larger sea turtles. Periodically, rock the sea turtle gently left to right and right to left by holding the outer edge of the shell (carapace) and lifting one side about 3 inches (7.6 cm) then alternate to the other side. Gently touch the eye and pinch the tail (reflex test) periodically to see if there is a response.
- b. Sea turtles being resuscitated shall be shaded and kept damp or moist (if appropriate) but under no circumstance be placed into a container holding water. A water-soaked towel placed over the head, carapace, and flippers is the most effective method.
- c. Sea turtles that revive and become active shall be released over the stern

of the boat only when fishing or scientific collection gear is not in use, when the engine gears are in neutral position, and in areas where they are unlikely to be recaptured or injured by vessels.

- d. A sea turtle is determined to be dead if the muscles are stiff (rigor mortis) and/or flesh has begun to rot; otherwise, the sea turtle is determined to be comatose or inactive and resuscitation attempts are necessary.

13. 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.
- g. Researchers shall also record whether the animal was:
 - i. Released with hook and with trailing line greater than or equal to half the length of the carapace (line is trailing, turtle is not entangled)
 - ii. Released with hook and with trailing line less than half the length of the carapace (line is trailing, turtle is not entangled).
 - iii. Released with hook and entangled (line is not trailing, turtle entangled).
 - iv. Released with all gear removed.

14. Netting bycatch special conditions:

- 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 20 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. In Waters Where Manatee are Present: The following conditions to the permit are offered by the USFWS to prevent and minimize interactions with endangered Florida manatee (*Trichechus manatus*).

16. Avoiding manatee interaction:

- a. Vessel personnel must be informed it is illegal to purposely or by mistake to 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.

- b. 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.
- c. 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.
- d. Rope attaching floats to nets should not have kinks or contain slack that could present an entanglement hazard to manatee.
- e. 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.

17. If a manatee is incidentally captured:

- a. 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.
- b. As appropriate, turn off the vessel or put engine in neutral.
- c. 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.
- d. Immediately contact the Florida Fish and Wildlife Conservation Commission (FWC), Division of Law Enforcement, 1-888-404-FWCC [3922], and as soon as FWC is notified, contact Nicole Adimey (USFWS) at 904-731-3079 (weekdays); 904-655-0730 (cell); fax 904-731-3045 to report any gear or vessel interactions, or sighting of manatees,

Also contact NMFS (Chief, Permits, Conservation and Education Division at 301-713-2289) as soon as possible.

18. Submerged Aquatic Vegetation, Coral Communities, Live or Hard Bottom Ecosystems:

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

19. Non-listed Bycatch: All incidentally captured species (e.g., fishes) must be released alive as soon as possible. Please include catch data in your annual report.

20. Atlantic Sturgeon Interaction:

- a. If an Atlantic sturgeon, prior to its ESA listing, is incidentally captured,

NMFS requests it be handled as recommended by NOAA sturgeon research protocols (Kahn and Mohead, 2010); and it minimally be PIT tagged, genetically sampled, and released.

- b. NMFS requests interactions with pre-listed Atlantic sturgeon (alive or salvaged) are reported to Lynn Lankshear (NMFS PR) by phone at 978-281-9300 x 6535 (Lynn.Lankshear@noaa.gov) using the information contained in Appendix 5. This report should contain descriptions of take, (including lethal take or salvage), location, and final disposition of the sturgeon. Specimens or body parts of dead Atlantic sturgeon should be preserved (preferably on ice or refrigeration) until sampling and disposal procedures are discussed with NMFS.
- c. Should an ESA listing for Atlantic sturgeon become effective during the permitted time frame authorized for smalltooth sawfish research, the researcher must consult with NMFS to apply for coverage of any incidental takes of Atlantic sturgeon co-occurring in the action area with smalltooth sawfish before proceeding with sawfish research in that area (defined as the St Marys and St Johns River watersheds).

21. Crocodiles and Alligators:

- a. All researchers shall receive training on handling and releasing a crocodile or alligator from research gear. The original training to the PI shall be provided by Joe Wasilewski (Florida Power and Light; Miami Florida). The PI may subsequently train CIs
- b. If a crocodile or alligator is incidentally captured, devote all research staff efforts to freeing the animal. Remember that a crocodile or alligator must breathe and surface approximately every 20 or 30 minutes. Once it has been established a crocodile or alligator is captured, attempts to raise the animal's head out of water to breath and to see the extent of entanglement should be attempted. The animal's snout/head should be kept out of the water to prevent it from drowning, but also to allow access to the net to cut the animal loose. A knife tied to a long pole or stick is useful to cut net while maintaining a safe distance from the crocodile or alligator. The Permit Holder must brief all research participants to ensure that they understand that freeing a crocodile or alligator can be dangerous.
- c. As appropriate, turn off the vessel or put the engine in neutral.
- d. Release tension on the net to allow the animal the opportunity to free itself. Exercise caution when attempting to assist the animal in freeing itself. Ensure that the animal does not escape with net still attached to it.
- e. If a crocodile is taken the Permit Holder shall notify the U.S. Fish and

Wildlife Service (USFWS) Law Enforcement Office in Miami, Florida (305-526-2610) and the Ecological Services Sub Office at Big Pine Key, Florida (305-872-2753). Secondary notification must be made to the FWC, South Region, Lakeland Florida (1-800-282-8002). A summary incident report shall be submitted to the USFWS, Field Supervisor, 1339 20th Street, Vero Beach, Florida 32960 (772-562-3909).

22. 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).
23. 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 would be ideal, but less specific information would also be 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.
24. Longline and Drum Line Gear: 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.
25. Individuals conducting permitted activities must possess qualifications commensurate with their roles and responsibilities.
26. Persons who require state or Federal licenses to conduct activities authorized under the permit (e.g. veterinarians, pilots) must be duly licensed when undertaking such activities.
27. The Permit holder must submit annual reports to the Chief, NMFS Permits, Conservation, and Education 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.
28. Research results must be published or otherwise made available to the scientific community in a reasonable period of time.
29. Careful and detailed records must be kept on the recovery and responses from handling, tissue sampling, tagging, tag retention, healing, and condition or health of any smalltooth sawfish.
30. To monitor or lessen negative impacts of tagging methods, researchers must examine tag attachment sites of recaptured sawfish for any lesions or

complications associated with the tagging methods. Additionally, any results obtained on tag retention and fish health must be reported to NMFS PR in annual reports and as periodically requested by NMFS. If impacts of the tagging are other than insignificant, NMFS would then reevaluate their use in the permit.

31. To ensure normal mobility and swimming behavior of smalltooth sawfish receiving tagging devices, researchers must document adaptation to these tags by individually monitoring and recording swimming behavior, number of times each fish is detected, time periods between detections, and the history of unrelocated individuals.
32. 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.
33. 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.

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 modification⁴ 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 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

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 of the species for which the area was designated.

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, Conservation and Education 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 like the Minerals Management Service, U.S. Coast Guard and U.S. Navy 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 (for example, a study that suggests sea turtles will exhibit a particular response to a particular tagging procedure) as well as data that does not support that conclusion.

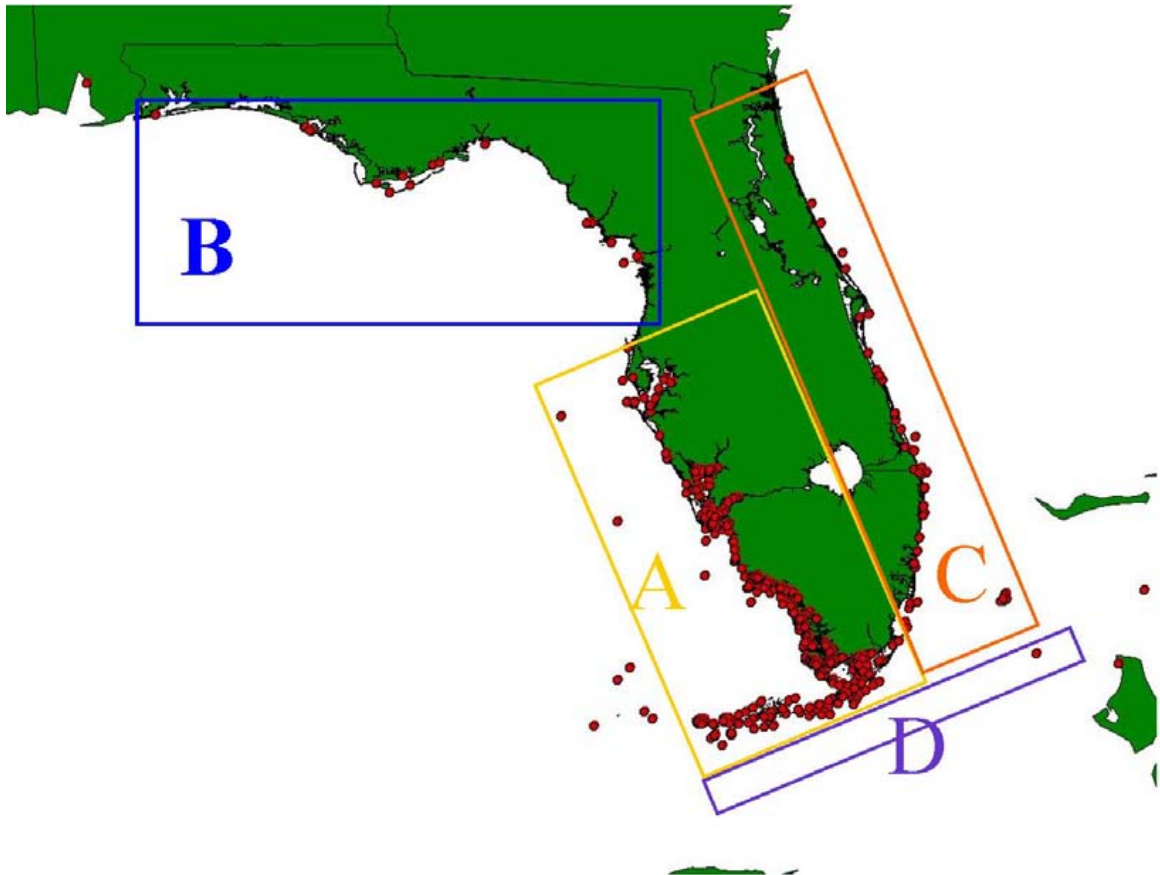
We rank the results of these searches based on the quality of their study design, sample sizes, level of scrutiny prior to and during publication, and study results. Carefully designed field experiments (for example, experiments that control potentially confounding variables) are rated higher than field 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.” Sampling associated with the proposed permit modification would continue to occur throughout Florida’s coastal waters (i.e. near shore waters, estuaries, and mouths of rivers) if reliable and sufficient reports of smalltooth sawfish encounters were received to warrant sampling in those areas. Research efforts, however, would primarily be focused in the region of the Florida coast from Naples to Key West, encompassing the Ten Thousand Islands and Everglades National Park (See Zone A in **Figure 1** below).

Figure 1: Map of the Action Area—Zones of Sampling



Zone A consists of state waters from Anclote to the Marquesas Keys, including all areas of Everglades National Park and the Florida Keys National Marine Sanctuary. Zone B consists of state waters from the Florida/Alabama border to Anclote. Zone C consists of state waters from the Florida/Georgia border to Biscayne National Park. Zone D consists of federal waters offshore of the keys between Florida and the Bahamas and Cuba. For the purposes of this consultation, the action area will be nearshore and state waters off the coast of Florida and the Florida Keys as well as offshore waters south of the Florida Keys within the U.S. EEZ.

STATUS OF THE SPECIES

The Endangered Species 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:

<u>Common Name</u>	<u>Scientific Name</u>	<u>Listing Status</u>
Smalltooth Sawfish U.S. DPS	<i>Pristis pectinata</i>	Endangered
Largetooth Sawfish	<i>Pristis perotteti</i>	Proposed Endangered
Atlantic Sturgeon South Atlantic DPS	<i>Acipenser oxyrinchus oxyrinchus</i>	Proposed Endangered
Gulf Sturgeon	<i>Acipenser oxyrinchus desotoi</i>	Threatened
Shortnose Sturgeon	<i>Acipenser brevirostrum</i>	Endangered
Loggerhead sea turtle	<i>Caretta caretta</i>	Threatened
Loggerhead sea turtle Northwest Atlantic Ocean DPS ⁵	<i>Caretta caretta</i>	Proposed Endangered
Green sea turtle	<i>Chelonia mydas</i>	Endangered ⁶
Hawksbill sea turtle	<i>Eretmochelys imbricata</i>	Endangered
Kemp's ridley sea turtle	<i>Lepidochelys kempii</i>	Endangered
Leatherback sea turtle	<i>Dermochelys coriacea</i>	Endangered
Blue whale	<i>Balaenoptera musculus</i>	Endangered
Fin whale	<i>Balaenoptera physalus</i>	Endangered
Humpback whale	<i>Megaptera novaeangliae</i>	Endangered
North Atlantic right whale	<i>Eubalaena glacialis</i>	Endangered
Sei whale	<i>Balaenoptera borealis</i>	Endangered
Sperm whale	<i>Physeter macrocephalus</i>	Endangered
Elkhorn Coral	<i>Acropora palmata</i>	Threatened
Staghorn Coral	<i>Acropora cervicornis</i>	Threatened
Johnson's Seagrass	<i>Halophila johnsonii</i>	Threatened
Smalltooth Sawfish Critical Habitat		Designated
Gulf Sturgeon Critical Habitat		Designated
Elkhorn Coral Critical Habitat		Designated
Staghorn Coral Critical Habitat		Designated

⁵ A distinct population segment, is a vertebrate population or group of populations that is discrete from other populations of the species and significant in relation to the entire species. The ESA provides for listing species, subspecies, or distinct population segments of vertebrate species.

⁶ Green sea turtles in U.S. waters are listed as threatened except for the Florida breeding population, which is 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.

Johnson's Seagrass Critical Habitat
North Atlantic Right Whale Critical Habitat

Designated
Designated

Listed Resources Not Likely to be Adversely Affected

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.

Critical habitat has been designated for the endangered North Atlantic right whale off the states of Georgia and Florida⁷ (59 FR 28793; June 3, 1994). 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; June 3, 1994). NMFS believes that the proposed research activities would not affect oceanographic characteristics, water depth, 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 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.

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 since

⁷ 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 15nm 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 5nm.

2008. NMFS believes that listed 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 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 2008 for the current 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.

Gulf sturgeon occurs 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). Gillnets are used in water less than 40 inches deep after visually identifying and targeting a smalltooth sawfish. 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 be typically used to capture Gulf sturgeon (i.e. normally six to twelve inch mesh). Longlines will be baited with prey items not consumed by the species to avoid interaction during these types of surveys. Also, researchers have not reported encountering a Gulf sturgeon in their monitoring reports submitted since 2008. 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.

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. However, researchers may occasionally venture north into areas designated as critical habitat for Gulf sturgeon if reliable and sufficient reports of smalltooth sawfish encounters were received to warrant sampling in those areas. However, researchers 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.

Shortnose sturgeon and largemouth sawfish historically occupied waters within the action area for the proposed action and therefore have the possibility of being present during research activities. Specifically, shortnose sturgeon historically occupied the St. John's and St. Mary's rivers in Florida while largemouth sawfish were historically reported along the Texas coast and east into Florida waters. Kahnle et al. (1998) and Rogers and Weber (1994) determined that shortnose sturgeon had been extirpated from those river systems while the most recent status review for largemouth sawfish reported the last sighting for Florida waters occurred in 1941 (NMFS, 2010a). Researchers did not report any sightings of shortnose sturgeon or largemouth sawfish in monitoring reports submitted since 2008 under the original 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 endangered shortnose sturgeon and largemouth sawfish proposed for listing and these species will not be considered further in this Opinion.

Critical habitat designated for the 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 (TTI/E), 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.

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.

For our discussion pertaining to loggerhead sea turtles, we note the distinction between the current listing (i.e. listed as threatened throughout its range) from the proposed Northwest Atlantic Ocean DPS (i.e. proposed as endangered) in our effects analysis and final jeopardy conclusions. NMFS assumes that loggerhead sea turtles affected within the action area would be expected to be members making up the proposed Northwest Atlantic DPS if and when that DPS is officially listed under the ESA. Therefore, the environmental baseline, exposure analysis, response analysis, and cumulative effects analysis is expected to be the same for both the current rangewide listing and the proposed DPS and will be treated as such in this Opinion. Factors shaping the status of the species rangewide compared to the status of the proposed Northwest Atlantic Ocean DPS may differ in their focus; however, we will treat the status of the species as it pertains to the current rangewide listing and assume that all factors shaping the status of the more geographically confined DPS would still be captured and identified in that discussion. Where the distinction is more apparent is in our evaluation of risk informing

our jeopardy determination. Since the proposed DPS represents a more geographically constrained unit compared to the current rangewide listing, our risk analysis may come to a different jeopardy conclusion for the current listing compared to the proposed DPS when all factors are considered. Therefore, our evaluation of risk and our final jeopardy determination will make the distinction between the current listing and the proposed DPS while all other sections will be treated the same for both.

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 to 34 rostral teeth on each side of the rostrum (versus 14-23 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, 2000). 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). Water temperatures no lower than 16-18 °C and the availability of appropriate coastal habitat serve as the major environmental constraints limiting the northern movements of smalltooth sawfish in the western North Atlantic. As a result, most records of this species from areas north of Florida occur during spring and summer periods (May to August) when inshore waters reach higher temperatures. Most specimens captured along the Atlantic coast north of Florida are large adults (over 10 feet) and likely represent seasonal migrants, wanderers, or colonizers from an historic Florida core population(s) to the south rather than being 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 31 inches (80 centimeters) at birth (Simpfendorfer, 2002) and may grow to a length of 18 feet (540 centimeters) or greater during their lifetime (Bigelow and Schroeder, 1953). A recent study 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 natural population increase for the species at 0.08 to 0.13 per year and estimated population doubling times from 5.4 years to 8.5 years. These low intrinsic rates of population increase suggests that the species is particularly vulnerable to excessive mortality and rapid population declines due to stochastic events, after which recovery may take decades. 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 largemouth 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 largemouth 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 (39-79 inches or 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). 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 32 feet (10 meter) (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, Trends, and Current Threats

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 3,305 sawfish encounters were reported from 2000-2009 (Florida Museum of Natural History, 2011). 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).

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 Louisiana 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 four lethal takes of smalltooth sawfish are exempted over a three year period for all these fisheries combined (NMFS, 2005a; NMFS, 2005b; NMFS, 2006a; NMFS, 2006b; NMFS, 2007; NMFS, 2008a; NMFS, 2009b; NMFS, 2009c).

In addition to commercial fisheries, Caldwell (1990) noted that saws were often removed from sawfish caught by recreational fishermen, often to avoid injury to the fishermen themselves or to keep the saw as a type of trophy. While the current threat of mortality associated with recreational fisheries is expected to be low given that possession of the species in Florida has been prohibited since 1992, bycatch for various fisheries is expected to continue to threaten the ability of the species to survive and recover in the wild.

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). Thus, past, present, and future impacts associated with global climate change such as sea level rise, increased frequency of severe weather events, and change in air and water temperatures may threaten the species' ability to survive and recover in the wild.

Atlantic Sturgeon (Proposed South Atlantic DPS)

Species Description, Distribution, and Population Structure

Atlantic sturgeon are long-lived, late-maturing, estuarine-dependent, anadromous fish species that may live up to 60 years, reach lengths up to 14 feet, and weigh over 800 pounds. They are distinguished by armor-like plates and a long protruding snout that is ventrally located, with four barbels crossing in front [Atlantic Sturgeon Status Review Team (ASSRT), 2007].

Historically, sightings of Atlantic sturgeon have been reported from Hamilton Inlet, Labrador, south to the St. Johns River, Florida. Within that historical range, their presence has been documented in 36 rivers with spawning occurring in at least 18 of those rivers. The proposed South Atlantic DPS, which is the subject of this consultation, includes all Atlantic sturgeon that spawn in the watersheds of the ACE Basin in South Carolina to the St. Johns River, Florida. Rivers known to have current spawning populations within this proposed DPS include the Combahee, Edisto, Savannah, Ogeechee, Altamaha, and Satilla Rivers while the Broad Coosawatchie, St. Marys, and St. Johns rivers have been documented to have spawning populations in the past or have evidence that spawning may have occurred at one time (ASSRT, 2007).

The South Atlantic DPS also includes Atlantic sturgeon held in captivity (e.g., aquaria, hatcheries, and scientific institutions) and which are identified as fish belonging to the South Atlantic DPS based on genetics analyses, previously applied tags, previously applied marks, or documentation to verify that the fish originated from (hatched in) a river within the range of the proposed South Atlantic DPS, or is the progeny of any fish that originated from a river within the range of the proposed South Atlantic DPS.

The genetic diversity of Atlantic sturgeon along its range has been well documented. Initial investigations began in the early 1990s and have continued to the present (Bowen and Avise, 1990; Ong et al., 1996; Waldman et al., 1996a; Waldman et al., 1996b; Waldman and Wirgin, 1998; King et al., 2001; Wirgin et al., 2002). Overall, these studies have consistently found subpopulations to be genetically diverse and the majority can be readily differentiated. More recent articles on Atlantic sturgeon genetic diversity indicate that from the areas that have been sampled, there are between seven and ten subpopulations that can be statistically differentiated (King et al., 2001; Wirgin et al., 2002; Waldman et al., 2002). For regulatory purposes, NMFS is currently proposing to list five discrete DPS' under the ESA (i.e. Gulf of Maine, Chesapeake Bay, New York Bight, Carolina, and South Atlantic DPS').

Life History Information

Atlantic sturgeon have been aged to 60 years (Mangin, 1964); however, this should be taken as an approximation. Vital parameters of sturgeon populations show clinal variation with faster growth and earlier age at maturation in more southern systems, though not all data sets conform to this trend. For example, Atlantic sturgeon mature in South Carolina at 5–19 years of age (Smith et al., 1982), in the Hudson River at 11–21 years of age (Young et al., 1998), and in the Saint Lawrence River at 22–34 years of age (Scott and Crossman, 1973). Atlantic sturgeon likely do not spawn every year, and multiple studies have shown that spawning intervals range from one to five years for males (Smith, 1985; Collins et al., 2000; Caron et al., 2002) and two to five years for females (Vladykov and Greeley, 1963; Van Eenennaam et al., 1996; Stevenson and Secor, 1999). Fecundity has been correlated with age and body size, with egg production ranging from 400,000 to over 8,000,000 eggs per year (Smith et al., 1982; Van Eenennaam and Doroshov, 1998; Dadswell, 2006).

While Atlantic sturgeon exhibit a high degree of spawning fidelity to their natal rivers, they also utilize multiple riverine, estuarine, and marine habitats throughout their lifetime for a variety of functions (e.g., nursery, foraging, and migration). Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in the spring/early summer (e.g. February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems) (Murawski and Pacheco, 1977; Smith, 1985; Bain, 1997; Smith and Clugston, 1997; Caron et al., 2002). In some southern rivers, a fall spawning migration may also occur (Rogers and Weber, 1995; Weber and Jennings, 1996; Moser et al., 1998). A fall migration of ripening adults upriver in the Saint Johns River is also observed; however, this fall migration is not considered a spawning run as adults do not spawn until the spring. Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers, where optimal flows are 46-76 centimeters/second and at depths of 11-27 meters (Borodin, 1925; Leland, 1968; Scott and Crossman, 1973; Crance, 1987; Bain et al., 2000). Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (e.g., cobble) (Gilbert, 1989; Smith and Clugston, 1997). Hatching occurs approximately 94-140 hours after egg deposition at temperatures of 20° and 18° C, respectively, and larvae assume a demersal existence (Smith et al., 1980). The yolk sac larval stage is completed in about 8-12 days,

during which time the larvae move downstream to rearing grounds over a 6–12 day period (Kynard and Horgan, 2002). During the first half of their migration downstream, movement is limited to night hours as larvae often utilize benthic structure (e.g., gravel matrix) as refugia during daylight hours (Kynard and Horgan, 2002). During the later half of migration when larvae are more fully developed, movement to rearing grounds occurs both day and night. Juvenile sturgeon then continue to move further downstream into brackish waters, and eventually become residents in estuarine waters for a duration ranging from months to years.

Upon reaching a size of approximately 76-92 centimeters, the subadults may move to coastal waters (Murawski and Pacheco, 1977; Smith, 1985), where populations may undertake multiple long range migrations (Dovel and Berggren, 1983; Bain, 1997; ASSRT, 2007). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Subadult Atlantic sturgeon wander among coastal and estuarine habitats, undergoing rapid growth (Dovel and Berggren, 1983; Stevenson, 1997). These migratory subadults, as well as adult sturgeon, are normally captured in shallow (10-50 meters) near shore areas dominated by gravel and sand substrate (Stein et al., 2004a). Despite extensive mixing in coastal waters, Atlantic sturgeon return to their natal river to spawn as indicated from tagging records (Collins et al., 2000) and the relatively low rates of gene flow reported in population genetic studies (King et al., 2001; Waldman et al., 2002). Males usually begin their spawning migration early and leave after the spawning season, while females make rapid spawning migrations upstream and quickly depart following spawning (Bain, 1997).

Atlantic sturgeon are omnivorous benthic (bottom) feeders and filter quantities of mud along with their food. Adult sturgeon diets include mollusks, gastropods, amphipods, isopods, and fish while juveniles feed on aquatic insects and other invertebrates (ASSRT, 2007).

Listing Status

On October 6, 2010, NMFS proposed to list five DPS' of Atlantic sturgeon under the ESA. The Gulf of Maine DPS is proposed for listing as threatened, while the Chesapeake Bay, New York Bight, Carolina, and South Atlantic DPS' are proposed to be listed as endangered. The species is also protected under CITES and is classified as "near threatened" on the IUCN's Red List of threatened species.

Abundance, Trends, and Current Threats

The proposed South Atlantic DPS is estimated to number less than six percent of historical abundance (ASSRT, 2007), with all river populations except the Altamaha river estimated to be less than one percent of historical abundance. Prior to 1890, Secor (2002) estimated there were 8,000 adult spawning females in South Carolina and 11,000 adult spawning females in Georgia. Current abundance estimates are only available for the Hudson and Altamaha rivers, where adult spawning populations are estimated to be approximately 870 and 343 fish per year, respectively (Schueller and Peterson, 2006; Kahnle et al., 2007). Surveys from other rivers in the species' U.S. range are more qualitative, primarily focusing on documentation of multiple year classes and

reproduction, as well as the presence of very large adults and gravid females in the river systems.

The Altamaha River is believed to have the largest population in the Southeast (ASSRT, 2007). The larger size of this population relative to the other river populations in the Southeast is likely due to the absence of dams, the lack of heavy development in the watershed, and relatively good water quality, as Atlantic sturgeon populations in the other rivers in the Southeast have been affected by one or more of these factors. Trammel net surveys, as well as independent monitoring of incidental take in the American shad fishery, suggest that the Altamaha population is pretty much stable and is neither increasing or decreasing (ASSRT, 2007).

While prior sampling of the St. Marys and St. Johns River 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. There have also been reports of Atlantic sturgeon tagged in the Edisto River (South Carolina) being recaptured in the St. Johns River, indicating this river may serve as a nursery ground; however, there are no data to support the existence of a current spawning population in the St. Johns (Rogers and Weber, 1995; Kahnle et al., 1998). Nevertheless, the best available evidence suggests that Atlantic sturgeon are found within these rivers so NMFS will assume that Atlantic sturgeon are utilizing these river systems for one or more essential life functions for the purposes of this consultation.

Atlantic sturgeon are very sensitive to fishing mortality compared to other coastal fish species based on certain life history traits (e.g. they are long-lived, have an older age at full maturity, have lower maximum fecundity values, etc.). Many authors have cited commercial over-harvesting as the single major cause of the decline in abundance of Atlantic sturgeon [Ryder, 1888; Vladykov and Greely, 1963; Hoff, 1980; Atlantic States Marine Fisheries Commission (ASMFC), 1990; Smith and Clugston, 1997]. For instance, in the late 1800s, commercial fisheries were landing upwards of 6,800,000 pounds of sturgeon annually (Murawski and Pacheco, 1977). Only 15 years later, this number had dropped to 20,000 pounds and continued overfishing in the 1900s led to a drastic collapse in the fishery with landings in 1990 reported at just 215 pounds (Stein et al., 2004b). The total landings recorded include shortnose sturgeon as well as Atlantic sturgeon; however, the harvest is thought to have been primarily Atlantic sturgeon due to the large mesh-size nets commonly used at that time (ASSRT, 2007). This collapse in the population prompted ASMFC to impose the Atlantic sturgeon fishing moratorium in 1998 and NMFS to close the U.S. Exclusive Economic Zone (EEZ) to Atlantic sturgeon retention in 1999. Despite this moratorium, poaching of Atlantic sturgeon continues and is a potentially significant threat to the species, but the present extent and magnitude of such activity is largely unknown. Nevertheless, many states (i.e. Virginia, South Carolina, New York) report that poaching has occurred and that a black market exists;

thus, poaching represents an additional source of mortality that is slowing the rate of recovery for the species that would otherwise occur (ASSRT, 2007)

In addition to the effects felt from prior commercial exploitation, Atlantic sturgeon are also incidentally taken as bycatch in various commercial fisheries along the entire U.S. Atlantic Coast. Since Atlantic sturgeon spend portions of their lives in rivers, estuaries, the nearshore ocean, and the in offshore areas of the U.S. EEZ, they are subject to incidental capture at greater rates than non-anadromous species (ASSRT, 2007). Adults migrating to spawn can be intercepted within rivers in the spring in the southern portion of the range and later in the summer in the northern portion. Fisheries conducted within rivers and estuaries may intercept any life stage, while fisheries conducted in the nearshore and ocean may intercept migrating juveniles and adults. Recapture data of incidentally caught Atlantic sturgeon as reported by the Delaware Division of Fish and Wildlife tagging studies showed that the majority of recaptures (61 percent) came from ocean waters within 4.8 kilometers from shore, 20 percent of the recaptures came from rivers and estuaries, 18 percent from the EEZ, and 1 percent were captured at unreported locations (Shirey et al., 1997). Similarly, Stein et al. (2004b) examined bycatch of Atlantic sturgeon using the NMFS sea sampling/observer 1989-2000 database which identified that the majority of recaptures occurred in five distinct coastal locations (Massachusetts Bay, Rhode Island, New Jersey, Delaware, and North Carolina) in isobaths ranging from 10 to 50 meters, although sampling was not randomly distributed.

According to Stein et al. (2004b), the five greatest bycatch rates of Atlantic sturgeon were in the weakfish-stripped bass fishery (0.1667 pounds per trip), followed by northern kingfish (0.0242 pounds per trip), American shad (0.0239 pounds per trip), southern flounder (0.0200 pounds per trip), and red hake (0.0172 pounds per trip). Bycatch mortality rates range between 0-51 percent, with greatest mortality occurring in sink gill nets where an estimated 13.8 percent of sturgeon died as a result of capture (Stein et al., 2004b; ASMFC, 2007). Mortality associated with bycatch has been estimated as high as 1,400 deaths a year during the years of 1989–2000 in the ocean fisheries ranging from North Carolina to Maine (Stein et al. 2004b). The two largest commercial fisheries likely to capture Atlantic sturgeon from the South Atlantic DPS in the state waters of South Carolina and Georgia are the American shad gillnet (52 percent of total sturgeon bycatch) and shrimp trawl fisheries (39 percent of total sturgeon bycatch) (Collins et al., 1996). In addition to direct mortality, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as exposure to toxins.

Dams for hydropower generation, flood control, and navigation adversely affect Atlantic sturgeon habitat by impeding access to spawning, developmental and foraging habitat, modifying free-flowing rivers to reservoirs, physically damaging fish on upstream and downstream migrations, and altering water quality in the remaining downstream portions of spawning and nursery habitat. Attempts to minimize the impacts of dams using measures such as fish passage have not proven beneficial to Atlantic sturgeon, as they do not regularly use existing fish passage devices, which are generally designed to pass pelagic fish (ASSRT, 2007). Individual riverine systems have been severely impacted by

dams, as access to large portions of historical sturgeon spawning and juvenile developmental habitat has been eliminated or restricted. In addition to blocking access to habitat, dams can degrade spawning, nursery, and foraging habitat downstream by reducing water quality. Atlantic sturgeon are very sensitive to low dissolved oxygen (DO) levels compared to other fish species (Niklitschek and Secor, 2009a; Niklitschek and Secor, 2009b). Low DO, in combination with high temperature, is particularly problematic for Atlantic sturgeon, and studies have shown that juveniles experience lethal and sublethal (metabolic, growth, feeding) effects as DO drops and temperatures rise (Secor and Gunderson, 1998; Niklitschek and Secor, 2005; Niklitschek and Secor, 2009a; Niklitschek and Secor, 2009b). Therefore, it is likely that dam operations are negatively affecting Atlantic sturgeon nursery habitat and impeding the ability of the species to recover in the wild.

In addition to dams, dredging and filling activities impact habitat features important to Atlantic sturgeon as they disturb benthic fauna, eliminate deep holes, and alter rock substrates (Smith and Clugston, 1997). In the South Atlantic DPS, maintenance dredging in Atlantic sturgeon nursery habitat in the Savannah River is frequent, and substantial channel deepening has taken place since 1994. Dredging also commonly occurs within the St. Johns River and has been linked to the reduction in submerged aquatic vegetation that act as foraging habitat for the species (Jordan, 2002). Since a large portion of the historical sturgeon habitat in the St. Johns River has already been curtailed by the presence of a dam, ongoing dredging activities remain a threat to suitable habitat that remains in this river. In addition to these indirect threats, hydraulic dredging can directly harm sturgeon by lethally entraining fish up through the dredge drag-arms and impeller pumps. Dickerson (2005) summarized observed takings of sturgeon from dredging activities conducted by the U.S. Army Corps of Engineers (USACE) and reported that 24 sturgeon (11 of which identified as Atlantic sturgeon) were observed from 1990-2005.

Water quality within the river systems in the range of the South Atlantic DPS is also negatively impacted by contaminants and large water withdrawals. Secor (1995) noted a correlation between low abundances of sturgeon and decreasing water quality caused by increased nutrient loading and increased spatial and temporal frequency of hypoxic conditions. Atlantic sturgeon are particularly susceptible to impacts from contaminated sediments due to their benthic foraging behavior and long-life span, and effects from these compounds on fish include production of acute lesions, growth retardation, and reproductive impairment (Cooper, 1989; Sinderman, 1994). Habitat utilized by the South Atlantic DPS in the Savannah River has already been modified by mercury contamination while eutrophication and loss of thermal refugia are a growing concern in the Altamaha River since the drainage basin is dominated by silviculture and agriculture, with two paper mills and over two dozen other industries or municipalities currently discharging effluent into the river (ASSRT, 2007).

Heavy metals and organochlorine compounds accumulate in sturgeon tissue, but their long-term effects are not known (Ruelle and Henry, 1992; Ruelle and Keenlyne, 1993). Elevated levels of contaminants, including chlorinated hydrocarbons, in several other fish species are associated with reproductive impairment (Cameron et al., 1992; Longwell et

al., 1992; Hammerschmidt et al., 2002; Drevnick and Sandheinrich, 2003), reduced egg viability (Von Westerhagen et al., 1981; Giesy et al., 1986; Mac and Edsall, 1991; Matta et al., 1997; Billsson et al., 1998), reduced survival of larval fish (Berlin et al., 1981; Giesy et al., 1986), delayed maturity (Jorgensen et al., 2003) and posterior malformations (Billsson et al., 1998). Pesticide exposure in fish may affect antipredator and homing behavior, reproductive function, physiological development, and swimming speed and distance (Beauvais et al., 2000; Scholz et al., 2000; Moore and Waring, 2001; Waring and Moore, 2004). Moser and Ross (1995) suggested that certain deformities and ulcerations found in Atlantic sturgeon in North Carolina's Brunswick River might be due to poor water quality in addition to possible boat propeller inflicted injuries.

Concerns also exist that changes in climate may further exacerbate habitat and water quality for Atlantic sturgeon in the near future. Since the status review report for the species was completed in 2007, the U.S. southeast experienced approximately three years of drought (South Carolina State Climatology Office, 2011). Abnormally low stream flows as a result of these types of prolonged drought conditions restrict access to habitat areas, reduce thermal refugia, and exacerbate water quality issues thereby further impacting the species' ability to survive and recover in the wild.

Loggerhead Sea Turtle (including the Proposed 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 vertebrales, and a nuchal (precentral) scute that is in contact with the first pair of costal scutes. Hatchlings lack the reddish tinge and vary from light to dark brown dorsally. Both pairs of appendages are dark brown and have distinct white margins. Hatchling mean body mass is about 20 grams and mean straight carapace length is about 45 mm (Dodd, 1988).

The loggerhead sea turtle inhabits continental shelf and estuarine environments and occurs throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans (Dodd, 1988). The majority of loggerhead nesting occurs at the western rims of the Atlantic and Indian Oceans concentrated in the north and south temperate zones and subtropics (NRC, 1990).

In the western North Atlantic, the majority of loggerhead nesting is concentrated along the coasts of the United States 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 (Addison and Morford, 1996; Addison, 1997), off the southwestern coast of Cuba (Gavilan, 2001), and along the coasts of Central America, Colombia, Venezuela, and the eastern Caribbean Islands. In the eastern Atlantic, the largest nesting population of loggerheads is in the Cape Verde Islands (Abella et al., 2007; Delgado et al., 2008), with some nesting also occurring along the West African coast (Fretey, 2001). From a global perspective, the southeastern U.S. nesting aggregation is critical to the survival of this species as it second in size only to the

nesting aggregations in the Arabian Sea off Oman. In addition, shelf waters along the Florida west coast, the Bahamas, Cuba, and the Yucatán Peninsula have been identified as important resident areas for adult female loggerheads that nest in Florida (Foley et al., 2008)

Non-nesting, adult female loggerheads are reported throughout the U.S. and Caribbean Sea. Little is known about the distribution of adult males who are seasonally abundant near nesting beaches although aerial surveys suggest that loggerheads in U.S. waters are distributed as a whole in the following proportions: 54 percent in the southeast U.S. Atlantic, 29 percent in the northeast U.S. Atlantic, 12 percent in the eastern Gulf of Mexico, and 5 percent in the western Gulf of Mexico (Turtle Expert Working Group [TEWG], 1998). Shallow water habitats with large expanses of open ocean access, such as Florida Bay, provide year-round resident foraging areas for significant numbers of male and female adult loggerheads while juveniles are also found in enclosed, shallow water estuarine environments not frequented by adults (Epperly et al., 1995a). Further offshore, adults primarily inhabit continental shelf waters, from New England south to Florida, the Caribbean, and Gulf of Mexico (Schroeder et al., 2003). Benthic, immature loggerheads foraging in northeastern U.S. waters are 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).

Currently, there are nine DPS' of loggerhead sea turtles proposed to be listed under the ESA divided geographically: South Atlantic Ocean DPS, Southeast Indian Ocean DPS, Mediterranean Sea DPS, North Indian Ocean DPS, North Pacific Ocean DPS, Northeast Atlantic Ocean DPS, Northwest Atlantic Ocean DPS, South Pacific Ocean DPS, and Southeast Indo-Pacific Ocean DPS.

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).

Loggerheads originating from the western Atlantic nesting aggregations 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). 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). Recent 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).

As post-hatchlings, loggerheads hatched on U.S. beaches migrate offshore and become associated with Sargassum habitats, driftlines, and other convergence zones (Carr, 1986; Witherington, 2002). 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 listed as threatened under the ESA in 1978 throughout its range. At the time of this consultation, nine separate loggerhead sea turtle DPS' are proposed for listing under the ESA with two proposed as endangered (South Atlantic Ocean and Southwest Indian Ocean) and seven proposed as threatened (Mediterranean Sea, North Indian Ocean, North Pacific Ocean, Northeast Atlantic Ocean, Northwest Atlantic Ocean, South Pacific Ocean, and Southeast Indo-Pacific Ocean). Critical habitat has not been designated for this species.

Abundance, Trends, and Current Threats

The most recent reviews show that only two loggerhead nesting aggregations have greater than 10,000 females nesting per year: Peninsular Florida in the United States and Masirah Island, Oman (Baldwin et al., 2003; Ehrhart et al., 2003; Kamezaki et al., 2003, Limpus and Limpus, 2003; Margaritoulis et al., 2003). Current data reports declines of 26 percent over a recent 20 year period (1989-2008) with a 41 percent decline since 1998 alone (NMFS and USFWS, 2009). The status of the Oman nesting beaches has not been evaluated recently; however, these beaches are located in regions vulnerable to extremely disruptive events (e.g. political upheavals, wars, and catastrophic oil spills), thus resulting in increased risk to loggerhead nesting success in these areas (Meylan et al., 1995). At present, there are no reliable estimates of population size of loggerheads in the pelagic and oceanic environments as studies tend to focus on known nesting populations or are too localized to reveal any reliable large scale estimates (Bjorndal and Bolten, 2000). 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.

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

In addition to domestic fisheries, sea turtles are subject to direct as well as incidental capture in numerous foreign fisheries, further exacerbating the ability of sea turtles to survive and recover on a more global scale. For example, pelagic, immature loggerhead sea turtles circumnavigating the Atlantic are exposed to international longline fisheries including the Azorean, Spanish, and various other fleets (Aguilar et al., 1995; Bolten et al., 1994; Crouse, 1999). Bottom set lines in the coastal waters of Madeira, Portugal, are reported to take an estimated 500 pelagic immature loggerheads each year (Dellinger and Encarnacao, 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. Shrimp trawl fisheries are also occurring off the shores of numerous foreign countries and pose a significant threat to sea turtles similar to the impacts seen in U.S. waters. 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 sea turtle survival and recovery throughout their respective ranges.

There are also many non-fishery impacts affecting the status of sea turtle species, both in the marine and terrestrial environment. In nearshore waters of the U.S., the construction and maintenance of Federal navigation channels has been identified as a source of sea turtle mortality. Hopper dredges, which are frequently used in ocean bar channels and sometimes in harbor channels and offshore borrow areas, move relatively rapidly and can entrain and kill sea turtles (NMFS, 1997a). Sea turtles entering coastal or inshore areas have been affected by entrainment in the cooling-water systems of electrical generating plants. Other nearshore threats include harassment and/or injury resulting from private

and commercial vessel operations, military detonations and training exercises, and scientific research activities.

Coastal development can deter or interfere with nesting, affect nesting success, and degrade nesting habitats for sea turtles. Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Lutcavage et al., 1997; Bouchard et al., 1998). These factors may directly, through loss of beach habitat, or indirectly, through changing thermal profiles and increasing erosion, serve to decrease the amount of nesting area available to females and may evoke a change in the natural behaviors of both adults and hatchlings (Ackerman, 1997; Witherington et al., 2003; Witherington et al., 2007). In addition, coastal development is usually accompanied by artificial lighting which has been known to alter the behavior of nesting adults (Witherington, 1992) and is often fatal to emerging hatchlings that are drawn away from the water (Witherington and Bjorndal, 1991). Predation by various land predators is a threat to developing nests and emerging hatchlings. Additionally, direct harvest of eggs and adults from beaches in foreign countries continues to be a problem for various sea turtle species throughout their ranges (NMFS and USFWS, 2009).

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 characteristically, mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals and porpoises (Law et al., 1991). Recent efforts have led to improvements in regional water quality in the action area, although the more persistent chemicals are still detected and are expected to endure for years (Mearns, 2001; Grant and Ross, 2002). Acute exposure to hydrocarbons from petroleum products released into the environment via oil spills and other discharges may directly injure individuals through skin contact with oils (Geraci, 1990), inhalation at the water's surface and ingesting compounds while feeding (Matkin and Saulitis, 1997). Hydrocarbons also have the potential to impact prey populations, and therefore may affect listed species indirectly by reducing food availability in the action area (for more information on the effects of present and past oil spills affecting populations in the Gulf of Mexico, refer to the *Environmental Baseline* section of this Opinion).

Climate change and variability are identified as major causes of changing marine productivity and may therefore influence sea turtle prey abundance in foraging areas throughout the globe (Mantua et al., 1997; Francis et al., 1998; Beamish et al., 1999; Hare et al., 1999; Benson and Trites, 2002). For example, decade-scale climatic regime

shifts have been related to changes in zooplankton in the North Atlantic (Fromentin and Planque, 1996) and decadal trends in the North Atlantic Oscillation (NAO) (Hurrell, 1995) can affect the position of the Gulf Stream (Taylor et al., 1998) and other circulation patterns in the North Atlantic that act as important migratory pathways for various life stages of sea turtles. 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.

Atmospheric warming creates habitat alteration which 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. All reptiles including sea turtles have a tremendous dependence on their thermal environment for regulating physiological processes and for driving behavioral adaptations (Spotila et al. 1997). In the case of sea turtles, where many other habitat modifications are documented (beach development, loss of foraging habitat, etc.), the prospects for accentuated synergistic impacts on survival of the species may be even more important in the long-term.

Information Specific to the Proposed Northwest Atlantic Ocean DPS

For the proposed 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). Declining trends in the annual number of nests were documented for all recovery units for which there were adequate data. As stated earlier, nesting for the Peninsular Florida Recovery Unit, which represents approximately 87 percent of all nesting effort in the DPS (Ehrhart et al., 2003), declined 26 percent over the 20-year period from 1989–2008 and 41 percent over the recent 10-year period 1998–2008 (NMFS and FWS, 2008; Witherington et al., 2009). The second largest recovery unit (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 5 percent over the period 1995–2006 (TEWG, 2009).

The main threats specific to the proposed Northwest Atlantic Ocean DPS include fishery bycatch mortality, particularly in gillnet, longline, and trawl fisheries; nesting beach habitat loss and degradation (e.g., beachfront lighting, coastal armoring); and ingestion of marine debris during the epipelagic lifestage (75 FR 12598). Gillnets, longlines, and trawl gear collectively result in tens of thousands of Northwest Atlantic loggerhead deaths annually throughout their range (Lewison et al., 2004; NMFS, 2002; NMFS, 2004). All size classes of loggerheads in coastal waters are prone to entanglement in gillnets, and, generally, the larger the mesh size the more likely that turtles will become

entangled. In addition, mortality from vessel strikes is increasing and likely also a significant threat to this DPS.

Although numerous efforts are underway to reduce loggerhead bycatch in fisheries, and many positive actions have been implemented, it is unlikely that this source of mortality can be sufficiently reduced across the range of the DPS to positively benefit recovery potential in the near future because of the diversity and magnitude of the fisheries operating in the North Atlantic, the lack of comprehensive information on fishing distribution and effort, limitations on implementing demonstrated effective conservation measures, geopolitical complexities, limitations on enforcement capacity, and lack of availability of comprehensive bycatch reduction technologies (75 FR 12598).

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° 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 U.S. Virgin Islands (U.S.V.I.) and Puerto Rico (NMFS and USFWS, 1991). Principal U.S. nesting areas for green sea turtles are in eastern Florida, predominantly Brevard through Broward counties. Regular nesting is also known to occur on St Croix, U.S.V.I., and on Vieques, Culebra, Mona, and the main island of Puerto Rico (Dow et al., 2007). 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 Review (NMFS and USFWS, 2007a).

Green sea turtles use mid-Atlantic and northern areas of the western Atlantic coast as important summer developmental habitat. They are found in estuarine and coastal waters as far north as Long Island Sound, Chesapeake Bay, and North Carolina sounds (Musick and Limpus, 1997). Like loggerheads, green turtles that use northern waters during the summer must return to warmer waters when water temperatures drop, or face the risk of cold stunning. Cold stunning of green sea turtles may occur in southern areas as well (i.e., Indian River, Florida), as these natural mortality events are dependent on water temperatures and not solely on geographical location.

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).

The genetic substructure of the green sea turtle regional subpopulations shows distinctive mitochondrial DNA properties for each nesting rookery (Bowen et al., 1992) although turtles from separate nesting origins are commonly found mixed together on foraging grounds.

Life History Information

Scientists estimate green turtles reach sexual maturity anywhere between 20 and 50 years, at which time females begin returning to their natal beaches (i.e., the same beaches where they were born) every 2-4 years to lay eggs (Balazs, 1982; Frazer and Ehrhart, 1985), while males may mate every year (Balazs, 1983). Adult females migrate from foraging areas to mainland or island nesting beaches and may travel hundreds or thousands of kilometers each way.

Green sea turtle mating occurs in the waters off the nesting beaches. The nesting season varies depending on location. 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). Mean clutch size is highly variable among populations, but averages 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.

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 pelagic plants and animals associated with drift lines of algae and other debris. Once the juveniles reach a certain age/size range, they leave the pelagic habitat and travel to nearshore foraging grounds. As adults, they feed almost exclusively on sea grasses and algae in shallow bays, lagoons, and reefs (Rebel, 1974).

Listing Status

The green sea turtle was listed as threatened under the ESA in 1978 except for the Florida and Pacific coast of Mexico breeding populations which were listed as endangered. Critical habitat for the green sea turtle has been designated for the waters surrounding Isla Culebra, Puerto Rico, and its associated keys.

Abundance, Trends, and 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. Seminoff (2004) estimated that analyses of subpopulation changes at 32 Index Sites distributed globally showed a 48 to 67 percent decline in the number of mature females nesting annually over the previous three generations. Of the 23 threatened nesting concentrations analyzed by NMFS and USFWS (2007a) for which estimates of current trends was possible, 10 nesting populations appeared to be increasing, 9 appeared to be stable, and 4 appeared to be decreasing. The review did mention that despite some increasing trends in global numbers, these estimates should be viewed cautiously since trend data was only available for about half of the total sites examined. According to the review, the poorest regions in terms of nesting included sites in Southeast Asia, the eastern Indian Ocean, and central Atlantic Ocean (NMFS and USFWS, 2007a).

In the western Atlantic, several major nesting assemblages have been identified and studied over time to monitor trends (Bass et al., 2006; Bowen et al., 1992). The largest known nesting assemblage in the western Atlantic, at Tortuguero, Costa Rica, has shown a long-term increasing trend since monitoring began in 1971, with an annual average of 17,402–37,290 nesting females seen each year (Troëng and Rankin, 2005). The estimated number of emergences was reported to be under 20,000 in 1971 and over 40,000 in 1996 with a high estimate of over 100,000 emergences reported in 1995 (Bjorndal et al., 1999). In the continental United States, 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. Occasional nesting has also been documented along the Gulf coast of Florida as well as the beaches on the Florida Panhandle (Meylan et al., 1994; Weishampel et al., 2003). While there appears to be an increasing trend in green sea turtle nesting in the southeast U.S., these numbers only reflect one segment of the population (nesting females) and should be taken with caution.

There are no reliable estimates of the total number of green sea turtles inhabiting foraging areas within the southeast United States; however, localized information is available for a few sites. Green turtles were once abundant enough in the shallow bays and lagoons of the Gulf to support a commercial fishery, which landed over one million pounds of green sea turtles in 1890 (Doughty, 1984). However, Doughty reported that by the year 1902, a significant decline in the fishery was observed. A long-term in-water monitoring study in the Indian River Lagoon of Florida has tracked the populations of juvenile green turtles in a foraging environment and noted significant increases in catch-per-unit effort (more than doubling) between the years 1983-1985 and 1988-1990. An extreme, short-term increase in catch per unit effort of around 300 percent was reported for the years 1995-1996 (Ehrhart et al., 1996). Catches of benthic immature turtles at the St. Lucie Nuclear Power Plant intake canal, which acts as a passive turtle collector on Florida's east coast, have also been increasing since 1992 (Martin and Ernst, 2000). It is likely that green sea turtles foraging in the region come from multiple genetic stocks.

Currently, anthropogenic impacts to the green sea turtle are similar to those facing other sea turtle species including interactions with domestic and international fisheries,

destruction of nesting and foraging habitat, ship strikes, oil spills, and climate change and/or variability (refer to the loggerhead sea turtle status and trends section above for more information on these threats).

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 (Frazier, 1980; McKenzie et al., 1999; Storelli and Marcotrigiano, 2003). Various types of marine debris 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 ingestion (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.

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 "tortoiseshell" 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 mm long and are mostly brown and somewhat heart-shaped (Hillis and Mackay, 1989; van Dam and Sarti, 1989; Eckert, 1995).

Hawksbill turtles are circumtropical, usually occurring between latitudes 30° N and 30° S in the Atlantic, Pacific, and Indian Oceans. Hawksbills are widely distributed throughout the Caribbean Sea and western Atlantic Ocean, regularly occurring in southern Florida and the Gulf of Mexico (especially Texas), in the Greater and Lesser Antilles, and along the Central American mainland south to Brazil (Groombridge and Luxmoore, 1989; NMFS and USFWS, 1998). Within the U.S., hawksbills are most common in Puerto Rico and U.S. Virgin Islands but are also seen in the Gulf of Mexico and along the U.S. east coast of Florida where the warm Gulf Stream current passes close to shore (Lund, 1985; Meylan and Donnelly, 1999). Besides Florida, Texas is the only other state where hawksbills are sighted with any regularity in the continental U.S. (Plotkin and Amos, 1988; Plotkin and Amos, 1990; Amos, 1989).

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 (NMFS and USFWS, 2007b). The most significant nesting within the U.S. occurs in Puerto Rico and the U.S. Virgin Islands, specifically on Mona Island and Buck Island, respectively. Although nesting within the continental U.S. is typically rare, it can 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.

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). Adult hawksbill turtles are capable of migrating long distances between nesting beaches and foraging areas, which are comparable to migrations of green and loggerhead turtles. In the Atlantic, a female hawksbill sea turtle tagged at Buck Island Reef National Monument in the U.S. Virgin Islands traveled 1,160 miles (1,866 km) to the Miskito Cays in Nicaragua (Spotila, 2004).

Life History Information

Although the age at which hawksbills reach sexual maturity is unknown, the best available estimates suggest maturity takes at least 20 years with some estimates suggesting as long as 38 years (Limpus and Miller, 2000). Males are typically mature at around 69 cm in length while females are typically mature at around 75 cm in length (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 (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; Leon 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 in 1970 and is also considered Critically Endangered by the IUCN (Mortimer and Donnelly, 2008). Critical habitat was designated in 1998 for hawksbill turtles in coastal waters surrounding Mona and Monito Islands, Puerto Rico.

Abundance, Trends, and Current Threats

Hawksbills are solitary nesters and, thus, determining population trends or estimates on nesting beaches is difficult. Only five regional nesting populations remain (Seychelles, Mexico, Indonesia, and two in Australia) (Meylan and Donnelly, 1999) and most populations are declining, depleted, and/or remnants of larger aggregations (NMFS and USFWS, 2007b). 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 100-150 nests on Buck Island Reef National Monument off St. Croix in the U.S. Virgin Islands (Meylan, 1999b). There are currently no reliable estimates of population abundance and trends for non-nesting hawksbills at the time of this consultation.

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 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). While the international trade in the shell of this species is prohibited between those countries that have signed the CITES convention, illegal trade is still occurring and remains a threat.

Although hawksbills 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 etc.), they are particularly sensitive to losses of coral reef communities. As stated earlier, coral reefs represent important resting and foraging habitat for hawksbill sea turtles who typically feed on sponge communities that are in association with the coral. 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 will limit the ability of hawksbill sea turtles to forage and represents a major threat to recovery.

Throughout the Atlantic and Gulf of Mexico, hawksbill sea turtles also face harassment in many forms including recreational use of beaches, beach erosion and replenishment, and effects of directed research activities. In addition, beach front lights appear to pose a serious problem for hatchling hawksbill turtles in U.S. coastal areas (USFWS, 1999). Just as with other sea turtles, nesting and foraging hawksbill sea turtles are subjected to the effects from past and present oil spills occurring in the Gulf of Mexico and other regions (see loggerhead sea turtle status section for more information). At the time of this consultation, no confirmed deaths of hawksbill sea turtles have been recorded in the vicinity of the *Deep Horizon* spill site, although this does not mean that no mortality has occurred (NMFS, 2011).

In addition to anthropogenic threats, hawksbill turtles are also threatened by natural causes including hurricanes (NMFS and USFWS, 2007b) and predation by exotic species (e.g. fire ants, raccoons and opossums) that occur on nesting beaches (USFWS, 1999).

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 carapace length of around 65 centimeters. 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 and weigh between 15-20 grams.

This species has a very restricted range relative to other sea turtle species with most adults occurring in the Gulf of Mexico in shallow near shore waters, although adult-sized individuals sometimes are found on the eastern seaboard of the United States as well. Nesting is essentially limited to the beaches of the western Gulf of Mexico, primarily in the Mexican state of Tamaulipas, although in recent years nests have also been recorded in Florida and the Carolinas (Meylan et al., 1995). Kemp's ridleys nest in daytime aggregations known as arribadas, primarily at Rancho Nuevo, a stretch of beach in

Mexico. Most of the population of adult females nests in this single locality (Pritchard, 1969).

Life History Information

Kemp's ridley sea turtles reach sexual maturity at 7-15 years of age. While some turtles nest annually, the weighted mean remigration rate is approximately two years. Nesting generally occurs from April to July and females lay approximately 2.5 nests per season with each nest containing approximately 100 eggs (Marquez, 1994)

Studies have shown that the time spent in the post-hatchling pelagic stage can vary from 1-4 years time, while the benthic immature stage typically lasts approximately 7-9 years (Schmid and Witzell, 1997). Little is known of the movements of the post-hatching, planktonic stage within the Gulf of Mexico although the turtles during this stage are assumed to associate with floating seaweed (e.g. *Sargassum spp.*) where they would presumably feed on the available sargassum and associated infauna or other epipelagic species found in the Gulf of Mexico.

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 cold (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 sounds 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).

Adult Kemp's ridleys primarily occupy neritic habitats, typically containing muddy or sandy bottoms where 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. This species is also protected by CITES and is listed as "critically endangered" under the IUCN Red List of Threatened Species (IUCN, 1996). No critical habitat has been designated for the species.

Abundance, Trends, and Current Threats

Of the seven extant species of sea turtles of the world, the Kemp's ridley has declined to the lowest global population level. 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). By the early 1970s, the world population estimate of

mature female Kemp's ridleys had reduced to 2,500-5,000 individuals and this trend continued through the mid-1980s. The severe decline in the Kemp's ridley population in the past appears to have been heavily influenced by a combination of exploitation of eggs and impacts from fishery interactions (e.g. the U.S. shrimp trawl fishery). From the 1940's through the early 1960's, nests from Rancho Nuevo, Mexico were heavily exploited but beach protection in 1966 helped to curtail this activity (NMFS and USFWS, 1992). Between the years of 1978 and 1991 only 200 Kemp's ridleys nested annually.

The TEWG (2000) developed a population model to evaluate trends in the Kemp's ridley population through the application of empirical data and life history parameter estimates chosen by the investigators. Model results identified three trends over time in benthic immature Kemp's ridley sea turtles. Increased production of hatchlings from the nesting beach beginning in 1966 resulted in an increase in the population of benthic Kemp's ridleys (defined as 20-60 cm in length and approximately 2-9 years of age) that leveled off in the late 1970s. A second period of increase followed by leveling occurred between 1978 and 1989 as hatchling production was further enhanced by the cooperative program between the U.S. Fish and Wildlife Service and Mexico's Instituto Nacional de Pesca to increase nest protection and relocation. A third period of steady increase has occurred since 1990 likely due to increased hatchling production and survival of immature turtles. The introduction of turtle excluder devices (TEDs) in the United States and Mexican shrimping fleets has likely influenced this trend. The 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; however, the TEWG did emphasize caution in these estimates.

Other recent nesting data has also suggested the population may be showing signs of recovery as the number of nests grew from a low of 702 nests in 1985, to 1,940 nests in 1995, to over 20,000 nests in 2009 (NMFS and USFWS, 2010). However, preliminary nesting data for 2010 indicate a dramatic drop in the number of nests (Conant, pers. comm. 2010) and recent impacts to foraging and nesting habitat as a result of the *Deep Horizon* oil spill in the Gulf of Mexico may further impact nesting success and slow down recovery of the species. According to the preliminary data available from NMFS at the time of this consultation, there are 481 confirmed deaths of Kemp's ridley sea turtles in the vicinity of the *Deep Horizon* oil spill site and this number is considered a conservative one (NMFS, 2011). 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. It is expected that the acute and chronic events of the *Deep Horizon* oil spill as well as other historical spills will continue to threaten the survival and recovery of the Kemp's ridley sea turtle for years to come (see the *Environmental Baseline* section of this Opinion for more information on oil spill effects to sea turtles).

In addition to effects from oil spills, other anthropogenic impacts to the Kemp's ridley population are similar to those facing other sea turtle species including interactions with fishing gear, marine pollution, foraging habitat destruction, threats at nesting beaches,

and effects of climate change and/or variability (see *abundance, trends, and current threats* section for the loggerhead sea turtle above). 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).

Leatherback Sea Turtle

Species Description, Distribution, and Population Structure

The leatherback is the largest sea turtle and the largest living reptile in the world. Mature males and females can reach lengths of over 2 m and weigh close to 900 kg (or 2000 lbs). The leatherback is the only sea turtle that lacks a hard, bony shell. A leatherback's carapace is approximately 4 cm 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 (NMFS and USFWS, 1995). They forage in temperate and subpolar regions between latitudes 71° N and 47° 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 (NMFS-SEFSC, 2001). Female leatherbacks nest from the southeastern United States 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-SEFSC, 2001).

Previous genetic analyses of leatherbacks using only mitochondrial DNA (mtDNA) 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., 1998). Further genetic analyses using microsatellite markers along with the mtDNA 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). General differences in migration patterns and foraging grounds may occur between the seven nesting assemblages, although data to support this is limited in most cases.

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 hatchlings are approximately 50-77 cm in length, with fore flippers as long as their bodies, and weigh approximately 40-50 g.

Although leatherbacks forage in coastal waters, they appear to remain primarily pelagic through all life stages (Heppell et al., 2003). Eckert (1999) found that leatherback juveniles remain in waters warmer than 26°C until they exceed 100 cm in length. The location and abundance of prey, including medusae, siphonophores, and salpae, in temperate and boreal latitudes likely has a strong influence on leatherback distribution in these areas (Plotkin, 1995). Leatherbacks are known to be deep divers, with recorded depths in excess of a half mile (Eckert et al., 1989), but may also come into shallow waters to locate prey items.

Listing Status

The leatherback sea turtle was listed as endangered under the ESA throughout its range on June 2, 1970. Critical habitat was designated in 1998 in coastal waters adjacent to Sandy Point, St. Croix, U.S. Virgin Islands. In January 2010, NMFS proposed to revise the critical habitat to include additional areas off of the U.S. west coast; although these areas have not been formally designated at the time of this consultation.

Abundance, Trends, and Current Threats

Estimates of total population size for Atlantic leatherbacks are difficult to ascertain due to the inconsistent nature of the available nesting data. In 1980, the leatherback population was estimated at approximately 115,000 adult females globally (Pritchard, 1982). 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). The TEWG (2007) also 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. In contrast, the TEWG reports that the colonies in the South China Sea and East Pacific have undergone catastrophic collapse. However, it should also be noted that these trends are for nesting females only and should be taken with caution as this represents only one segment of the total leatherback population.

The Florida stock nests primarily along the east coast of Florida. This 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.

Currently, anthropogenic impacts to the leatherback population are similar to those facing other sea turtle species including interactions with fishery gear, marine pollution, destruction of foraging habitat, and threats to nesting beaches (see loggerhead status and trends section for more information on these threats). Of all the extant sea turtle species, however, leatherbacks seem to be the most vulnerable to entanglement in fishing gear, especially gillnets, pot/trap lines, and trawl gear used in various fisheries around the world. This susceptibility may be the result of their body type (large size, long pectoral flippers, and lack of a hard shell), their attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, their method of locomotion, and/or perhaps their attraction to the lightsticks used to attract target species in longline fisheries. From 1990-2000, 92 entangled leatherbacks were reported from New York through Maine and many other stranded individuals exhibited evidence of prior entanglement (Dwyer et al., 2002). For many years, the use of turtle excluder devices (TEDs) required for use in many U.S. fisheries were less effective at excluding the larger leatherback sea turtles compared to the smaller, hard-shelled turtle species. However, recent modifications to the design of TEDs are now required and should help reduce the amount of leatherback deaths that result from net capture. Zug and Parham (1996) point out that a combination of the loss of long-lived adults in fishery-related mortalities and a lack of recruitment from intense egg harvesting in some areas has caused a sharp decline in leatherback sea turtle populations and represents a significant threat to survival and recovery of the species worldwide.

Leatherback sea turtles may be also be more susceptible to marine debris ingestion than other sea turtle species 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 as plastic bags (Mrosovsky et al., 2009). Balazs (1985) speculated that the object might resemble a food item by its shape, color, size or even movement as it drifts about, and induce a feeding response in leatherbacks. Just as with other sea turtles, nesting and foraging leatherback sea turtles are subjected to the effects from past and present oil spills occurring in the Gulf of Mexico and other regions (see loggerhead sea turtle status section for more information). At the time of this consultation, no confirmed deaths of leatherbacks have been recorded in the vicinity of the *Deep Horizon* spill site, although this does not mean that no mortality has occurred (NMFS, 2011). In addition to direct

contact, injection of oil-contaminated prey items represents a particular threat to leatherbacks emanating from the *Deep Horizon* spill in the Gulf of Mexico and this may continue to be a threat to recovery in the years ahead.

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.

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 sea turtles within the action area.

Natural Sources of Stress and Mortality

Disease, Parasites, and Biotoxins

A disease known as fibropapilloma is a major threat to listed turtles in many areas of the world including the action area. The disease is characterized by tumorous growths, which can range in size from very small to extremely large, and are found both internally and externally. Large tumors can interfere with feeding and essential behaviors, and tumors on the eyes can cause permanent blindness (Foley et al., 2005). It was first described in green turtles in the Florida Keys in the 1930's. Since then it has been recorded in many green turtle populations around the world as well as other sea turtle species, such as loggerheads (Huerta et al., 2002). In Florida, many immature green turtles captured in the IRL 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 brevetoxicosis (e.g., uncoordinated and lethargic but otherwise

robust and healthy in appearance) and completely recovered within days of being removed from the area of the red tide.

While disease organisms commonly occur among wild fish populations, they are not expected to pose significant threats to smalltooth sawfish or Atlantic sturgeon populations. However, there is concern that non-indigenous sturgeon pathogens could be introduced, most likely through aquaculture or aquarium operations (ASSRT, 2007). To address these threats, the ASMFC is recommending many aquaculture operations to be certified as disease-free, although the extent that introduced pathogens present to wild populations is currently unknown.

Competition and Predation

As benthic feeders, smalltooth sawfish and Atlantic sturgeon may compete with other bottom-feeding fishes and invertebrates for prey resources. While concerns have been raised regarding the potential for increased predation on juvenile Atlantic sturgeon by introduced flathead catfish (Brown et al., 2005), Atlantic sturgeon subpopulations seem to be coexisting with flatheads in the rivers north of Florida (where flatheads have been present for many years) (ASSRT, 2007). Gadomski and Parsley (2005), however, have shown that catfish and other species do prey on juvenile sturgeon; thus, further research is warranted to determine at what level, if any, flatheads and other exotic species prey upon juvenile Atlantic sturgeon and to what extent such predation is affecting the sturgeon occurring in Florida rivers. Crocodiles (Thorburn et al., 2004), large sharks (Compagno, 1984; Thorburn et al., 2004), and marine mammals such as dolphins (Bigelow and Schroeder, 1953) are known predators of juvenile sawfishes. Current data from acoustic monitoring, public encounter database data, and satellite archival tagging data suggests that small juveniles use red mangrove prop root habitat to avoid predators, and therefore indicate that predation, via habitat loss, is likely a threat to recovery throughout the action area.

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 (*Dasybus novemcinctus*), and red fire ants (*Solenopsis invicta*) (Stancyk, 1982; Dodd, 1988). In the absence of well managed nest protection programs, predators may take significant numbers of eggs.

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 (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 and Atlantic sturgeon or indirectly affect habitat through increased erosion. Sea turtle nests may also be unearthed during storm events and cause mortality of sea turtle hatchlings. Sand accretion, rainfall, and wave action that result from these storms can also reduce hatchling success. Additionally, with more intense storms expected in the coming years based on climate modeling, it is expected that sea turtle nesting habitat will be further impacted (Goldenburg et al., 2001; Webster et al., 2005; 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 and Atlantic sturgeon. However, gaps in information and the complexity of climatic interactions complicate the ability to predict the effects that climate variability may have to these species from year to year.

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

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).

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-SEFSC, 2001; Stein et al, 2004b; 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 at least 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 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 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 (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-SEFSC, 2010). 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. For instance, 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, 2010b). Consultation on the fishery is ongoing and was not yet completed at the time of this consultation.

Smalltooth sawfish occasionally are caught as bycatch in the following federally managed fisheries operating in and around the action area: Highly Migratory Species (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 appears to be with the HMS Atlantic Shark fishery with 51 captures (1 mortality) expected over a three year period followed by the Gulf of Mexico Reef Fish fishery (8 non-lethal captures) and the South Atlantic Snapper-Grouper fishery (8 non-lethal captures) over the same three year period.

According to Stein et al. (2004b), the five greatest bycatch rates of Atlantic sturgeon were in the weakfish-stripped bass fishery (0.1667 pounds per trip), followed by northern kingfish (0.0242 pounds per trip), American shad (0.0239 pounds per trip), southern flounder (0.0200 pounds per trip), and red hake (0.0172 pounds per trip). Bycatch mortality rates range between 0-51 percent, with greatest mortality occurring in sink gill nets where an estimated 13.8 percent of sturgeon died as a result of capture (Stein et al., 2004b; ASMFC, 2007).

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. NMFS is also actively participating in a cooperative effort with the ASFMC to standardize and/or implement programs to collect information on level of effort and bycatch in state fisheries in Atlantic waters. When this information becomes available, it can be used to refine take reduction plan measures in state waters.

Habitat 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 smalltooth 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 and Atlantic sturgeon (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).

Historically, Atlantic sturgeon likely accessed all parts of the St. Johns River; however, the construction of Kirkpatrick Dam (originally Rodman Dam) has restricted migration and blocked access to potential spawning habitat upstream. Water quality in this system also seems to be degraded, and low dissolved oxygen is a common occurrence during the summer months when water temperatures rise. Dredging commonly occurs throughout the action area to maintain navigation channels and these activities have been linked to the reduction in submerged aquatic vegetation where Atlantic sturgeon likely forage (Jordan, 2002). It seems that the extirpation of the Atlantic sturgeon subpopulation in the St. Mary's River system was likely caused by reduced dissolved oxygen levels during the summer in the nursery habitat, probably due to eutrophication from non-point source pollution (ASSRT, 2007).

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. The construction and maintenance of federal navigation channels has been identified as a source of sea turtle mortality as hopper dredges move relatively rapidly and can entrain and kill sea turtles located in the dredge 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. Although nourishment provides more sand to nesting beaches, the quality of that sand may be less suitable than pre-existing natural beaches. Sub-optimal nesting habitat may cause decreased nesting success, place an increased energy burden on nesting females, result in abnormal nest construction, and reduce the survivorship of eggs and hatchlings (Mann, 1977; Ackerman, 1980; Mortimer, 1990). Beach armoring in the action area (e.g., bulkheads, seawalls, soil retaining walls, rock revetments, sandbags, and geotextile tubes) can impede a turtle's access to upper regions of the beach/dune system, thereby limiting the amount of available nesting habitat (Mazaris et al., 2009). Impacts also occur when structures have been installed during the nesting season. For example, unmarked nests can be crushed or uncovered by heavy equipment, nesting turtles and hatchlings can get caught in construction debris or excavations, and hatchlings can get trapped in holes or crevices of exposed riprap and geotextile tubes.

Artificial lighting on or near the beach adversely affects both nesting and hatchling sea turtles located in the action area. Specifically, artificial lighting may deter adult female turtles from emerging from the ocean to nest and can disorient or misorient emerging hatchlings away from the ocean (Ehrhart, 1983, Salmon and Witherington, 1995).

Hatchlings have a tendency to orient toward the brightest direction, which on natural, undeveloped beaches is commonly toward the broad open horizon of the sea. However, on developed beaches, the brightest direction is often away from the ocean and toward lighted structures. Hatchlings unable to find the ocean, or delayed in reaching it, are likely to incur high mortality from dehydration, exhaustion, or predation (Peters and Verhoeven, 1994; Salmon 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 breathe 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). 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 (Loehfener et al., 1989). Thirty-four percent of post-hatchlings captured in Sargassum 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.

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 possibility of entrapping young hatchlings (Witherington, 1999).

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-October, 2010 although the cause of death is not immediately certain for all carcasses recovered (NMFS, 2011). 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, 2011). 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.

Ocean Noise

Increases in underwater sound generated from various man-made sources such as commercial shipping and recreational vessels, seismic exploration, offshore construction (e.g. for offshore wind farms), and sonars of various types 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-SEFSC, 2001).

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.

U.S. Military Activities

Sea turtles and marine fish in the action area are affected by military activities including vessel operations and various training operations. NMFS has and will continue to establish conservation measures for all federal agency vessel operations to avoid or minimize interaction with listed sea turtles in the Gulf of Mexico. At the present time, however, they present the potential for some level of interaction including short term behavioral harassment and the possibility of vessel strikes. Past and ongoing U.S. Navy aerial bombing training in the ocean off the southeast U.S. coast, involving drops of live ordnance (e.g. 500 and 1,000 lb bombs) has the potential to annually injure or kill listed species in the action area (NMFS, 1997b).

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.

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 and Atlantic sturgeon in the action area in the near future (NMFS, 2009a).

Scientific Research

Listed species in the action area (particularly sea turtles) have been the subject of numerous scientific research activities (mostly non-lethal), as authorized by NMFS permits. Research activities for sea turtles include photographing, weighing, tagging, blood sampling, biopsy sampling, and performing laparoscopy on intentionally captured individuals or incidentally caught individuals. Research activities for smalltooth sawfish include net and longline capture, photographing, measuring, tagging, tracking, and blood

and tissue sampling. At the time of this consultation, there are currently 29 active or proposed research permits directed towards sea turtles and four active or proposed permits directed at smalltooth sawfish in the Gulf of Mexico and along the east coast of Florida. We are not aware of any directed research activities targeted at Atlantic sturgeon in the action area as most studies are conducted in areas north of Florida.

The number of authorized takes varies widely depending on the research and species involved. Before any research permit is issued, the proposal must be reviewed under the permit regulations (i.e., must show a benefit to the species). In addition, since issuance of the permit is a federal activity, issuance of the permit by the NMFS must also be reviewed for compliance with section 7(a)(2) of the ESA to ensure that issuance of the permit does not result in jeopardy to the species. Authorized “takes” by harassment represent substantial research effort relative to species abundance in the action area with repeated disturbances of individuals likely to occur each year. However, all permits for sea turtles 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.

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

Conservation and Management Efforts

Several conservation and management efforts have been undertaken for listed sea turtles and marine fish to aid in recovery efforts. 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

(CERP) is a major reconstruction project jointly led by the Army Corps of Engineers (USACE) and the South Florida Water Management District (SFWMD), which has the potential to restore habitats and hydrological regimes in South Florida important for smalltooth sawfish as well as Atlantic sturgeon.

Effective May 27, 1999, NMFS prohibited the take of Atlantic sturgeon in the U.S. EEZ. This rule followed the closure of the state waters under the ASMFC moratorium on the Atlantic sturgeon fishery. Other efforts in place are geared at educating the public about the needs of species as well as to foster partnerships among agencies and organizations with an interest in the conservation of sturgeon species.

NMFS has implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles from commercial fisheries in the action area. These include sea turtle release gear requirements for the Atlantic Highly Migratory Species Fishery, Gulf of Mexico reef fish, and South Atlantic snapper-grouper fishery, and TED requirements for Southeast shrimp trawl fishery. NMFS published a final rule on July 6, 2004, to implement management measures to reduce bycatch and bycatch mortality of Atlantic sea turtles in the Atlantic pelagic longline fishery (69 FR 40734). The management measures include mandatory circle hook and bait requirements, and mandatory possession and use of sea turtle release equipment to reduce bycatch mortality. In the Hawaii-based longline swordfish fishery which required vessels to switch from using a J-shaped hook with squid bait to a wider circle-shaped hook with fish bait has reduced capture rates of leatherback and loggerhead turtles significantly by 83 and 90 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 (66 FR 67495, December 31, 2001) detailing handling and resuscitation techniques for sea turtles that are incidentally caught during scientific research or fishing activities. Those participating in fishing activities or scientific research are required to handle and resuscitate (as necessary) sea turtles as prescribed in the final rule. These measures help to prevent mortality of hard-shelled turtles caught in fishing or scientific research gear. There is also an extensive network of Sea Turtle Stranding and Salvage Network participants along the Atlantic and Gulf of Mexico coasts

who not only collect data on sea turtle mortality, but also rescue and rehabilitate any live stranded sea turtles that are encountered.

EFFECTS OF THE PROPOSED 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 and commercial evidence 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 to have effects on listed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

For this consultation, we are particularly concerned about 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 harassment of listed smalltooth sawfish. For this Opinion, we define harassment as 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.

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 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 from permits authorizing similar types of research within or near the action area.

While annual reports detailing prior "takes" are useful in estimating exposure levels, it must be noted that the frequency, duration, area, and focus of research activities often vary on an annual basis due to factors such as weather, funding, opportunistic events, and evolving research goals and needs. Also, the threshold for reporting whether an actual

“take” occurred has evolved over the years, thus possibly introducing some level of human error or bias into numbers reported in prior annual reports (e.g. some researchers may have reported a “take” only if the animal somehow reacted to an vessel approach or other research activity while other researchers may have assumed a “take” whether the animal exhibited a visible reaction or not). Thus, past annual reports introduce some level of uncertainty as to their accuracy for predicting future activities, levels of effort, and expected “takes” of listed and proposed species. Despite this uncertainty, annual reports remain one of the most valuable resources to the Endangered Species Division for estimating exposure levels of future permit actions and were thus utilized in this consultation. The Permits Division has made an effort to standardize reporting of “takes” resulting from research activities which should lead to more accurate and informative annual reports in future years and hopefully reduce the level of error and uncertainty associated with the number of “takes” reported.

For permit modification No. 13330-01, the amount of smalltooth sawfish to be taken annually (i.e. 45 individuals) would remain unchanged from the original permit. The researcher is currently authorized to “take” smalltooth sawfish by longline, gillnet, seine net, drum (set) lines, or rod and reel throughout Florida’s coastal waters. To increase tag retention and provide less invasive means of tagging, the applicant requests replacing two tagging methods while excluding another. Plastic rototags used to secure acoustic transmitters would be replaced with neoprene clasp tags, nylon umbrella darts used to secure PAT tags would be replaced with dorsal fin harnesses, and SPOT tags would be excluded as a tagging method. Since the researcher will be expected to conduct similar levels of research effort that was assessed in the original biological opinion, annual exposure for this permit modification was assessed at the proposed levels (numbers taken from **Table 1**): 15 neonate/young-of-the-year (less than 150 centimeters stretched total length) individuals, 15 juveniles (150-350 centimeters stretched total length) annually, and 15 adults (greater than 350 centimeters stretched total length). Juveniles and adults would be exposed to all research activities annually while neonate/young-of-the-year individuals would be exposed to all research activities except for PAT tagging.

In addition to smalltooth sawfish, NMFS expects that members of the south Atlantic DPS of Atlantic sturgeon could be encountered and exposed to net or hook-and-line capture in the St. John’s and St. Mary’s rivers according to recent reports of sturgeon occurring in those river systems. While prior sampling of the St. Marys and St. Johns River 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]. Researchers expect to sample primarily in the region of the Florida coast from Naples to Key West and would only sample in the St. Mary’s or St. John’s rivers if reliable and sufficient reports of smalltooth sawfish encounters are received to warrant sampling in those areas. Therefore, there is insufficient data to estimate actual numbers of Atlantic sturgeon that are likely to be exposed given the lack of population data for those river systems as well as the variability in research effort expected to be conducted in those

river systems over the remaining life of the permit. Subsequent monitoring reports, however, could provide information on the amount of individuals encountered during research activities which would lead to more accurate exposure estimates in future consultations conducted by NMFS. If an Atlantic sturgeon, prior to its proposed ESA listing, is incidentally captured, researchers will expose the individuals to PIT tagging and genetic sampling prior to release.

NMFS also believes that loggerhead, Kemp's ridley, green, hawksbill, and/or leatherback sea turtles could be encountered in the action area and may be exposed to net, hook-and-line, and nearshore or offshore longline capture directed at smalltooth sawfish. The original permit included an Incidental Take Statement (ITS) that exempted "take" of these listed species based on the rate of sea turtle bycatch seen for other permitted smalltooth sawfish research as well as commercial fisheries operating in and around the action area that were known to frequently capture sea turtles in similar gear types, albeit at much higher levels of effort than proposed by the researchers. Based on this data, NMFS exempted two annual incidental "takes" in the form of mortality for loggerhead sea turtles and exempted one annual additional incidental "take" in the form of mortality for either a green, hawksbill, Kemp's Ridley, or leatherback sea turtle, meaning that up to 10 loggerhead mortalities and up to 5 additional mortalities of any combination of green, hawksbill, Kemp's ridley, or leatherback sea turtles would be exempted over the life of the permit (NMFS, 2008b).

For this consultation, NMFS reviewed available monitoring reports submitted by various smalltooth sawfish researchers as well as recent opinions that evaluated "take" of sea turtles resulting from commercial fisheries operating in the action area since the original 2008 biological opinion was issued to determine if exposure of listed sea turtles needed to be adjusted. 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 (see **Table 2** below). To estimate probable exposure of sea turtles to activities in this proposed permit modification, 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 three standard deviations to account for variability in research effort from year to year as well as population growth over the life of the permit. Based on this analysis, we would expect that similar research effort conducted by the researchers over the remaining permit duration (i.e. through 2013) would result in the exposure of three total sea turtles being exposed to net, hook-and-line, and/or longline capture each year over the life of the permit.

Table 2. Smalltooth Sawfish and Sea Turtle Captures Recorded in Monitoring Reports Submitted from 2003-2010

Permit Number	Sawfish captured (# deaths)	Sea turtles captured (# deaths)
#1352	112 (0)	0
# 1475	136 (0)	3 (0)
#1538	2 (0)	0
#13330*	65 (0)	0

*Researchers' current permit

NMFS also reviewed recent biological opinions⁸ 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 (4,891 incidental takes or 51 percent of the total incidental take across all these fisheries), followed by leatherbacks (3,866 incidental takes or 40 percent of the total), greens (316 incidental takes or 4 percent of the total), hawksbills (262 incidental takes or 3 percent of the total), and Kemp's ridleys (238 incidental takes or 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, of the three sea turtles likely to be exposed each year, two would be expected to be loggerhead sea turtles while one sea turtle encountered would be expected to be a different species (i.e. either a green, hawksbill, Kemp's ridley or leatherback sea turtle). While it is more likely that a leatherback would be encountered based on the estimated incidental take numbers reported for commercial fisheries, the amount of research effort expected to occur offshore where leatherbacks are more likely to occur would be highly variable from year to year depending on the needs of the research team. Therefore, given the high variability in sampling effort occurring offshore, we will assume equal probability of encountering a leatherback, green, hawksbill, or Kemp's ridley sea turtle each year over the duration of the proposed permit modification. While the number of sea turtles likely to be exposed did not deviate from the incidental take reported in the original ITS, the type of incidental take expected (i.e. lethal vs. non-lethal) was adjusted to reflect more recent data since the original biological opinion was issued. This will be further discussed in our response analysis below.

⁸ For information on the incidental take numbers reported in these respective biological opinions please refer to NMFS (2004), NMFS (2005b), NMFS (2006a), NMFS (2007), and NMFS (2008a) in the literature cited for this Opinion.

Also, for the purposes of this consultation, any loggerhead sea turtle encountered would be expected to be a member of the proposed Northwest Atlantic Ocean DPS and are treated as such in our effects analysis for the current listing. Therefore, the level of exposure presented in this Opinion would carry over and remain valid for the DPS if that entity is officially listed under the ESA.

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.

Stressors associated with the permit modification include harassment, injury, or mortality from ship strikes or general vessel transit; harassment, injury, or mortality associated with longline, gillnet, seine net, drum (set) lines, or rod and reel capture; harassment associated with handling and size measurements; harassment and/or injury associated with blood and tissue sampling; and harassment and/or injury associated with acoustic transmitter tag attachment (with new method of attaching with neoprene clasp), plastic headed dart tags, PAT tags (with new method of attaching with a harness), and PIT tags. SPOT tags will not be used and, therefore, no listed species will be exposed to the effects from this type of tag as part of this proposed permit modification.

Responses to Vessels

Vessel interactions have the potential to disturb listed smalltooth sawfish, sea turtle species, and Atlantic sturgeon proposed for listing by inducing behavioral and possibly physiological stress to animals observed in the vicinity of the survey vessel. The responses by animals to human disturbance are similar to their responses to potential predators (Beale and Monaghan, 2004; Frid, 2003; Frid and Dill, 2002; Gill et al., 2001; Harrington and Veitch, 1992; Lima, 1998; Romero, 2004). These responses include interruptions of essential behavior and physiological processes such as feeding, mating, resting, digestion etc. This can result in stress, injury and increased susceptibility to disease and predation (Frid and Dill, 2002; Romero, 2004; Walker et al., 2006).

The probability of a vessel collision during transit depends, in part, on the size and speed of the vessel. However, because the personnel involved would be trained observers and the research vessels would operate at relatively slow speeds, the probability of smalltooth sawfish, Atlantic sturgeon, or sea turtles being struck by research vessels is extremely unlikely and, therefore, discountable.

Responses to 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), Atlantic sturgeon (Stein et al., 2004b; ASSRT, 2007), and sea turtles (Hays et al., 2003; Watson et

al., 2005; Gillman et al., 2006) 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 since 2008, 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. Loss of rostral teeth could affect the feeding success of the sawfish or its ability to defend itself after release although they would eventually grow back.

To date, there have been no lethal takes of sawfish resulting from similar research practices conducted over the past eight years since the smalltooth sawfish was officially listed under the ESA (see **Table 2** above). Mitigation measures such as short sets and monitoring nets at all times while they are set reduces the chances of killing smalltooth sawfish individuals when they are caught in gear utilized by the researchers. 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.

Entanglement in gillnets could also result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations of Atlantic sturgeon incidentally captured based on studies done for similar species such as shortnose sturgeon (Moser and Ross, 1995; Collins et al., 2000; Moser et al., 2000; Kahn and Mohead, 2010). Moser and Ross (1995) reported gill net mortalities for shortnose sturgeon approached 25 percent when water temperatures exceeded 28°C 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 DO concentrations, and minimal holding or handling time, etc.), have reduced the effects of gillnetting on sturgeon significantly, with very few documented mortalities reported in recent years. Researchers are expected to adopt these conservative measures that, if done in accordance with NMFS's sturgeon protocols (Moser et al., 2000; Kahn and Mohead, 2010), would lower the risk of direct mortality to Atlantic sturgeon as a result of

gillnetting for smalltooth sawfish as part of the proposed research activities. Based on these conservation measures, we would expect that any incidentally caught Atlantic sturgeon would be expected to undergo short-term stress responses similar to smalltooth sawfish with no serious injury or mortality expected over the life of the permit.

Incidental 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. NMFS 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 of the total incidental takes exempted across all these fisheries, an estimated 25 percent were estimated to be “lethal” takes from either drowning or serious injury from hook wounds. A majority of the research effort expected is to occur in nearshore and estuarine waters where shorter set lines, hook-and-line, and nets are to be used. 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 periodically check their nets for bycatch, we expect that no mortalities of sea turtles would be expected from these types of research activities and sea turtles would be expected to undergo only short term stress or mild injury from incidental capture in these areas.

For the less frequent longline activities to occur offshore, NMFS expects that an occasional sea turtle mortality may occur due to the longer time that lines are set in the water (up to four hours) and the length of lines to be utilized (estimated to be a mile long in some cases). While the probability of mortality was difficult to estimate given the variability of research effort occurring offshore, NMFS expects that of the nine total sea turtles likely to be incidentally caught across all research activities (i.e. six loggerheads and three others consisting of either a green, hawksbill, Kemp’s ridley, or leatherback in any combination), we anticipate no more than two incidental mortalities of any species are likely to occur over the remaining life of the permit based on the likely rate of lethal “take” associated with commercial fisheries. While we realize that commercial fisheries represent a substantially higher level of effort compared to that proposed under this permit modification, this estimated lethal “take” represents the “worst-case” scenario for the species given the best available information. If additional mortalities are reported, researchers are required under the proposed permit to cease all activities and contact NMFS immediately to prevent any further exceedance of incidental take.

Mitigation measures to be employed by the researchers include periodically checking deployed nets for bycatch as well as following the de-hooking protocol as outlined in NMFS’ *Careful Release Protocols for Sea Turtle Release with Minimal Injury* (Epperly et al., 2004). Nevertheless, NMFS expects that up to two sea turtles of any species may die over the course of the remaining permit duration. For those turtles released alive, they are expected to experience short term stress responses but would be expected to return to normal body chemistry shortly after release consistent with the literature (Hoopes et al., 2000).

Responses to Handling and Size Measurements

Handling and restraining smalltooth sawfish and shortnose sturgeon may cause short term stress responses similar to those expected during capture. Sturgeon, however, have 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. In some cases, if pre-spawning adults are captured and handled, it is possible that they would interrupt or abandon their spawning migrations after being handled (Moser and Ross, 1995). Mitigation measures such as adhering to NMFS's sturgeon protocols (Moser et al., 2000; Kahn and Mohead, 2010) 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 and Atlantic sturgeon 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.

Handling can result in raised levels of stressor hormones in sea turtles. The additional on-board holding time imposes an additional stressor on already acidotic turtles (Hoopes et al., 2000). It has been suggested that the muscles used by sea turtles for swimming might also be used during lung ventilation (Butler et al., 1984). Thus, an increase in breathing effort in negatively buoyant animals may have heightened lactate production. However, handling by researchers of incidentally caught sea turtles is expected to be at a minimum in order to safely remove the hook or release the turtle from nets (if still alive). Therefore, NMFS expects that individual turtles would experience short-term stresses as a result of handling by researchers but that stress levels would return to normal soon after release similar to responses expected from net capture (Hoopes et al., 2000).

Responses to Tissue and Blood Sampling

Tissue samples would be clipped from dorsal fins of smalltooth sawfish and any incidentally caught Atlantic sturgeon for genetic analyses. Possible responses include short term injury or infection at the clipped 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 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 or Atlantic sturgeon as a result of tissue sampling.

In addition to tissue 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 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. Using these protocols, researchers will sample less than six percent of total blood volume from any individual sawfish and still obtain sufficient material for conducting hormone assays. 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 practice on elasmobranchs held in captivity at their facility. 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 with no long term fitness consequences.

Responses to Tagging Activities continued under the Previous Permit

Every sampled smalltooth sawfish is currently being fitted with acoustic transmitter tags, plastic headed dart tags, and PIT tags, while PAT tags are only fitted on individuals over 150 centimeters long (i.e. juveniles and adults). Incidentally caught Atlantic sturgeon are also authorized to be PIT tagged on an opportunistic basis. Since the methods of attachment for both acoustic transmitters and PAT tags for smalltooth sawfish are to be modified for this proposed action, those tagging activities will be explicitly discussed in the next section.

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 and Atlantic sturgeon 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 shortnose 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 and would not sample very small sturgeon individuals thereby avoiding this type of response in any incidentally caught Atlantic sturgeon.

The effects of 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. In many cases, multiple tags will be applied to the same smalltooth sawfish. 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.

Based on the measures proposed as well as the expected size-to-weight ratios expected, NMFS expects stresses as a result of PIT and dart tagging to be minimal and short-term for tagged smalltooth sawfish and Atlantic sturgeon, and that the small wound resulting from the insertion of the tag would heal soon upon release with no long term fitness consequences expected.

Responses to Modified Tagging Activities

As part of the original permit, acoustic transmitters were authorized to be attached to smalltooth sawfish by epoxying the transmitter to a swivel ear tag also referred to as a “rototag”. These tags were attached to the first dorsal fin of a smalltooth sawfish by punching a 3-5 millimeter hole through the fin with a leather hole-punch, and then fastening the two halves of the tag together through the fin. However, after using this tagging method, the applicant found that some of the transmitters eventually migrated through the fin and fell out which has greatly limited the long-term data collection of habitat use and movements. To address these issues, the researchers are proposing to modify their attachment methods by utilizing a neoprene clasp which has proven to increase tag retention on other elasmobranch species (Wetherbee et al., 2007). In the modified tagging procedure, a small 1-2 millimeter hole would be created through the anterior base of the first dorsal fin using a 20-gauge, four centimeter long surgical needle. The front of the clasp is positioned at the anterior of the dorsal fin where it would be anchored through thick connective tissue. A second attachment point is created 30 to 36 millimeters posterior of the first attachment point at the base of the dorsal fin. Before the neoprene clasp is fastened, a small piece of anti-chaffing tubing is inserted through the anterior hole, and 80 pound test monofilament line is threaded through the tubing. The monofilament is then 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.

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. The neoprene clasp procedure proposed in the permit modification 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 acoustic transmitters 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.

As part of the original permit, PAT tags were authorized to be attached using nylon umbrella darts connecting the tag with 136 kilogram monofilament leaders that were designed to detach from the host animal in a predictable time period (generally 3-6 months after release), float to the surface, and then download data summaries via the ARGOS satellite system. However, researchers found that tag retention by this method was significantly less than the programmed data collection period (63 days on average before release compared to the 90-180 days for which the tag is programmed to obtain data before release) thereby limiting the long term data collection. Researchers also found that lesions were sometimes evident on recaptured sawfish where the tag had been ripped off, presumably from the tag getting caught on mangrove branches or other structures in nearshore areas. To address these issues, the researchers are proposing to utilize a harness attachment method rather than nylon umbrella dart. As part of this procedure, 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. The metal crimps will corrode over time and the tag will slip off the animal leaving only a small hole. Also, given the larger size of the animals to be tagged with this method (i.e. juveniles and adults over 150 centimeters), 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.

As noted previously, the anterior section of the dorsal fin, through which the harness would 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 the harness attachment. The effects would be 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 current techniques employed (i.e. use of an umbrella dart). To be conservative and ensure the tag to animal weight ratio is not exceeded, PAT tags would be used only on sawfish exceeding 200 centimeters in length. 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.

Another important consideration is whether the sounds emitted by the sonic 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 sonic transmitters would 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 PAT tagging using the harness method to be minimal and short-term. The more secure harness should help minimize premature ripping of the PAT from the animal compared to current techniques of attaching using an umbrella dart and the wound generated by attaching the harness would be expected to heal shortly after release. Also, the signals emitted by the sonic 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 PAT tagging using the modified harness attachment method.

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 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.

For our jeopardy analysis, we treat the proposed Northwest Atlantic Ocean DPS of loggerhead sea turtles separate from the species as currently listed rangewide as this approach is supported by interagency policy on the recognition of distinct vertebrate populations (61 Federal Register 4722). We note, however, that any take for loggerhead sea turtles is expected to affect members of the proposed Northwest Atlantic Ocean DPS if and when that DPS is officially listed. Similarly, green sea turtles in U.S. waters are listed as threatened except for the Florida breeding population, which is 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 thus, our evaluation of risk to this species is consistent with this approach. The following sections provide our analysis of risk for both marine fish and listed sea turtles affected by the proposed action.

Smalltooth Sawfish (U.S. DPS) and Atlantic Sturgeon (Proposed South Atlantic DPS)

Research activities as proposed are not expected to result in mortality or serious injury for listed smalltooth sawfish (U.S. DPS) or for Atlantic sturgeon (South Atlantic DPS) proposed for listing 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, including the modified methods of attaching acoustic transmitters by way of neoprene clasp or PAT tags using a harness, would be expected 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 expect that the research permit modifications as proposed are not likely to cause a reduction in smalltooth sawfish's or Atlantic sturgeon's growth, survival, annual reproductive success, or lifetime reproductive success (i.e. fitness). As a result, we do not expect activities authorized by the proposed permits to have an appreciable effect on the extinction risk of the population(s) these individuals represent or the species those populations comprise.

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 estimates of incidental take associated with commercial fisheries utilizing net, rod-and-reel, and longline equipment utilized on a much larger scale, we expect that up to two loggerhead sea turtles and one individual of another species (i.e. either a green, hawksbill, Kemp's Ridley, or leatherback in any combination) may be captured each year over the remaining life of the permit. Of the nine total sea turtles expected to be incidentally captured over the remaining life of the permit, we expect that up to two sea turtles of any species may die due to offshore longline capture while others would be expected to undergo short term stress responses and/or minimal injury with no long term fitness consequences. Therefore, our risk analysis will focus on the population and species level consequences of removing two total individuals of either species from the action area over the remaining life of the permit since we are unable to estimate with any certainty which species would experience this mortality.

The lethal take of up to two sea turtles of any species would reduce the population of these sea turtles as compared to the number that would have been present in the absence of the proposed action (assuming all other variables remained the same). Assuming some or all of those lethal captures are females, these incidental mortalities are also then expected to reduce the reproduction of these species in the Atlantic compared to their respective reproductive outputs in the absence of the proposed action.

Estimates of the total loggerhead population in the Atlantic are not currently available; however, a recent loggerhead assessment prepared by NMFS states that the loggerhead adult female population in the western North Atlantic ranges from 20,000 to 40,000 or

more with a 95 percent Confidence Interval (CI) of 18,333-68,192 total individuals (NMFS-SEFSC, 2009). Assuming that mortalities resulting from the proposed research activities are to reproductively capable females, then two mortalities over the three years remaining on the permit would result in the removal of two individuals making up 0.011 percent of the adult female loggerhead population in the Western Atlantic (using the low end of the population estimate as a worse case scenario).

Loss of reproductively capable females may preclude nests from being laid and a reduction in nests means that there are fewer offspring produced and, therefore, potentially fewer turtles that will mature and reproduce in the future. Assuming the proposed action resulted in a loss of two females who had yet to nest for the first time, this could represent a potential loss of up to 84 nests total over their lifetime, using the high estimate for expected lifespan [i.e. 38 years (Frazer and Ehrhart, 1985; NMFS, 2001)], mean nest laid per season [i.e. 4.1 (Murphy and Hopkins, 1984)], and remigration interval [i.e. 3.7 years (Tucker, 2010)]. As stated in the *Status of the Species* section of this Opinion, loggerhead nesting for the Peninsular Florida Recovery Unit, which represents approximately 87 percent of all nesting effort in the proposed Northwest Atlantic Ocean (Ehrhart et al., 2003), declined 26 percent over the 20-year period from 1989–2008 and 41 percent over the recent 10-year period 1998–2008, with the most recent nest count standing at 28,880 at the time of the study (NMFS and FWS, 2008; Witherington et al., 2009). Much of this decline has been attributed to bycatch in commercial fisheries that have removed extensive numbers of reproductively capable adults from the population for decades. Loggerhead sea turtles reach sexual maturity between 20 and 38 years of age (Frazer and Ehrhart, 1985; NMFS, 2001), meaning that impacts in nesting success may not be felt for at least 20 years. Thus, Witherington et al. (2009) postulated that much of the recent decrease in nesting success in Florida has been attributed to the losses in young adults and juveniles during the 1980's before TEDs were required on trawling vessels.

As described in the *Environmental Baseline* sections of this Opinion, action has been taken to reduce anthropogenic effects to sea turtles in the Western North Atlantic, including regulatory measures implemented to reduce the number and severity of sea turtle interactions in the U.S. South Atlantic and Gulf of Mexico shrimp fisheries which is a leading known cause of sea turtle mortality in the Atlantic. Since these regulatory measures are relatively recent, it is unlikely that current nesting trends reflect the benefit of these measures. Therefore, given the estimated numbers of adult female loggerheads in the Northwest Atlantic as well as current nest counts, we expect that a loss of two individuals over the life of the permit would not be expected to have an appreciable effect on population growth and reproductive rates for loggerheads in the action area and the impact on nesting success would be considered negligible over time given the expected benefits from recent conservation measures enacted for commercial fisheries. As a result, we do not expect activities authorized by the proposed permit to have an appreciable effect on the extinction risk of the Northwest Atlantic Ocean DPS for loggerhead sea turtles and, in turn, would not have an appreciable effect on the extinction risk of the species as currently listed rangewide.

In addition to loggerheads, the two sea turtle mortalities expected over the life of the permit could also consist green, hawksbill, Kemp's ridley, or leatherback sea turtles. As described in the *Status of the Species* section of this Opinion, while populations of these respective sea turtle species have seen drastic decreases from their historical abundances, there are many indications that population numbers and/or nesting in and around the action area appear to be steady or even increasing. For instance, an average of 5,039 green sea turtle nests have been laid annually over the past six years in Florida and overall nesting trends appear to be increasing throughout the southeastern U.S. (Seminoff, 2004; NMFS and USFWS, 2007a). The largest known nesting assemblage in the western Atlantic, at Tortuguero, Costa Rica, has also shown a long-term increasing trend since monitoring began in 1971, with an annual average of 17,402–37,290 nesting females seen each year (Troëng and Rankin, 2005). The five-year status review for hawksbill sea turtles states their populations appear to be increasing or stable at the two principal nesting beaches in the U.S. Caribbean where long-term monitoring has been carried out (NMFS and USFWS, 2007b) and 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). Also, the TEWG (2007) estimated an annual nesting growth rate of 1.17 percent between 1989 and 2005 for this Florida nesting stock. Recent nesting data for Kemp's ridley sea turtles has also suggested the population may be showing signs of recovery (NMFS and USFWS, 2010), although recent impacts resulting from the *Deep Horizon* oil spill in the Gulf of Mexico may influence nesting success in the years to come. While NMFS has seen an unusual increase in strandings since the spill event occurred, research is currently being done to identify the cause of the increase in strandings and this information may further inform this analysis once it is available.

Although the anticipated mortalities of these species would result in an instantaneous reduction in absolute population numbers, we believe that a loss in up to two individuals (whether they be adults or juveniles of either sex) of any of these species over the remaining permit duration would not be expected to result in an appreciable effect on population growth and reproductive rates and the impact on nesting success would be considered negligible over time given the expected benefits from recent conservation measures enacted for commercial fisheries as well as the increasing trends in nesting seen for these populations in and around the action area. As a result, we do not expect activities authorized by the proposed permit to have an appreciable effect on the extinction risk of the population(s) these individuals represent or the species those populations comprise. It must be noted, however, that more information pertaining to nesting success and any resulting impacts from the *Deep Water Horizon* oil spill (particularly for Kemp's ridley sea turtles) will further inform this analysis.

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 and Atlantic sturgeon.

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 Proposed Action*, *Status of the Species*, *Environmental Baseline*, *Effects of the Proposed Action*, and *Cumulative Effects* sections of this Opinion. This information was used to assess the risk the proposed research activities pose to the future survival and recovery of smalltooth sawfish, the proposed South Atlantic DPS of Atlantic sturgeon, loggerhead sea turtles (including the proposed Northwest Atlantic Ocean DPS), green sea turtles, Kemp's ridley sea turtles, hawksbill sea turtles, and leatherback sea turtles.

As explained in the *Approach to the Assessment* section, risks to listed individuals are measured using changes to an individual's "fitness." 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). When individuals of listed plants or animals are expected to experience reductions in fitness in response to an action, those fitness reductions can reduce the abundance, reproduction, or growth rates of the populations that those individuals represent (see Stearns, 1992). If we determine that reductions in individual plants' or animals' fitness reduce a population's viability, we consider all available information to determine whether these reductions are likely to appreciably reduce the viability of the species as a whole.

The Permits Division proposes to issue a permit modification No. 13330-01 to NMFS-SEFSC for harassment of listed smalltooth sawfish off the coast of mainland Florida and the Florida Keys during capture and tagging activities pursuant to section 10(a)(1)(A) of the ESA. These actions may result in direct “takes” of listed smalltooth sawfish as well as incidental “takes” of listed loggerhead sea turtles (including members of the proposed Northwest Atlantic Ocean DPS), green sea turtles, hawksbill sea turtles, Kemp’s ridley sea turtles, leatherback sea turtles, and members of the proposed South Atlantic DPS for Atlantic sturgeon.

The objective of the permitted activity is to collect data on the biology, distribution and abundance of the endangered smalltooth sawfish to facilitate the recovery of the species. Sampling will occur primarily off the Florida coast from Naples to Key West encompassing the Ten Thousand Islands region and Everglades National Park. While researchers intend to focus their sampling efforts in these regions, additional sampling may occur in other areas off Florida (both Gulf and Atlantic sides) if reliable and sufficient reports of smalltooth sawfish encounters are received to warrant sampling in those areas. Researchers are currently authorized to capture and sample up to 45 smalltooth sawfish annually by way of longline, gillnet, seine net, drum (set) lines, or rod and reel throughout Florida’s coastal waters. All captured sawfish are to be handled, measured, tagged, sampled, and released alive. Current tagging methods include rototags (fin tags), dart tags, umbrella dart tags, Passive Integrated Transponder (PIT) tags, acoustic transmitters, Pop-Up Archival Transmitting (PAT) tags, and Smart Position Only Transmitting (SPOT) tags. Researchers also collect tissue samples (fin clips) and blood samples from captured individuals. Similar tissue sampling and PIT tagging are also performed on an opportunistic basis for any Atlantic sturgeon incidentally captured. Finally, dead sawfish acquired through strandings or from law enforcement confiscations are also measured and sampled for scientific purposes.

To increase tag retention and provide less invasive means of tagging, the applicant requests replacing two tagging methods while excluding another. Plastic rototags used to secure acoustic transmitters would be replaced with neoprene clasp tags, nylon umbrella darts used to secure PAT tags would be replaced with dorsal fin harnesses, and SPOT tags would be excluded as a tagging method in all sampling conducted. The amount of smalltooth sawfish to be taken annually (i.e. 45 individuals) would remain unchanged from the original permit. Since the researcher will be expected to conduct similar levels of research effort that was assessed in the original biological opinion, annual exposure for this permit modification was assessed at the following proposed levels: 15 neonate/young-of-the-year (less than 150 centimeters stretched total length) individuals, 15 juveniles (150-350 centimeters stretched total length) annually, and 15 adults (greater than 350 centimeters stretched total length). Juveniles and adults would be exposed to all research activities annually while neonate/young-of-the-year individuals would be exposed to all research activities except for PAT tagging.

In addition to smalltooth sawfish, NMFS expects that members of the south Atlantic DPS of Atlantic sturgeon could be encountered and exposed to net or hook-and-line capture in the St. John’s and St. Mary’s rivers according to recent reports of sturgeon occurring in

those river systems. While prior sampling of the St. Marys and St. Johns River 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]. Researchers expect to sample primarily in the region of the Florida coast from Naples to Key West and would only sample in the St. Mary's or St. John's rivers if reliable and sufficient reports of smalltooth sawfish encounters are received to warrant sampling in those areas. Therefore, there is insufficient data to estimate actual numbers of Atlantic sturgeon that are likely to be exposed given the lack of population data for those river systems as well as the variability in research effort expected to be conducted in those river systems over the remaining life of the permit. If an Atlantic sturgeon, prior to its proposed ESA listing, is incidentally captured, researchers will also expose the individuals to PIT tagging and genetic sampling prior to release.

NMFS also believes that loggerhead, Kemp's ridley, green, hawksbill, and/or leatherback sea turtles could be encountered in the action area and may be exposed to mortality and/or stress associated with net or long-line capture directed at smalltooth sawfish. The original permit included an Incidental Take Statement (ITS) that exempted "take" in the form of mortality of two loggerhead sea turtles annually as well as one additional annual mortality consisting of either a green, hawksbill, Kemp's ridley, or leatherback. NMFS reviewed available monitoring reports submitted by various smalltooth sawfish researchers as well as recent opinions that evaluated "take" of sea turtles resulting from commercial fisheries operating in the action area since the original 2008 biological opinion was issued to determine if exposure of listed sea turtles needed to be adjusted. Based on this analysis, we would expect that similar research effort conducted by the researchers over the remaining permit duration (i.e. through 2013) would result in the exposure of three total sea turtles being exposed to net, hook-and-line, and/or longline capture each year over the life of the permit. Of the three sea turtles likely to be exposed each year, two would be expected to be loggerhead sea turtles while one sea turtle encountered would be expected to be a different species (i.e. either a green, hawksbill, Kemp's ridley or leatherback sea turtle).

Smalltooth sawfish and Atlantic sturgeon 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 (ASSRT, 2007; 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 (South Atlantic Fisheries Management Council [SAFMC], 1998). Smalltooth sawfish and Atlantic sturgeon 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 while the proposed South Atlantic DPS is estimated to number less than six percent of historical abundance (ASSRT, 2007).

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 sawfishes and Atlantic sturgeon's historical ranges have been altered or dammed thus limiting the species' abilities to expand their ranges. 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.

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* oil spill although the cause of death is not immediately certain for all carcasses recovered (NMFS, 2011). 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, 2011). 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.

Stressors associated with the proposed permit modification include harassment, injury, or mortality associated ship strikes or general vessel transit; harassment, injury, or mortality associated with longline, gillnet, seine net, drum (set) lines, or rod and reel capture; harassment associated with handling and size measurements; harassment and/or injury associated with blood and tissue sampling; and harassment and/or injury associated with acoustic transmitter tag attachment (with new method of attaching with neoprene clasp), plastic headed dart tags, PAT tags (with new method of attaching with a harness), and PIT tags. SPOT tags will not be used and therefore, no listed species will be exposed to the effects from this type of tag as part of this proposed permit modification.

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), Atlantic sturgeon (Stein et al., 2004b; ASSRT, 2007), and sea turtles (Hays et al., 2003; Watson et al., 2005; Gillman et al., 2006) based on years of data on incidental captures reported for commercial fisheries. Research activities as proposed are not expected to result in mortality and serious injury for listed smalltooth sawfish or for Atlantic sturgeon proposed for listing. Based on observations from prior sampling efforts and in the literature on the expected responses of these species to capture, handling, tissue and/or blood sampling, and tagging, NMFS expects that the proposed research activities, including the modified methods of attaching acoustic transmitters by way of neoprene clasp or PAT tags using a harness, would be expected 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 expect that the research permit modifications as proposed are not likely to cause a reduction in smalltooth sawfish's or Atlantic sturgeon's growth, survival, annual reproductive success, or lifetime reproductive success (i.e. fitness). As a result, we do not expect activities authorized by the proposed permits to have an appreciable effect on the extinction risk of the population(s) these individuals represent or the species those populations comprise.

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. Mitigation measures to be employed by the researchers include periodically checking deployed nets for bycatch as well as following the de-hooking protocol as outlined in NMFS' *Careful Release Protocols for Sea Turtle Release with Minimal Injury* (Epperly et al., 2004). Nevertheless, NMFS expects that up to two sea turtles of any species may die over the course of the remaining permit duration. For those turtles released alive, they are expected to experience short term stress responses but would be expected to return to normal body chemistry shortly after release consistent with the literature (Hoopes et al., 2000). The lethal take of up to two loggerhead, Kemp's ridley, green, hawksbill, or leatherback sea turtles over the remaining life of the permit

will reduce the population of these sea turtles as compared to the number that would have been present in the absence of the proposed action (assuming all other variables remained the same). Assuming some or all of those lethal captures are females, these incidental mortalities are also then expected to reduce the reproduction of these species in the Atlantic compared to their respective reproductive outputs in the absence of the proposed action.

Although the anticipated mortalities of these species would result in an instantaneous reduction in absolute population numbers, we believe that a loss in up to two individuals (whether they be adults or juveniles of either sex) of any of these species over the remaining permit duration would not be expected to result in an appreciable effect on population growth and reproductive rates and the impact on nesting success would be considered negligible over time given the expected benefits from recent conservation measures enacted for commercial fisheries. As a result, we do not expect activities authorized by the proposed permit to have an appreciable effect on the extinction risk of the population(s) these individuals represent or the species those populations comprise. It must be noted, however, that more information pertaining to nesting success and any resulting impacts from the *Deep Water Horizon* oil spill (particularly for Kemp's ridley sea turtles) will further inform this analysis.

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.

We also expect anthropogenic effects described in the *Environmental Baseline* will continue, including habitat degradation, vessel traffic and risk of ship strikes, increases in background ocean noise levels, and interactions with fishing gear. 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 in the future.

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 Endangered Species Division's opinion that the Permits Division's proposed action of issuing permit modification No. 13330-01 to NMFS-SEFSC, as proposed, is not likely to jeopardize the

continued existence of the following species currently listed under the ESA: smalltooth sawfish, loggerhead sea turtles, green sea turtles, Kemp's ridley sea turtles, hawksbill sea turtles, and leatherback sea turtles. In addition, it is the Endangered Species Division's conference opinion that the proposed action is not likely to jeopardize the continued existence of the following species currently proposed for listing under the ESA: South Atlantic DPS of Atlantic Sturgeon and the Northwest Atlantic Ocean DPS for loggerhead sea turtles. Finally, no designated critical habitat under NMFS' authority would be affected.

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.

The measures described below are non-discretionary and must therefore be undertaken in order for the exemption in section 7(0)(2) to apply. Failure to implement the terms and conditions through enforceable measures, may result in a lapse of the protective coverage section of 7(0)(2).

Amount or Extent of Take Anticipated

The section 7 regulations require NMFS to specify the impact of any incidental take of endangered or threatened species; that is, the amount or extent of that take (50 CFR 402.14(i)(1)(i)). The amount of take represents the number of individuals that are expected to be taken by proposed actions while the extent of take represents "the extent of land or marine area that may be affected by an action" if we cannot assign numerical limits for animals that could be incidentally taken during the course of an action (Federal Register 51, June 3, 1986, page 19953).

Based on prior monitoring reports submitted by smalltooth sawfish researchers as well as estimates of incidental take associated with commercial fisheries utilizing net, rod-and-reel, and longline equipment albeit on a much larger scale, we expect that up to two loggerhead sea turtles and one individual of another species (i.e. either a green, hawksbill, Kemp's Ridley, or leatherback) may be captured each year over the remaining life of the permit. Of the nine total sea turtles expected to be incidentally captured over the remaining life of the permit, we expect that up to two sea turtles of any species may die due to offshore longline capture while others would be expected to undergo short term harassment and/or minimal injury from being released from nets or hook gear.

Effect of the Incidental Take

In the accompanying biological opinion, NMFS evaluated the species' expected responses as well as the population and species level risks associated with the expected incidental take of sea turtles by the proposed research activities. 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). Short term harassment and/or minimal injury associated with net or hook-and-line capture would not be expected to result in any long term consequences that would appreciably reduce the ability of these species to survive or recover in the wild. The lethal take of up to two sea turtles of any species as a result of the research activities will reduce the population of these sea turtles as compared to the number that would have been present in the absence of the proposed action (assuming all other variables remained the same). However, NMFS concluded that the mortality expected is unlikely to cause an appreciable reduction in these species' likelihood of surviving and recovering in the wild and would, therefore, not jeopardize their continued existence. Nevertheless, NMFS must take action to minimize these takes. The following reasonable and prudent measures have been identified as ways to minimize sea turtle interactions during research activities. These measures are non-discretionary and must be implemented by NMFS.

Reasonable and Prudent Measures

In addition to the proposed and existing bycatch reduction measures contained in the proposed action, NOAA Fisheries Service has determined that the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of sea turtles:

1. NMFS-SEFSC shall, on an annual basis, estimate the total effort levels in this research in order to provide accurate estimates of sea turtle bycatch;
2. Detect and report any adverse effects resulting from this research on sea turtles;
3. Assess the actual level of incidental take in comparison with the anticipated incidental take specified in this opinion;
4. Detect and report on when the level of anticipated incidental take is exceeded;
5. Determine the effectiveness of reasonable and prudent measures and their implementing terms and conditions.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, NMFS must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1. NMFS shall condition the permit holder to observe his nets for sea turtles, and disentangle and return to the water, to the maximum extent practicable and with vigilante consideration of safety, any live sea turtles that are found in nets during research. These conditions shall outline approved net checking and handling protocol.
2. NMFS shall require the permit holder to report any sea turtle interactions to NMFS within 14 days of the incident. This report must contain the description of the take, species of sea turtle, date and location of interaction, where the animal was hooked or otherwise entangled, depths of imbedded hooks, and release condition.
3. These reports must be forwarded to the Permits, Conservation and Education Division of the Office of Protected Resources, National Marine Fisheries Service 1315 East-West Highway, Silver Spring, Maryland, 20910.

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. *Cumulative Impact Analysis.* Before authorizing any additional permits for activities similar to those contained in the proposed permit, 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 on listed species.

REINITIATION NOTICE

This concludes formal consultation and conference on the proposal to issue scientific research permit modification No. 13330-01 for research on ESA listed smalltooth sawfish off the coast of Florida. 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.

You may ask NMFS to confirm the conference opinion as a biological opinion issued through formal consultation if the Northwest Atlantic Ocean DPS for loggerhead sea turtles or the South Atlantic DPS for Atlantic Sturgeon is officially listed. The request must be in writing. If NMFS reviews the proposed action and finds that there have been no significant changes in the action as planned or in the information used during the conference, NMFS will confirm the conference opinion as the biological opinion on the project and no further section 7 consultation will be necessary.

After the Northwest Atlantic Ocean DPS for loggerhead sea turtles and/or the South Atlantic DPS for Atlantic Sturgeon is listed and any subsequent adoption of this conference opinion, the Federal agency shall request reinitiation of consultation if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect the species or critical habitat in a manner or to an extent not considered in this conference opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the species or critical habitat that was not considered in this conference opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

LITERATURE CITED

- Abella, E., Marco, A., and L.F. Lopez-Jurado. 2007. Success of Delayed Translocation of Loggerhead Turtle Nests. *The Journal of Wildlife Management* 71, 2290-2296.
- 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.
- Ackerman, R.A. 1980. Physiological and ecological aspects of gas exchange by sea turtle eggs. *American Zoologist* 20: 575-583.
- 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.
- Anderson, W.G., J.R. Taylor, J.P. Good, N. Hazon and M. Grosell. 2007. Body fluid volume regulation in elasmobranch fish. *Comparative Biochemistry and Physiology Part A* 148: 3-13.
- ASMFC. 1990. Interstate fishery management plan for Atlantic sturgeon. Fisheries Management Report No. 17. Atlantic States Marine Fisheries Commission, Washington, D.C. 73 pp.
- ASMFC. 2007. Estimation of Atlantic Sturgeon Bycatch in Coastal Atlantic Commercial Fisheries of New England and the Mid-Atlantic. Special Report to the ASMFC Atlantic Sturgeon Management Board, August 2007.
- ASSRT. 2007. Status Review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.
- Austin, D.F. 1978. Exotic plants and their effects in southeastern Florida. *Environmental*

- Avens, L., and L.R. Goshe. 2007. Skeletochronological analysis of age, and growth for leatherback sea turtles in the western North Atlantic. Page 223 in: Frick, M., A. Panagopoulou, A.F. Rees, and K. Williams (eds.), Twenty-seventh Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Myrtle Beach, South Carolina, USA.
- Bain, M. B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and Divergent Life History Attributes. *Environmental Biology of Fishes* 48: 347-358.
- Bain, M. B., N. Haley, D. Peterson, J. R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic sturgeon *Acipenser oxyrinchus* Mitchill, 1815, in the Hudson River Estuary: Lessons for Sturgeon Conservation. *Instituto Espanol de Oceanografia. Boletin* 16: 43-53.
- 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., S.P. Epperly, and J. Braun-McNeill. 2006. Green turtle (*Chelonia mydas*) foraging and nesting aggregations in the Caribbean and Atlantic: impact of currents and behavior on dispersal. *J Hered.* 97:346-354.
- Beale, C.M. and P. Monaghan. 2004. Human disturbance: people as predation-free predators? *Journal of Applied Ecology* 41: 335-343.
- 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.
- Beauvais, S. L., S. B. Jones, S. K. Brewer, and E. E. Little. 2000. Physiological measures of neurotoxicity of diazinon and malathion to larval rainbow trout (*Oncorhynchus mykiss*) and their correlation with behavioral measures. *Environmental Toxicology and Chemistry* 19: 1875-1880.
- 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.

- Berlin, W. H., R. J. Hesselberg, and M. J. Mac. 1981. Chlorinated hydrocarbons as a factor in the reproduction and survival of Lake Trout (*Salvelinus namaycush*) in Lake Michigan. Technical Paper 105, U.S. Fish and Wildlife Service. 42 pp.
- 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.
- Billsson, K., L. Westerlund, M. Tysklind, and P. Olsson. 1998. Developmental disturbances caused by polychlorinated biphenyls in zebrafish (*Brachydanio rerio*). *Marine Environmental Research* 46: 461-464.
- 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., A.B. Bolten, and M.Y. Chaloupka. 2000. Green turtle somatic growth model: evidence for density dependence. *Ecological Applications* 10(1):269-282.
- Bjorndal, K. A., A. B. Bolten and 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.
- 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., 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
- Borodin, N. 1925. Biological observations on the Atlantic Sturgeon, *Acipenser sturio*. *Transactions of the American Fisheries Society* 55: 184-190.
- 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.
- Bowen, B. W. and J. C. Avise. 1990. Genetic structure of Atlantic and Gulf of Mexico

- populations of sea bass, menhaden, and sturgeon: Influence of zoogeographic factors and life-history patterns. *Marine Biology* 107: 371-381.
- 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.
- 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.
- Brown, J. J., J. Perillo, T. J. Kwak, and R. J. Horwitz. 2005. Implications of *Plyodictis olivaris* (Flathead Catfish) introduction into the Delaware and Susquehanna drainages. *Northeastern Naturalist* 12: 473-484.
- Bugoni, L., L. Krause, and M. Virginia 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.
- Cameron, P., J. Berg, V. Dethlefsen, and H. Von Westernhagen. 1992. Developmental defects in pelagic embryos of several flatfish species in the southern north-sea. *Netherlands Journal of Sea Research* 29: 239-256.
- 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.
- Caron, F., D. Hatin, and R. Fortin. 2002. Biological characteristics of adult Atlantic sturgeon (*Acipenser oxyrinchus*) in the Saint Lawrence River estuary and the effectiveness of management rules. *Journal of Applied Ichthyology* 18: 580-585.
- Carr, A.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.
- 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).

- Casper, B.M. and D. Mann. 2004. The hearing abilities of the Nurse Shark, *Ginglymostoma cirratum*, and the Yellow Stingray, *Urobatis jamaicensis*. Presentation at American Elasmobranch Society Meeting, University of South Florida, College of Marine Science, St. Petersburg, FL, May 28.
- 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.
- Collins, M. R., S. G. Rogers, and T. I. J. Smith. 1996. Bycatch of sturgeons along the Southern Atlantic Coast of the USA. *North American Journal of Fisheries Management* 16: 24-29.
- Collins, M. R., T. I. J. Smith, W. C. Post, and O. Pashuk. 2000. Habitat utilization and biological characteristics of adult Atlantic sturgeon in two South Carolina rivers. *Transactions of the American Fisheries Society* 129: 982-988.
- Compagno, L.J.V. 1984. 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 elasmobranchs: status of taxa and prospects for the future. *The Journal of Aquaculture 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.
- Cooper, K. 1989. Effects of polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans on aquatic organisms. *Reviews in: Aquatic Sciences* 1(2): 227-242.
- 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.
- Cox, T.M., R.L. Lewison, R. Zydels, L. Crowder, C. Safina, and J. Read. 2007. Comparing effectiveness of experimental and implemented bycatch reduction measures: the ideal and the real. *Conserv Biol* 21: 1155–1164.
- Crabbe, M.J.C. 2008. Climate change, global warming and coral reefs: Modelling the effects of temperature. *Computational Biology and Chemistry* 32: 311-314.
- Crance, J. H. 1987. Habitat suitability index curves for anadromous fishes. In: *Common Strategies of Anadromous and Catadromous Fishes*, ed. M. J. Dadswell. Bethesda, Maryland, American Fisheries Society. Symposium 1: 554.
- 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.
- Dadswell, M. 2006. A review of the status of Atlantic sturgeon in Canada, with

- comparisons to populations in the United States and Europe. *Fisheries* 31: 218-229.
- Dare, M.R. 2003. Mortality and Long-Term Retention of Passive Integrated Transponder Tags by Spring Chinook Salmon. *North American Journal of Fisheries Management* 23: 1015-1019.
- Delgado C, T. Dellinger, N. Varo, and L.F. Lopez-Jurado. 2008. Preliminary approach to the hatchlings sex-ratio of a population of *Caretta caretta* of Boa Vista Island, Cape Verde Archipelago (Western Africa)—an update for 2004 season. In: Kalb H, Rohde AS, Gayheart K, Shanker Kc (eds) *Proceedings of the twenty-fifth annual symposium on sea turtle biology and conservation*. NOAA Technical Memorandum NMFS-SEFSC-582, pp 166–167.
- Dellinger, T. and H. Encarnaç o. 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.
- 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 administration 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. 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.
- Doughty, R. W. 1984. Sea turtles in Texas: a forgotten commerce. *Southwestern Historical Quarterly* 88: 43-70.
- Dovel, W. L. and T. J. Berggren. 1983. Atlantic sturgeon of the Hudson River estuary, New York. *New York Fish and Game Journal* 30: 140-172.
- 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.
- Drevnick, P. E. and M. B. Sandheinrich. 2003. Effects of dietary methylmercury on reproductive endocrinology of fathead minnows. *Environmental Science and Technology* 37: 4390-4396.

- Dutton, P.H., G.H. Balazs, and A.E. Dizon. 1998. Genetic stock identification of sea turtles caught in the Hawaii-based pelagic longline fishery. Pages 45-46 in: Epperly, S.P., and J. Braun (eds.), Proceedings of the Seventeenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-415.
- Dwyer, K.L., C.E. Ryder, and R. Prescott. 2002. Anthropogenic mortality of leatherback sea turtles in Massachusetts waters. In: Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Conservation and Biology. NOAA Tech Memo NMFS-SEFSC-503.
- Eckert, S.A., K.L. Eckert, P. Ponganis, and G.L. Kooyman. 1989. Diving and foraging behavior of leatherback sea turtles (*Dermochelys coriacea*). Canadian Journal of Zoology 67:2834-2840.
- Eckert, 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. 1999. Global distribution of juvenile leatherback turtles. Hubbs Sea World Research Institute Technical Report 99-294.
- Ehrhart, L.M. 1983. Marine turtles of the Indian River Lagoon System. Florida Sci. 46: 337-346.
- Ehrhart, L. M., W.E. Redfoot, and D.A. Bagley. 1996. A study of the population ecology of in-water marine turtle populations on the east-central Florida coast from 1982-96. Vol. . pp. 164 pp. Department of Biology, University of Central Florida, Orlando.
- Ehrhart, LM., D.A. Bagley, and W.E. Redfoot. 2003. Loggerhead turtles in the Atlantic Ocean: geographic distribution, abundance, and population status. Pages 157-174 in Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Institution Press, Washington, D.C.
- 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., 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

- 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.
- Fleming, E.H. 2001. Swimming against the tide: recent surveys of exploitation, trade, and management of marine turtles in the northern Caribbean. Traffic North America, Washington, D.C.
- Foley, A, 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.
- 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.
- Fretey, J. 2001. Biogeography and conservation of marine turtles of the Atlantic coast of Africa. CMS Technical Series Publication No. 6, UNEP/CMS Secretariat, Bonn, Germany. 429 pp.
- Frid, A. 2003. Dall's sheep responses to overflights by helicopter and fixed-wing aircraft. *Biological Conservation* 110: 387-399.
- Frid, A. and L. Dill. 2002. Human-caused disturbance stimuli as a form of predation risk. *Conservation Ecology*, (6): 11.
- Fritts, T.H. 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.
- Fromentin, J.M. and B. Planque. 1996. Calanus and environment in the eastern North Atlantic. II. Influence of the North Atlantic Oscillation on *C. finmarchicus* and *C. helgolandicus*. *Marine Ecology Progress Series*, 134: 111- 118.

- FWC. 2009. Statewide nesting beach survey progra: 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>
- Gadomski , D. M. and M. J. Parsley. 2005. Laboratory studies on the vulnerability of young white sturgeon to predation. *North American Journal of Fisheries Management* 25: 667-674.
- 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, *Caretta caretta*, in the wider Caribbean region. In *Marine turtle conservation in the wider Caribbean 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. 2004. Hormonal regulation of elasmobranch physiology. Pages 287-323 in *Biology and Ecology of Sharks and Their Relatives*. (J. Carrier, J. Musick and M. Heithaus, eds.). CRC Press, Boca Raton, FL.
- 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.
- Giesy, J. P., J. Newsted, and D. L. Garling. 1986. Relationships between chlorinated hydrocarbon concentrations and rearing mortality of Chinook salmon (*Oncorhynchus tshawytscha*) eggs from Lake Michigan. *Journal of Great Lakes Research* 12: 82-98.
- Gilbert, C. R. 1989. Atlantic and shortnose sturgeons. United States Department of Interior Biological Report 82: 28 pp.
- Gill, J.A., K. Norris, and W.J. Sutherland. 2001. Why behavioural responses may not reflect the population consequences of human disturbance. *Biological Conservation*, 97: 265-268.

- Gilman, E., D. Kobayashi, T. Swenarton, N. Brothers, P. Dalzell, and I. Kinan-Kelly. 2007. Reducing sea turtle interactions in the Hawaii-based longline swordfish fishery. *Biological Conservation* 139, 19-28.
- 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.
- 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.
- 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.
- 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.
- 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.
- Hammerschmidt, C. R., M. B. Sandheinrich, J. G. Weiner, and R. G. Rada. 2002. Effects of dietary methylmercury on reproduction of fathead minnows. *Environmental Science and Technology* 36: 877-883.
- 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.
- Harrington, F.H. and A.M. Veitch. 1992. Calving success of woodland caribou exposed to low-level jet fighter overflights. *Arctic* 45: 213-218.
- 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., A.C. Broderick, M.H. Godfrey, and B.J. Godley. 2009. Climate change and marine turtles. *Endangered Species Research* 7: 137-159.
- Hays, G.C., A.C. Broderick, B.J. Godley, P. Luschi, and W.J. Nichols. 2003. Satellite telemetry suggests high levels of fishing-induced mortality in marine turtles. *Marine Ecology Progress Series* 262:305-309.
- 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.
- 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.
- 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. 1963. Hallazgo del area de anidacion de la tortuga "lora" *Lepidochelys kempii* (Garman), en la costa occidental del Golfo de Mexico (Rept. Chel.).

- Ciencia Mexico 22: 105-112.
- Hillis, Z. and A.L. Mackay. 1989. Research report on nesting and tagging of hawksbill sea turtles *Eretmochelys 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.
- 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.
- Hoff, J. G. 1980. Review of the present status of the stocks of the Atlantic sturgeon *Acipenser oxyrinchus*, Mitchill. Prepared for the National Marine Fisheries Service, Northeast Region, Gloucester, MA. Region, Gloucester, Massachusetts.
- 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.
- 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.
- IPCC. 2007. Summary for Policymakers. Cambridge University Press, Cambridge.
- IUCN. 1996. Marine Turtle Specialist Group. *Lepidochelys kempii*. In: IUCN 2010.

IUCN Red List of Threatened Species. <www.iucnredlist.org>.

- 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 miliarius*. *Journal of Herpetology* 29(1):129-132.
- Johnson, S.A. and L.M. Ehrhart. 1996. Reproductive Ecology of the Florida Green Turtle: Clutch Frequency. *Journal of Herpetology* 30: 407-410.
- Jordan, F. 2002. Field and laboratory evaluation of habitat use by rainwater killifish (*Lucania parva*) in the Saint Johns river Estuary, Florida. *Estuaries* 25: 288-295.
- Jorgensen, E. H., O. Aas-Hansen, Al G. Maule, J. E. T. Strand, M. M. Vijayan. 2004. PCB impairs smoltification and seawater performance in anadromous Arctic char (*Salvelinus alpinus*). *Comparative Biochemistry and Physiology, Part C* 138: 203-212.
- 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.
- Kahnle, A. W., K. A. Hattala, K. McKown. 2007. Status of Atlantic sturgeon of the Hudson River estuary, New York, USA. In J. Munro, D. Hatin, K. McKown, J. Hightower, K. Sulak, A. Kahnle, and F. Caron (editors). Proceedings of the symposium on anadromous sturgeon: Status and trend, anthropogenic impact, and essential habitat. American Fisheries Society, Bethesda, Maryland.
- 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. Sukanuma, 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.
- Keck, M.B. 1994. Test for detrimental effects of PIT tags in neonatal snakes. *Copeia* 1994:226-228.
- 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.
- King, T. L., B. A. Lubinski, and A. P. Spidle. 2001. Microsatellite DNA variation in Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and cross-species amplification in the Acipenseridae. *Conservation Genetics* 2: 103-119.
- 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.
- Kynard, B. and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*, and shortnose sturgeon, *A. brevirostrum*, with notes on social behavior. *Environmental Behavior of Fishes* 63: 137-150.
- Lagueux, C. 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. WIDECAS, IUCN-MTSG, WWF, and UNEP-CEP.
- 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.
- Leland, J. G., III. 1968. A survey of the sturgeon fishery of South Carolina. Contributed by Bears Bluff Labs. No. 47: 27 pp.
- 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.
- Lewis, 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.
- Lima, S.L. 1998. Stress and decision making under the risk of predation: recent developments from behavioral, reproductive, and ecological perspectives. *Advances in the Study of Behavior* 27: 215-290.
- 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.
- Loehfener, 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.
- Longwell, A. C., S. Chang, A. Hebert, J. Hughes, and D. Perry. 1992. Pollution and developmental abnormalities of Atlantic fishes. *Environmental Biology of Fishes* 35: 1-21.
- 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., 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. 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. 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.
- Mac, M. J. and C. C. Edsall. 1991. Environmental contaminants and the reproductive success of Lake Trout in the Great Lakes: an epidemiological approach. *Journal of Toxicology and Environmental Health* 33: 375-394.
- Mangin, E. 1964. Croissance en Longueur de Trois Esturgeons d'Amerique du Nord: *Acipenser oxyrinchus*, Mitchill, *Acipenser fulvescens*, Rafinesque, et *Acipenser brevirostris*. *LeSueur. Verh. Int. Ver. Limnology* 15: 968-974.
- 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.
- 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 Metro, 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.
- Marquez-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).
- Marquez, M.R. 1994. Synopsis of biological data on the Kemp's ridley turtle, *Lepidochelys kempi* (Garman, 1880). *NOAA Tech. Mere. NMFS-SEFSC-343*: 1-91.
- Martin, R.E. 1996. Storm impacts on loggerhead turtle reproductive success. *Marine Turtle Newsletter*. 73:10-12.
- Martin, R. E. and R.G. Ernst. 2000. Physical and Ecological Factors Influencing Sea Turtle Entrainment Levels at the St. Lucie Nuclear Plant. 62 pp.
- Matkin, C.O. and E. Saulitis. 1997. Restoration notebook: killer whale (*Orcinus orca*). Exxon Valdez Oil Spill Trustee Council, Anchorage, Alaska.
- Matta, M. B., C. Cairncross, R. M. Kocan. 1997. Effect of a polychlorinated biphenyl metabolite on early life stage survival of two species of trout. *Bulletin of*

- Environmental Contamination and Toxicology 59: 146-151.
- 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.
- McEachran, J.D., and J.D. Fechhelm. 1998. Fishes of the Gulf of Mexico. Volume 1: Myxiniiformes 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.
- 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. M., B. Schroeder, and A. Mosier. 1994. Marine turtle nesting activity in the state of Florida, 1979-1992, p. 83. In: K. A. Bjorndal, A. B. Bolten, D. A. Johnson, and P. J. Eliazar (comps.), Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351
- Meylan, A., Schroeder B., and 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.
- 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.
- Moore A. and C. P. Waring. 2001. The effects of a synthetic pyrethroid pesticide on some aspects of reproduction in Atlantic salmon (*Salmo salar* L.). *Aquatic Toxicology* 52: 1-12.
- 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.
- 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. *Eretmochelys imbricata*. In: IUCN 2010. IUCN Red List of Threatened Species. <www.iucnredlist.org>
- 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.
- Moser M. L., J. B. Bichy, and S. B. Roberts. 1998. Sturgeon distribution in North Carolina. Center for Marine Science Research. Final Report to U.S. ACOE, Wilmington District, NC.
- Mrosovsky, N. 1981. Plastic jellyfish. *Marine Turtle Newsletter* 17:5-6. (<http://www.seaturtle.org/mtn/archives/mtn17/mtn17p5.shtml?nocount>).
- Mrosovsky, N., G.D. Ryan, and M.C. James. 2009. Leatherback turtles: The menace of plastic. *Marine Pollution Bulletin* 58: 287-289.
- Murawski, S. A. and A. L. Pacheco. 1977. Biological and fisheries data on Atlantic Sturgeon, *Acipenser oxyrinchus* (Mitchill). National Marine Fisheries Service Technical Series Report 10: 1-69.
- Murphy, T. M. and S.R. Hopkins. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region. 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., 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.
- 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.
- Niklitschek, E.J. and D.H. Secor. 2005. Modeling spatial and temporal variation of suitable nursery habitats for Atlantic sturgeon in the Chesapeake Bay. *Estuar. Coast. Shelf Sci.* 64(1):135-148.
- Niklitschek, E. J. and D. H. Secor. 2009a. Dissolved oxygen, temperature and salinity effects on the ecophysiology and survival of juvenile Atlantic sturgeon in estuarine waters: I. Laboratory Results, *Journal of Experimental Marine Biology and Ecology*, Volume 381, Supplement 1, Ecological Impacts of Hypoxia on Living Resources, 1 December 2009, Pages S150-S160.
- Niklitschek, E. J. and D. H. Secor. 2009b. Dissolved oxygen, temperature and salinity effects on the ecophysiology and survival of juvenile Atlantic sturgeon in estuarine waters: II. Model development and testing, *Journal of Experimental Marine Biology and Ecology*, Volume 381, Supplement 1, Ecological Impacts of Hypoxia on Living Resources, 1 December 2009, Pages S161-S172.
- NMFS. 1997a. Section 7 consultation on the continued hopper dredging of channels and borrow areas in the southeastern United States. National Marine Fisheries Service Southeast Regional Office, September 25, 1997.
- NMFS. 1997b. Endangered Species Act section 7 consultation on Navy activities off the southeastern United States along the Atlantic Coast. Biological Opinion. May 15, 1997.
- NMFS. 2000. Status review of smalltooth sawfish (*Pristis pectinata*). National Marine Fisheries Service.
- 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. U.S. Department of Commerce, National Marine Fisheries Service, Miami, Florida, SEFSC Contribution PRD-00/01-08; Parts I-III and Appendices I-V1.
- 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, St. Petersburg, Florida, December 2, 2002.
- NMFS. 2003. Endangered Species Act section 7 consultation on Gulf of Mexico Outer Continental Shelf oil and gas lease sales 189 and 197. Biological Opinion. August

30.

- NMFS. 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. 2005a. 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. 2005b. Biological opinion on the continued authorization of reef fish fishing under the Gulf of Mexico (GOM) Reef Fish Fishery Management Plan (RFFMP) and proposed Amendment 23. National Marine Fisheries Service Southeast Regional Office. St. Petersburg, FL. 124pp.
- NMFS. 2006a. Biological opinion on the continued authorization of snapper-grouper fishing in the U.S. South Atlantic Exclusive Economic Zone (EEZ) as managed under the Snapper-Grouper Fishery Management Plan (SGFMP) of the South Atlantic Region including Amendment 13C to the SGFMP. National Marine Fisheries Service Southeast Regional Office. St. Petersburg, FL. 127pp.
- NMFS. 2006b. 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. 2007. Biological opinion on the continued authorization of fishing under the Fishery Management Plan (FMP) for Coastal Migratory Pelagic Resources in the Atlantic and Gulf of Mexico (CMPR FMP). National Marine Fisheries Service Southeast Regional Office. St. Petersburg, FL. 128pp.
- 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. 2008b. Biological Opinion on permitting the Southeast Fisheries Science Center to conduct research on the biology, distribution, and abundance of smalltooth sawfish along the coast of Florida. National Marine Fisheries Service, Silver Spring, Maryland. 71pp.
- 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/SER12005/07518). National Marine Fisheries Service

- Southeast Regional Office. St. Petersburg, FL. 219pp.
- NMFS. 2009c. Biological opinion on the continued authorization of fishing under the Fishery Management Plan for the Stone Crab Fishery of the Gulf of Mexico (F/SERI2005107541). National Marine Fisheries Service Southeast Regional Office. St. Petersburg, FL. 130pp.
- NMFS. 2010a. Status review of the largemouth sawfish (*Pristis perotteti*). National Marine Fisheries Service.
- NMFS. 2010b. 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. 2011. Sea turtles, dolphins, and whales and the Gulf of Mexico oil spill. Turtles documented by species current as of February 15, 2011.
<<http://www.nmfs.noaa.gov/pr/health/oilspill.htm>>
- NMFS-SEFSC. 2001. Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the Western North Atlantic. NOAA Technical Memorandum, NMFS-SEFSC-455. 226 pp.
- NMFS-SEFSC. 2009. An assessment of loggerhead sea turtles to estimate impacts of mortality reductions on population dynamics. NMFS SEFSC Contribution PRD-08/09-14. 45 pp.
- NMFS-SEFSC. 2010. Data analysis request: Update of turtle bycatch in the Gulf of Mexico and southeastern Atlantic shrimp fisheries. Memorandum dated December 22, 2010. National Marine Fisheries Service. Southeast Fisheries Science Center, Miami, FL.
- NMFS and 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 the Kemps' Ridley Sea Turtle. National Marine Fisheries Service, Washington, D.C. 40pp.
- NMFS and USFWS. 1995. Status reviews for sea turtles listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland.
- NMFS and USFWS. 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. Green sea turtle (*Chelonia mydas*) 5-year review: summary and evaluation. Washington, D.C.
- NMFS and USFWS. 2007b. Hawksbill sea turtle (*Eretmochelys imbricata*). 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.
- NMFS and USFWS. 2009. Loggerhead sea turtle (*Caretta caretta*) 2009 status review under the U.S. Endangered Species Act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service. Silver Spring, MD. 222 pp.
- NMFS and USFWS. 2010. Draft Bi- National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*), Second Revision. National Marine Fisheries Service. Silver Spring, MD.
- Norman, J.R. and F.C. Fraser. 1937. Giant fishes, whales and dolphins. Putman and Company, Limited., London.
- 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.
- 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.
- Ong, T. L., J. Stabile, I. I. Wirgin, and J. R. Waldman. 1996. Genetic divergence between *Acipenser oxyrinchus oxyrinchus* and *A. o. desotoi* as assessed by mitochondrial DNA sequencing analysis. *Copeia* (2): 464-469.
- 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. T., (Ed). 1995. National Marine Fisheries Service and the U.S. Fish and Wildlife Service Status Reviews for Sea Turtles Listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland.
- Plotkin, P. 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.
- Pritchard, P. C. H. 1969. Endangered species: Kemp's ridley turtle. *Florida Naturalist* 49: 12-19.
- Pritchard, P.C.H. 1971. The leatherback or leathery turtle, *Dermochelys coriacea*. IUCN Monograph 1:1-39.
- Pritchard, P.C.H. 1982. Nesting of the leatherback turtle, *Dermochelys coriacea* in Pacific Mexico, with a new estimate of the world population status. *Copeia* 1982(4):741-747.
- Pritchard, P.C.H., 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
- 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.

- Rhodin, A.G.J. 1985. Comparative chondro-osseous development and growth of marine turtles. *Copeia* 1985(3):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.
- Romero, L.M. 2004. Physiological stress in ecology: lessons from biomedical research. *Trends in Ecology and Evolution*, 19: 249-255.
- Ross, J.P. 2005. Hurricane effects on nesting *Caretta caretta*. *Mar Turtle News*. 108:13-14.
- Ruelle, R. and C. Henry. 1992. Organochlorine compounds in pallid sturgeon. *Contaminant Information Bulletin*, June, 1992.
- Ruelle, R. and K. D. Keenlyne. 1993. Contaminants in Missouri River pallid sturgeon. *Bulletin of Environmental Contamination and Toxicology* 50: 898-906.
- Ryder, J. A. 1888. The sturgeon and sturgeon industries of the eastern U.S., with an account of experiments bearing on sturgeon culture. *Bulletin of the U.S. Fisheries Commission*, 1888. p 231-281.
- 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.
- 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.
- 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. and W.N. Witzell. 1997. Age and growth of wild Kemp's ridley turtles (*Lepidochelys kempii*): cumulative results of tagging studies in Florida. *Chelonian Conservation and Biology* 2: 532-537.
- Scholz N. L., N. K. Truelove, B. L. French, B. A. Berejikian, T. P. Quinn, E. Casillas and T. K. Collier. 2000. Diazinon disrupts antipredator and homing behaviors in Chinook salmon (*Oncorhynchus tshawytscha*). *Canadian Journal of Fisheries and Aquatic Sciences* 57: 1911-1918.
- Schroeder, B.A., A.M. Foley, and D.A. Bagley. 2003. Nesting patterns, reproductive migrations, and adult foraging areas of loggerhead turtles. Pages 114-124 in Bolten, A.B. and B.E. Witherington (editors). *Loggerhead Sea Turtles*. Smithsonian Books, Washington D.C.
- Schuller, P. and D. L. Peterson. 2006. Population status and spawning movements of Atlantic sturgeon in the Altamaha River, Georgia. Presentation to the 14th American Fisheries Society Southern Division Meeting, San Antonio, February 8-12th, 2006.
- 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.
- Scott, W. B. and E. J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184: 966 pp.
- Secor, D. H. 1995. Chesapeake Bay Atlantic sturgeon: current status and future recovery. Summary of Findings and Recommendations from a Workshop convened 8 November 1994 at Chesapeake Biological Laboratory. Chesapeake Biological Laboratory, Center for Estuarine and Environmental Studies, University of Maryland System, Solomons, Maryland.
- Secor, D. H. 2002. Atlantic sturgeon fisheries and stock abundances during the late nineteenth century. *American Fisheries Society Symposium* 28: 89-98.
- Secor, D. H., and T. E. Gunderson. 1998. Effects of hypoxia and temperature on survival, growth, and respiration of juvenile Atlantic sturgeon, *Acipenser oxyrinchus*. *Fishery Bulletin* 96:603-613.
- 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. Green turtle (*Chelonia mydas*). Red List assessment. <<http://www.iucn-mtsg.org/>>
- 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.
- Shirey, C. A., C. C. Martin, and E. D. Stetzar. 1997. Abundance of sub-adult Atlantic sturgeon and areas of concentration within the lower Delaware River. DE Division of Fish and Wildlife, Dover, DE, USA.
- 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.
- Sindermann, C. J. 1994. Quantitative effects of pollution on marine and anadromous fish populations. NOAA Technical Memorandum NMFS-F/NEC-104, National Marine Fisheries Service, Woods Hole, Massachusetts.
- 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.
- Smith, T. I. J. 1985. The fishery, biology, and management of Atlantic sturgeon, *Acipenser oxyrinchus*, in North America. *Environmental Biology of Fishes* 14(1): 61-72.
- Smith, T. I. J. and J. P. Clugston. 1997. Status and management of Atlantic sturgeon, *Acipenser oxyrinchus*, in North America. *Environmental Biology of Fishes* 48: 335-346.
- Smith, T. I. J., E. K. Dingley, and E.E. Marchette. 1980. Induced spawning and culture of Atlantic sturgeon. *Progressive Fish Culturist* 42: 147-151.
- Smith, T. I. J., D. E. Marchette and R. A. Smiley. 1982. Life history, ecology, culture and management of Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*, Mitchill, in South Carolina. South Carolina Wildlife Marine Resources. Resources Department, Final Report to U.S. Fish and Wildlife Service Project AFS-9. 75 pp.
- 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.
- South Carolina State Climatology Office. 2011. South Carolina Drought Status By County, February 3, 2011. http://www.dnr.sc.gov/climate/sco/Drought/drought_current_info.php. Accessed May 18, 2011.
- 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., 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*. CRC Press. Boca Raton, Florida: 297-341.
- 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.
- Stein, A. B., K. D. Friedland, and M. Sutherland. 2004a. Atlantic sturgeon marine distribution and habitat use along the northeastern coast of the United States. *Transactions of the American Fisheries Society* 133: 527-537.
- Stein, A. B., K. D. Friedland, and M. Sutherland. 2004b. Atlantic sturgeon marine bycatch and mortality on the continental shelf of the Northeast United States. *North American Journal of Fisheries Management* 24: 171-183.
- Stevenson, J. T. 1997. Life history characteristics of Atlantic Sturgeon (*Acipenser oxyrinchus*) in the Hudson River and a model for fishery management. M.S. thesis, Marine Environmental and Estuarine Studies Program, Un. of MD, College Park, MD. 222 pp.
- Stevenson, J. T., and D. H. Secor. 1999. Age determination and growth of Hudson River Atlantic sturgeon, *Acipenser oxyrinchus*. *Fishery Bulletin* 97: 153-166.
- 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.
- 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., and G.O. Marcotrigiano. 2003. Heavy metal residues in tissues of marine turtles. *Marine Pollution Bulletin* 46: 397-400.
- Stoskopf, M. K. 1993. Shark pharmacology and toxicology. Pages 809–816 in M. Stoskopf, editor. *Fish medicine*. Saunders, Philadelphia.
- Taylor, A.H., M.B. Jordan, and J.A. Stephens. 1998. Gulf Stream shifts following ENSO events. *Nature*, 393: 638.
- TEWG. 1998. An assessment of the Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the western North Atlantic. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SEFSC-409, 96 pp.
- TEWG. 2000. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. U.S. Dep. Commer. NOAA Tech. Mem. NMFS-SEFSC-444, 115 pp.
- TEWG. 2007. An assessment of the leatherback turtle population in the Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-555.
- TEWG. 2009. An assessment of the loggerhead turtle population in the western North Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-575. 142 pages. Available at <http://www.sefsc.noaa.gov/seaturtletechmemos.jsp>.
- 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.
- 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.
- USFWS. 1999. South Florida multi-species recovery plan. Atlanta, Georgia. 2172p.
- 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 Eenennaam, J. P., and S. I. Doroshov. 1998. Effects of age and body size on gonadal development of Atlantic sturgeon. Journal of Fish Biology 53: 624-637.
- Van Eenennaam, J. P., S. I. Doroshov, G. P. Moberg, J. G. Watson, D. S. Moore and J. Linares. 1996. Reproductive conditions of the Atlantic sturgeon (*Acipenser oxyrinchus*) in the Hudson River. Estuaries 19: 769-777.

- Van Houton, K.S. and O.L. Bass. 2007. Stormy oceans are associated with declines in sea turtle hatching. *Curr BioI* 17: R590.
- Vladykov, V. D. and J. R. Greely. 1963. Order Acipenseroidei. In: *Fishes of Western North Atlantic*. Sears Foundation. Marine Research, Yale Univ. 630 pp.
- Von Westernhagen, H., H. Rosenthal, V. Dethlefsen, W. Ernst, U. Harms, and P. D. Hansen. 1981. Bioaccumulating substances and reproductive success in Baltic flounder *Platichthys flesus*. *Aquatic Toxicology* 1: 85-99.
- Waldman, J. R., and I. I. Wirgin. 1998. Status and restoration options for Atlantic sturgeon in North America. *Conservation Biology* 12: 631-638.
- Waldman, J. R., J. T. Hart, and I. I. Wirgin. 1996a. Stock composition of the New York Bight Atlantic sturgeon fishery based on analysis of mitochondrial DNA. *Transactions of the American Fisheries Society* 125: 364-371.
- Waldman, J. R., K. Nolan, J. Hart, and I. I. Wirgin. 1996b. Genetic differentiation of three key anadromous fish populations of the Hudson River. *Estuaries* 19: 759-768.
- Waldman, J. R., C. Grunwald, J. Stabile, and I. Wirgin. 2002. Impacts of life history and biogeography on the genetic stock structure of Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus*, Gulf sturgeon *A. oxyrinchus desotoi*, and shortnose sturgeon *A. brevirostrum*. *Journal of Applied Ichthyology* 18: 509-518.
- Waring C. P. and A. Moore. 2004. The effect of atrazine on Atlantic salmon (*Salmo salar*) smolts in fresh water and after sea water transfer. *Aquatic Toxicology* 66:93-104.
- 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.
- Walker, B.G., P.R. Boersma, and J.C. Wingfield. 2006. Habituation of adult Magellanic penguins to human visitation as expressed through behavior and corticosterone secretion. *Conservation Biology*, 20: 146-154.
- Weber, W. and C. A. Jennings. 1996. Endangered species management plan for the shortnose sturgeon, *Acipenser brevirostrum*. Final Report to Port Stewart Military Reservation, Fort Stewart, GA.
- Webster, P.J., G.J. 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.
- 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, 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, S. L. 1988. *Thalassia testudinum* productivity and grazing by green turtles in a highly disturbed seagrass bed. *Marine Biology* 98: 447-455.
- 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.
- Wirgin, I., J. Waldman, J. Stabile, B. Lubinski, and T. King. 2002. Comparison of mitochondrial DNA control region sequence and microsatellite DNA analyses in estimating population structure and gene flow rates in Atlantic sturgeon *Acipenser oxyrinchus*. *Journal of Applied Ichthyology* 18: 313-319.
- 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(1):30-54.
- 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.
- 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.
- 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.
- Young, J. R., T. B. Hoff, W. P. Dey, and J. G. Hoff. 1988. Management recommendations for a Hudson River Atlantic sturgeon fishery based on an age-structured population model. *Fisheries Research in the Hudson River*. State of University of New York Press, Albany, New York. pp. 353.

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