NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7 BIOLOGICAL OPINION

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

Activity Considered: Issuance of a permit to Tasha Metz (Texas A&M University at Galveston, Permit No. 18029)

Consultation Conducted By: Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service

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Director, Office of Protected Resources

Date: ____________________

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TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

AF-annual nesting females
C-Celcius
CFR- Code of Federal Regulations
cm-centimeter
dB-decibel
DDE-dichlorodiphenyldichloroethylene
DDT-dichlorodiphenyltrichloroethane
DPS-Distinct Population Segment
ESA-Endangered Species Act
FP-fibropapillomatosis
kg-kilogram
km-kilometer
m-meter
mm-millimeter
NAO-North Atlantic Oscillation
NMFS-National Marine Fisheries Service
NOAA-National Oceanic and Atmospheric Administration
PCB-polychlorinated biphenyl
PFOA-perfluorooctanoic acid
PFOS-perfluorooctanesulfonic acid
PIT-Passive Integrated Transponder
TED-turtle excluder device
US-United States
USFWS-United States Fish and Wildlife Service

1 INTRODUCTION

Section 7 (a)(2) of the Endangered Species Act (ESA) requires Federal agencies to insure their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. When a Federal agency's action "may affect" a protected species, that agency is required to consult formally with the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) or the United States Fish and Wildlife Service (USFWS), depending on the endangered species (50 Code of Federal Regulations [CFR] §402.14(a)). Federal agencies are exempt from this general requirement if they have concluded that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS or the USFWS concurs with that conclusion (50 CFR §402.14(b)).

Section 7 (b)(3) of the ESA requires that at the conclusion of consultation, NMFS and/or USFWS provide a biological opinion (Opinion) stating how the Federal agencies' actions will affect ESA-listed species and their critical habitat under their jurisdictions. If incidental take is expected, Section 7 (b)(4) requires the consulting agency to provide an incidental take statement that specifies the impact of any incidental taking and includes reasonable and prudent measures to lessen such impacts.

For the actions described in this document, the action agency is the NMFS' Office of Protected Resources-Permits and Conservation Division (Permits Division), which proposes to issue permit 18029 for capture, tagging, and biological sampling of North Atlantic green distinct population segment (DPS), hawksbill, Kemp's ridley, and northwestern Atlantic loggerhead DPS sea turtles in the northwestern and north central Gulf of Mexico. The consulting agency for this proposal is the NMFS Office of Protected Resources-Endangered Species Act Interagency Cooperation Division.

This Opinion and incidental take statement were prepared by NMFS Endangered Species Act Interagency Cooperation Division in accordance with Section 7(b) of the ESA and implementing regulations at 50 CFR §402. This document represents NMFS' opinion on the effects of these actions on endangered and threatened species and critical habitat that has been designated for those species. A complete record of this consultation is on file at NMFS' Office of Protected Resources in Silver Spring, Maryland.

1.1 Consultation history

On March 3, 2014, the NMFS' Permits Division published a notice in the Federal Register soliciting public comment on its intent to issue the proposed permit.

On October 23, 2014, the NMFS' Permits Division provided initial information on the proposed permit and associated actions on the part of the applicant for review by the ESA Interagency Cooperation Division and other reviewers.

On September 1, 2015, the ESA Interagency Cooperation Division received a request for formal consultation from NMFS' Permits Division to authorize Permit 18029 to Tasha Metz (Texas A&M University at Galveston). Information was sufficient to initiate consultation on this date.

On February 26, 2016, the ESA Interagency Cooperation Division met with the Permits Division to discuss mortality and take levels.

On March 15, 2016, the NMFS' Permits Division provided constructive criticism on an analytical framework for the ESA Interagency Cooperation Division's approach to evaluating exposure and take.

On March 16, 2016, the NMFS' Permits Division and the ESA Interagency Cooperation Division met to discuss concerns regarding the analytical approach. These discussions continued over the next several days via email and in-person discussion until March 24, 2016. This resulted in a change in the proposed permit's take level, which constituted an important change in the action. A revised proposed permit was provided to the ESA Interagency Cooperation Division on March 31, 2016.

2 DESCRIPTION OF THE PROPOSED ACTION

The proposed action is the issuance of a scientific research permit (File No. 18029) to Tasha Metz, Texas A&M University at Galveston, pursuant to Section 10(a)(1)(a) of the Endangered Species Act of 1973, as amended (ESA; 16 United States Code 1531 et seq.), to conduct scientific research on North Atlantic DPS green sea turtles (*Chelonia mydas*), hawksbill sea turtles (*Eretmochelys imbricata*), Kemp's ridley sea turtles (*Lepidochelys kempii*), and northwestern Atlantic DPS loggerhead sea turtles (*Caretta caretta*). The purposes of the proposed permit are to fill gaps in our knowledge of sea turtle relative abundance, distribution, habitat use and health status the northwestern Gulf of Mexico, which is necessary for proper management and conservation of these species. This research will utilize in-water capture (via entanglement net, cast net, dip net and hand or rodeo capture) and visual surveys, biological sampling, as well as satellite telemetry of sea turtles in estuarine and nearshore waters off Texas and Louisiana over a 5-year period to document species composition and size structure, status of populations and movements within and between habitats. Table 1 summarizes the actions to which individual sea turtles will be exposed.

The proposed actions include two projects:

- continuation of work started during the Natural Resource Damage Assessment entanglement netting plan by documenting and assessing possible impacts of *Deepwater Horizon* oil and dispersants on sea turtles throughout selected beachfront, tidal pass, and estuarine/bay habitats west of the Mississippi River Delta, and
- continuation of assessing the impact of fibropapilloma virus (FP) infection on recent increases in and continued growth of Texas' green turtle population via directed capture operations.

Table 1. Proposed take of ESA-listed species under permit 18029.

Sea turtle species	Capture/ handling/ restraint	Flipper tag	PIT tagging	Morpho-metrics	Blood collection	Epiphyte sampling	Satellite tagging	Biopsy
Green	260	260	260	260	260	260	30	260
Hawksbill	15	15	15	15	15	15	10	15
Kemp's ridley	160	160	160	160	160	160	50	160
Loggerhead	30	30	30	30	30	30	30	30

2.1 Capture

Sea turtles will be captured in one of several ways: entanglement in gill nets, cast nets, hand/rodeo capture, or dip net.

2.1.1 *Deepwater Horizon* project

Large-mesh entanglement nets will be set in *Deepwater Horizon* oil-impacted and additional areas of the Louisiana and Texas coast to assess possible impact of the *Deepwater Horizon* discharge on sea turtles (Figure 1). Netting sites will be selected randomly from habitats that are 1.2–2.1 meters (m) deep and within 6.4 kilometers (km) of vessel launch points. The ability to set nets at a given location will also depend on water depth, wind and wave action at the site, topology, tides, and other factors that cannot be assessed with accuracy from existing maps. Thus, the feasibility of deploying entanglement nets at each of the random sample locations will be assessed in the field. Sites exposed to winds greater than 20 knots and seas greater than 0.6 m, or with currents strong enough to pull the floatline of the nets underwater will be rejected. Navigation channels will also be excluded due to unfavorable depth and to avoid safety risks.

Figure 1. Boat crew checking nets for captured animals. Photo courtesy of André Landry.

A netting crew consisting of up to eight people and two boats will conduct entanglement netting during April–October. Entanglement nets will be deployed daily at one of the randomly selected locations during daylight periods for up to six consecutive days per study area. Efforts will be made to target nearshore/beachfront and estuarine habitats for three days each during the six consecutive days of sampling. Extra days may be scheduled for each study area in case unfavorable weather conditions prevent sampling on other days and also to repair nets for reuse at the second study area. Large-mesh, entanglement nets (91.4 m long and 2.5 m to 4.0 m deep, with 17.7 centimeters (cm) bar mesh of number 9 twisted nylon) will be deployed within 5 km of shore at the randomly-selected sample locations where feasible, for a minimum soak time duration of 6-12 hours per day.

Entanglement nets have a leadline that weighs roughly 13.6 kilograms (kg)/m of net and the nets are deployed in waters that are shallower than the maximum depth of the net so the nets would span the entire water column from surface to bottom. The net is also attached to anchors on either end to keep it from drifting, and buoys are attached to the floatline at the surface to make it visible to observers. Netting effort at all locations will consist of 2-4 nets at each site, set in pairs (i.e., two nets hooked together) and set in-line or perpendicular to each other with about 50 m between each pair of nets. Two vessels, with one boat checking each pair of nets (182.8 m of net), will be used to check the nets every 20 minutes, or more frequently, as splashes or other signs of potential capture dictate, in order to minimize drowning risk to turtles while entangled. Crews will be experienced in dealing with incidental captures, and will remove any captured animals from nets as soon as possible. Based on net mesh size, the minimum size of sea turtle to be captured by this project is 15 cm straight carapace length.

Entanglement netting is the best method for sea turtle capture in these two projects based on the applicant's extensive experience capturing turtles by this method in Texas and Louisiana waters. Strike netting is not a viable option for turtle capture at these netting locations due to water visibilities being on average less than 1 m depth, making the sighting turtles for strike netting considerably more difficult. However, if turtles are seen at the surface, they may be captured from the vessel by alternative methods, including dip net (61 cm hoop diameter, 76.2 cm deep, 1.5 m handle length and 2.2 cm bar-mesh); cast net (1.1–1.2 m diameter, 1.2–1.4 kg weight, and 1 cm bar-mesh); or by hand. These alternative methods may also be used when a tracked individual is located at the surface and can be recaptured.

Hydrographic data including water temperature, salinity, conductivity, dissolved oxygen content, depth, turbidity, and tidal flow, as well as other environmental parameters (air temperature, wind speed, sea state, cloud cover, etc.) will be taken three times daily. A Yellow Springs Instruments meter will be used to collect these hydrographic data.

2.1.2 Fibropapilloma virus project

The same entanglement net methods will be used for the FP project as for the *Deepwater Horizon* project. However, sea turtle use of jettied and tidal pass habitats in south Texas will also be undertaken that will require other methods to capture sea turtles.

Cast netting will largely be used in capturing green sea turtles in the Laguna Madre. Researchers will cast a two-meter-wide net onto small, post-pelagic green sea turtles as they surface to breathe from jetties along Brazos Santiago Pass (South Padre Island) and Mansfield Channel (Port Mansfield). Entanglement netting is not possible at these locations. Captured turtles will be immediately retrieved from the water and brought ashore for processing. Attempts to capture jetty turtles with cast-nets, dip nets, or by hand (rodeo) will be made concurrent to or immediately following visual surveys. These capture methods are most effective when turtles surface frequently, spend extended time (greater than 30 seconds) at the surface, and are within 5 m of the jetty. Capture of turtles by cast net (1.1–1.2 m diameter, 1.2–1.4 kg) will involve standing on the jetty and tossing the net at turtles on or near the surface of the water and removing the turtle from the net as quickly as possible. Turtles may be captured by hand or dip net (61 cm hoop diameter, 76.2 cm deep, 1.5 m handle length, and 2.2 cm bar-mesh) when turtles are within arm's reach of the jetty or close enough to the jetty to be scooped by the dip net (within 1.5 m of the jetty).

2.2 Handling, restraint, and release

Biopsy procedures will differ between the *Deepwater Horizon* and FP projects based primarily upon the greater potential for FP transmission in the later project than in the former.

2.2.1 *Deepwater Horizon* project

Immediately upon capture, all sea turtles will be visually inspected for any external abnormalities and overall health condition. Captured turtles will then be placed in a shaded holding area on the research vessel and kept moist either in a size-appropriate, water-filled container (about 1 m long by 0.5 m wide by 0.5 m high) or covered with wet towels if too large to fit in a container. Most sea turtle processing procedures will be conducted at the end of the netting day, once nets have been retrieved, in order to maintain vigilance to respond to any other animals captured in the nets and to prevent possible immediate recapture of a turtle if it is released while nets are still deployed. Depending on field conditions, turtles may be temporarily transported to shore to perform data collection procedures including measuring, application of flipper, passive integrated transponder (PIT) and satellite tags, and collection of tissue samples. Although some of these procedures may be performed on the boat (such as measuring), conducting tissue sampling and tag application activities on shore provides for a more stable work platform to minimize injury to the turtles and crew (as opposed to working on a pitching/rolling boat). A 12-hour maximum holding time is possible. Additionally, some shore-based procedures (such as satellite tag attachment) may take as long as 3 hours to complete. Turtles will be constantly monitored and attended to throughout the holding period until release.

All sea turtles deemed healthy will be released at their respective capture locations within 12 hours of capture. If the health status of a captured sea turtle cannot be determined by field personnel, personnel will consult with staff at the closest rehabilitation facility to determine whether or not to send the turtle for rehabilitation. Any sea turtles exhibiting significant injuries needing medical attention as determined by the on-call vet will be transferred to the closest rehabilitation facility (Audubon Aquarium of the Americas in Louisiana, via coordination and cooperation the Louisiana Department of Wildlife and Fisheries and Aquarium staff, or the NOAA Galveston Lab Sea Turtle Facility in Texas).

2.2.2 Fibropapilloma virus project

Turtles captured at the jetties will be processed in the same manner described for those taken in entanglement nets (inspection for tumors, morphometrics, tags, etc.), plus they may receive a painted number (using non-toxic white window paint) on their carapace for possible re-sighting identification during subsequent visual surveys. As mentioned in the *Deepwater Horizon* project, most sea turtle processing procedures will be conducted at the end of the entanglement netting day, once nets have been retrieved, in order to maintain vigilance to respond to any other animals captured in the nets and to prevent possible immediate recapture of a turtle.

Upon removal from a net, each turtle will be immediately inspected for the presence of external tumors and, where possible, tumors within the oral cavity. Captured turtles will then be placed in separate, shaded holding areas or individual containers (about 1 m long x 0.5 m wide x 0.5 m high) on the research vessel and kept moist either with water in the container or covered with wet towels. Individual turtles with and without tumors be assigned with "FP" and "No FP" designations, respectively. Turtles displaying FP will be examined in detail for number, location, and size range of tumors, followed by photographs of these tumors and their location.

2.3 Flipper and internal tagging

The same procedures apply for the *Deepwater Horizon* project as for the FP project. Where appropriate (i.e. for healthy turtles that have not previously been tagged), Inconel-style 681 flipper tags (issued by Archie Carr Center for Sea Turtle Research at the University of Florida in Gainesville) and unencrypted 125 or 134 kiloHertz PIT tags will be applied to turtles that have not received them previously. The insertion sites for the Inconel-style flipper and PIT tags will be disinfected using alcohol swabs, with the Inconel-style tags pierced through the trailing edge of each front flipper using tag crimpers and a PIT tag inserted subcutaneously into the dorsal musculature of one front flipper via pre-sterilized needles. Antibiotic ointment, such as Neosporin®, will be applied to the tag insertion sites thereafter. Fecal samples may also be collected if the turtle naturally defecates while in captivity in order to ascertain diet or observe any abnormalities.

2.4 Morphometrics

The same procedures apply for the *Deepwater Horizon* project as for the FP project. All captured sea turtles will be photographed, weighed, and measured for standard carapace length and curved carapace length, visually inspected for flipper and living tags (the latter distinguishes Headstart individuals), and electronically scanned for PIT and metal-wire tags as a means of detecting individuals that have been previously tagged. When possible, turtles also will be weighed for total biomass by either securely wrapping smaller turtles (15-45 cm standard carapace length) in a net and suspending it from a hanging digital scale or by placing larger turtles (less than 45 cm standard carapace length) on a platform scale. Turtles may also receive a temporary marking on the carapace to identify order of capture.

2.5 Blood sampling

The same procedures apply for the *Deepwater Horizon* project as for the FP project. Blood will be drawn from the dorsal cervical sinus utilizing standard sampling practices that include aseptic procedures (gloves and disinfection of collection site) to prevent cross-contamination of turtles and samples (Owens and Ruiz 1980). The turtle will be gently restrained by hand and the neck outstretched at a lower plane from the carapace to allow the sinuses to fill with blood. The skin of the neck will be disinfected with an alcohol swab and the needle will then be inserted in a perpendicular direction on the outside edge of the tendons that run parallel to the vertebral column. Blood will be collected through a double-ended needle directly into a vacutainer (either heparinized or uncoated).

2.6 Biopsy

Biopsy procedures will differ between the *Deepwater Horizon* and FP projects based primarily upon the greater potential for FP transmission in the later project than in the former.

2.6.1 *Deepwater Horizon* project

Skin and tissue biopsies may also be taken from a rear flipper as an alternative to blood for genetic analyses. These samples will also be collected using aseptic procedures (gloves and disinfection of collection site) to prevent cross-contamination of turtles and samples. The surface of the skin or tissue will be wiped down using alcohol prep pads to disinfect the sample site and remove as much algae, mud, and epiphytes as possible before biopsy sampling is conducted. A sterile 3- to 5-millimeter (mm) biopsy punch (designed for collecting epidermis samples from humans) will be used to collect one skin sample to the depth of the biopsy punch (metal cap). The edge of the punch will be used like a scalpel to sever the tissue, if necessary. The punched area will be wiped with 10% povidone-iodine or over-the-counter antibiotic ointment, such as Neosporin®, to prevent chance of infection. If necessary, a tissue glue, such as Vet-Bond or an over-the-counter tissue glue surrogate such as Super-Glue® or Krazy-Glue®, will be used for hemostasis. The biopsy punch will then be discarded, so as not to use the same punch on more than one turtle. Samples from each turtle will be placed in a vial of 70% ethanol and labeled with tag number, capture date and capture location and stored at room temperature.

Scute scrapings may also be collected as a less invasive procedure for toxicological assessment. A 10 cm by 10 cm swab will be rubbed on the outside of the carapace 3 cm posterior to the head using fiberglass or cotton mesh gauze.

2.6.2 Fibropapilloma virus project

Tumors found on captured green turtles will be sampled utilizing the same biopsy method described for skin samples taken for the *Deepwater Horizon* project. Only one tumor per turtle will be sampled, unless differing appearance of some tumors warrants additional samples.

2.7 Epiphyte sampling

The same procedures apply for the *Deepwater Horizon* project as for the FP project. Epibiotic organisms, such as barnacles and algae, will be removed from turtles during processing procedures.

2.8 Satellite tagging

Satellite tagging will be conducted differently for the Deepwater Horizon and FP projects. Although the general framework of attachment will be the same, details will vary between the projects.

2.8.1 *Deepwater Horizon* project

Turtles that are considered healthy and releasable will be deemed candidates to receive a satellite transmitter. As specified by the NOAA permit requirements, transmitters will not exceed 5% of the turtle's body weight. However, field teams conducting this study will attempt to have tags not exceed 3% of the turtle's body weight. Kemp's ridley, loggerhead, and green turtles (juvenile through adult life stages) captured during the entanglement netting surveys may be fitted with Sirtrack KiwiSat 202 tags or Wildlife Computers' Fastloc geographic positioning system tags (130 g 2xAA Back Mount MK10-AF type, http://www.wildlifecomputers.com/products.aspx?ID=4)(Figure 2 and Figure 3).

Figure 2. Sanding scutes prior to satellite tag attachment. Photo courtesy of André Landry.

Figure 3. Satellite tag attached to captured sea turtle. Photo courtesy of André Landry.

Satellite tags will be attached to turtles greater than 40 cm standard carapace length following the techniques employed by Seney et al. (2010). The method utilizes a two-part liquid epoxy to glue the tag to surface of the carapace. Although some heat is generated during the epoxy curing process, this heat is not excessive or harmful to the turtle and dissipates quickly (www.seaturtle.org/tracking). This epoxy is then overlaid with an epoxy putty to create a more hydrodynamic surface. The tag and epoxy is also covered with two coats of anti-fouling paint to prevent the growth of algae and barnacles which could interfere with tag operation. This method is designed to allow the tag to eventually detach as scute material sloughs off of the carapace as the turtle grows. The neoprene attachment method also developed by Seney et al. (2010) will be utilized to attach satellite tags to turtles 30-40 cm in standard carapace length. This method uses a piece of 1.5 mm neoprene (oval-shaped and sized according to turtle size), which is glued to the carapace between the first and second vertebral scutes using the same two-part liquid epoxy mentioned above, taking care not to allow the glue to cover the suture lines between scutes (blue automotive silicone may be used to cover the sutures). The satellite tag is then glued to the neoprene using the same liquid two-part epoxy. The tag, epoxy, and neoprene is then covered in anti-fouling paint to prevent the growth of algae and barnacles. This attachment method is designed to allow the attachment to expand with the more rapid growth of juvenile turtles before the tag is shed when scutes slough off of the carapace. Depending on availability of tags and the number of turtles captured, up to 30 tags will be deployed each year across species and study areas. Tags will be deployed on a first-caught, first-tagged basis, although attempts will be made to evenly distribute the tags among species and study areas (roughly two tags per species per study area each year). This number and distribution of tags allows for statistical comparison of tracks within and between study areas for each species. Barring any equipment failure or turtle death, tagged turtles will be tracked for a minimum of 6-12 months during which time movement and behavior may be characterized via geographic integrated system spatial analyses of track data as a function of the past extent of *Deepwater Horizon* oil in the environment.

2.8.2 Fibropapilloma virus project

Green turtles greater than 40 cm in standard carapace length may also be equipped with satellite transmitters. As such, six FP-infected, green turtles, two from each of the lower, middle and upper coast study areas (when and if FP turtles are found in middle and upper coastal sites), will be equipped with a Sirtrack KiwiSat 202 satellite transmitter and released at their original capture site. Transmitters will be attached via the epoxy method described in the *Deepwater Horizon* project for turtles greater than 40 cm standard carapace length, will not exceed 2-3% of a turtle's body weight, and will provide temperature and depth data in addition to location (Seney and Landry 2008). All sea turtles deemed healthy will be released at their respective capture locations within 24 hours of capture.

2.9 NMFS Permits Division’s permit conditions

The following information outlines the main mitigation measures researchers would employ to minimize the potential for any adverse impacts to the target species (green, Kemp’s ridley, hawksbill, and loggerhead sea turtles). The research project is designed to minimize the potential of any stress, pain, or suffering as well as unintentional effects. All the investigators and personnel involved are experienced in capturing sea turtles and would undertake the following precautions. The following specific research conditions are placed on the research to ensure compliance with appropriate research protocols:

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

2. Accidental mortality of authorized sea turtles: If a turtle is seriously injured or dies during sampling, the applicant must cease research immediately and notify the Chief, Permits and Conservation Division by phone (301-427-8401) as soon as possible, but no later than two days following the event. The incident report must include a complete description of the events and identification of steps that will be taken to reduce the potential for additional serious injury and research-related mortality or exceedance of authorized take. The applicant must submit a written report describing the circumstances surrounding the event. The Permit Holder must send this report to the Chief, Permits and Conservation Division, F/PR1, 1315 East-West Highway, Silver Spring, Maryland 20910. Pending review of these circumstances, NMFS may suspend authorization of research activities or amend the permit in order to allow research activities to continue.

3. The applicant is responsible for following the status of any sea turtle transported to rehabilitation as a result of permitted activities and reporting the final disposition (death,

permanent injury, recovery and return to wild, etc.) of the animal to the Chief, Permits Division.

4. An annual report would be submitted and reviewed by NMFS for each year the permit is valid. In addition to an account of actual 'take' that occurred, the reports would include a narrative description of activities and effects. Research results must be published or otherwise made available to the scientific community in a reasonable period of time. Copies of technical reports, conference abstracts, papers, or publications resulting from permitted research must be submitted the Permits Division.

5. If an animal becomes highly stressed, injured, or comatose during capture or handling or is found to be compromised upon capture, researchers must forego or cease activities that will further significantly stress the animal (erring on the side of caution) and contact the on call medical personnel as soon as possible. Compromised turtles include animals that are obviously weak, lethargic, positively buoyant, emaciated, or that have severe injuries or other abnormalities resulting in debilitation. One of the following options must be implemented (in order of preference):

    - Based on the instructions of the veterinarian, if necessary, immediately transfer the animal to the veterinarian or to a rehabilitation facility to receive veterinary care.

    - If medical personnel cannot be reached at sea, the applicant should err on the side of caution and bring the animal to shore for medical evaluation and rehabilitation as soon as possible.

    - If the animal cannot be taken to a rehabilitation center due to logistical or safety constraints, allow it to recuperate as conditions dictate, and return the animal to the sea.

6. When handling and/or tagging turtles, researchers would use the following procedures:

    - Clean and disinfect all equipment (tagging equipment, tape measures, etc.) and surfaces that comes in contact with sea turtles between the processing of each turtle, and

    - Maintain a separate set of sampling equipment for handling animals displaying FP tumors and/or lesions. Equipment that comes in contact with the turtle must be cleaned and disinfected between the processing of each turtle. All measures possible should be exercised to minimize exposure and cross-contamination between affected turtles and those without apparent disease, including use of disposable gloves and thorough disinfection of equipment and surfaces. Appropriate disinfectants include 10% bleach and other viricidal solutions with proven efficacy against herpes viruses.

7. All turtles shall be examined for existing tags, including PIT tags, before attaching or inserting new ones. If existing tags are found, the tag identification numbers must be recorded. Researchers must have PIT tag readers capable of reading 125, 128, 134.2, and

400 kiloHertz tags. Use new, sterile tag applicators (needles). The application site must be cleaned and then scrubbed with a disinfectant (e.g., Betadine, Chlorhexidine) followed by 70% isopropyl alcohol before the applicator pierces the animal's skin. If it has been exposed to fluids from another animal, the injector handle must be disinfected between animals.

8. Flipper tagging with metal tags. All tags (e.g., oil residue) as well as tag applicators (including the tag injector handle) shall be cleaned and disinfected between sea turtles before being used. The application site must also be cleaned and disinfected before the tag pierces the animal's skin.

    - For turtles 15-30 cm in standard carapace length, researchers must have specialized experience in tagging turtles less than 30 cm to tag turtles under this permit.

    - PIT tags must be inserted into the thickest part of the triceps superficialis muscle. The tag must occupy no more than an estimated 20% of the muscle's total volume and length. Alternative sites may be used provided: 1) there is sufficient mass to accommodate the tag (less than 20%) and 2) there is minimal risk of injury to vital structures or other anatomical features.

    - Local anesthetic (e.g., lidocaine) must be used.

9. Researchers must use non-toxic paints that do not generate heat or contain xylene or toluene for carapace painting. Markings should be easily legible using the least amount of paint necessary to re-identify the animal.

10. Netting special conditions

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

    - Highly visible buoys shall be attached to the float line of each net such that they are spaced at an interval of every 10 yards or less.

    - Nets must be checked at least every 30 minutes, and more frequently whenever turtles or other bycatch organisms are observed in the net. If water temperatures are less than 10^{o} Celsius (C) or greater than 30^{o} C, nets must be checked at less than 20-minute intervals. "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. The float line of all nets shall be observed at all times for movements that indicate an animal has encountered the net. When this occurs the net must be immediately checked.

    - Researchers must plan for unexpected circumstances or demands of the research activities and have the ability and resources to meet net checking requirements at all times (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).

- Nets used at sites where FP is known to occur must be thoroughly disinfected prior to use in areas where FP is either not known to be present, is considered uncommon, or where there is limited or no information on FP prevalence. Drying nets in sunlight may be used as an additional measure to inactivate FP-associated herpes virus.

11. Blood sampling:

- Blood samples must be taken or supervised by experienced personnel.

- New disposable needles must be used on each animal.

- Collection sites must be thoroughly cleaned prior to sampling using Chlorhexidine-alcohol solution or betadine followed by 70% alcohol. Two applications of alcohol may be used if disinfectant solutions may affect intended analyses.

- If an animal cannot be adequately immobilized for blood sampling or conditions on the boat preclude the safety and health of the turtle, samples must not be taken.

- Attempts (needle insertions) to extract blood from the neck must be limited to a total of four, two on either side. Best practices must be followed, including retraction of the needle to the level of the subcutis prior to redirection to avoid lacerating vessels and causing other unnecessary soft tissue injury.

- A single sample must not exceed 3 milliliter per 1 kg of animal.

- For sea turtles weighing 1 kg or less, a single sample must not exceed 6% of total blood volume. Total blood volume is estimated as 7% of total body weight. If additional samples are to be taken in less than two months on the same turtle, sample size must not exceed 3 millimeters/kg of turtle.

- Sampling period. Within a 45-day period of time, the cumulative blood volume taken from a single turtle must not exceed the maximum safe limit described above. If more than 50% of the maximum safe limit is taken, in a single event or cumulatively from repeat sampling events, from a single turtle within a 45-day period that turtle must not be re-sampled for 3 months from the last blood sampling event.

- Research coordination. Researchers must, to the maximum extent practicable, attempt to determine if any of the turtles they blood sample may have been sampled within the past 3 months or would be sampled within the next 3 months by other researchers. The applicant must contact the other researchers working in the area that could capture the same turtles to ensure that none of the above limits are exceeded.

12. Biopsy (tissue-skin) sampling:

    - A new biopsy punch must be used on each turtle.

    - Sterile techniques must be used at all times. Samples must be collected from the trailing edge of a flipper if possible and practical (preference should be given to a rear flipper if practical). The tissue surface must be thoroughly swabbed once with (*e.g.,* Betadine, Chlorhexidine) followed by alcohol before sampling. The procedure area and researcher hands must be clean.

    - If it can be easily determined (through markings, tag number, etc.) that a sea turtle has been recaptured and has been already sampled under this permit, no additional biopsy samples may be collected from the animal over the permit year.

13. Satellite tagging:

    - Adequate ventilation around the head of the turtle must be provided during the attachment of satellite tags or attachment of transmitters if attachment materials produce fumes. To prevent skin or eye contact with harmful chemicals used to apply tags, turtles must not be held in water during the application process.

    - Total combined weight of all transmitter attachments must not exceed 5% of the animal's body mass. No more than one telemetry tag may be attached at one time.

    - Each attachment must be made so that there is no risk of entanglement. The transmitter attachment must either contain a weak link (where appropriate) or have no gap between the transmitter and the turtle that could result in entanglement. The lanyard length (if used) must be less than 1/2 of the carapace length of the turtle. It must include a corrodible, breakaway link that will release the unit after its battery life.

    - Transmitters must not be placed at the peak height of the carapace.

    - Researchers must make attachments as hydrodynamic as possible.

14. Animals must be released back in the water no more than 12 hours after capture.

15. General handling and releasing of turtles: The researchers must use care when handling live animals to minimize any possible injury. When possible, transfer injured, compromised, or comatose animals to rehabilitation facilities and allow them an appropriate period of recovery before return to the wild An experienced veterinarian, veterinary technician, or rehabilitation facility must on call for emergencies. All turtles must be handled according to procedures specified in 50 CFR 223.206(d)(1)(i).

16. If an animal becomes highly stressed, injured, or comatose during capture or handling or is found to be compromised upon capture, researchers must forego or cease activities that will further significantly stress the animal (erring on the side of caution) and contact the on call medical personnel as soon as possible. Compromised turtles include animals that are obviously weak, lethargic, positively buoyant, emaciated, or that have severe injuries or other abnormalities resulting in debilitation. One of the following options must be implemented (in order of preference):

    - Based on the instructions of the veterinarian, if necessary, immediately transfer the animal to the veterinarian or to a rehabilitation facility to receive veterinary care.

    - If medical personnel cannot be reached at sea, the applicant should err on the side of caution and bring the animal to shore for medical evaluation and rehabilitation as soon as possible.

    - If the animal cannot be taken to a rehabilitation center due to logistical or safety constraints, allow it to recuperate as conditions dictate, and return the animal to the sea.

17. Turtles are to be protected from temperature extremes of heat and cold, and kept moist during sampling. The turtle would be provided adequate air flow. The area surrounding the turtle may not contain any materials that could be accidentally ingested.

18. During release, turtles shall be lowered as close to the water's surface as possible, to prevent potential injuries. Researchers must carefully monitor newly released turtles' apparent ability to swim and dive in a normal manner. If a turtle is not behaving normally within one hour of release, the turtle must be recaptured and taken to a rehabilitation facility.

2.10 Action area

Action area means all areas affected directly, or indirectly, by the Federal action, and not just the immediate area involved in the action (50 CFR 402.02). The research under proposed permit 18029 will take place in estuaries, bays, and nearshore waters of the Gulf of Mexico from South Texas to Louisiana west of the Mississippi River (Figure 4). These include two distinct study areas.

For the *Deepwater Horizon* study, large-mesh entanglement nets will be set in oil-impacted and additional areas of the Louisiana and Texas coast including inshore and beachfront waters near the lower Laguna Madre, Texas, Corpus Christi Bay, Texas, Matagorda Bay, Texas, Galveston Bay, Texas, Sabine Pass/Lake, Texas, Calcasieu Pass/Lake, Louisiana, Vermilion Bay, Louisiana, Terrebone Bay, Louisiana, and Barataria Bay, Louisiana. Establishing a study site at Grand Isle will provide access to Barataria and Caminada Passes that serve as ingress and egress points to and from Barataria and Caminada Bays, which are known to have been impacted by *Deepwater Horizon* oil.

In-water assessments characterizing the geographical extent of FP will be conducted at historical netting sites within lower, middle and upper Texas bay systems, namely the lower Laguna Madre, Aransas Bay Complex, and Lavaca-Matagorda Bay. Week-long sampling events will be conducted (7-8 field days) at each of the aforementioned study areas in April-May (spring) and August (summer) annually. The August characterization will take advantage of greatest potential for green turtle abundance, peak foraging activity, highest habitat diversity/health, and ontogenetic-related recruitment shifts, during which time constituents are supposedly exposed to an FP variant.

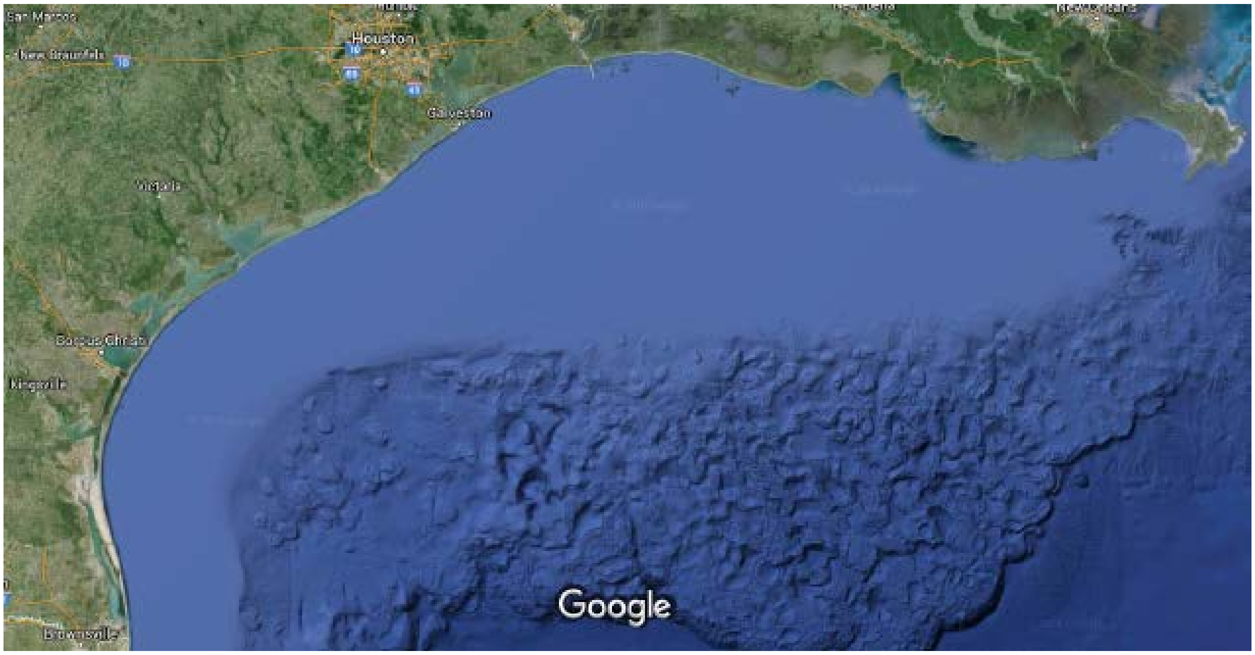

Figure 4. The northwestern Gulf of Mexico, including the various bay and estuary systems of the action area.

2.11 Interrelated and interdependent actions

Interrelated actions are those that are part of a larger action and depend on that action for their justification. *Interdependent* actions are those that do not have independent use, apart from the action under consideration. For permit 18029, we did not identify any interrelated or interdependent actions.

3 OVERVIEW OF NMFS' ASSESSMENT FRAMEWORK

Section 7 (a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to insure their actions either are not likely to jeopardize the continued existence of endangered or threatened species; or adversely modify or destroy their designated critical habitat.

"To jeopardize the continued existence of an ESA-listed species" means to engage in an action that reasonably will be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02). The jeopardy analysis considers both survival and recovery of the species.

Section 7 assessment involves the following steps:

1) We identify the proposed action and those aspects (or stressors) of the proposed action that are likely to have direct or indirect effects on the physical, chemical, and biotic environment within the action area, including the spatial and temporal extent of those stressors.

2) We identify the ESA-listed species and designated critical habitat that are likely to co-occur with those stressors in space and time.

3) We describe the environmental baseline in the action area including: past and present impacts of Federal, state, or private actions and other human activities in the action area; anticipated impacts of proposed Federal projects that have already undergone formal or early Section 7 consultation, impacts of state or private actions that are contemporaneous with the consultation in process.

4) We identify the number, age (or life stage), and gender of ESA-listed individuals that are likely to be exposed to the stressors and the populations or subpopulations to which those individuals belong. This is our exposure analysis.

5) We evaluate the available evidence to determine how those ESA-listed species are likely to respond given their probable exposure. This is our response analyses.

6) We assess the consequences of these responses to the individuals that have been exposed, the populations those individuals represent, and the species those populations comprise. This is our risk analysis.

7) The adverse modification analysis considers the impacts of the proposed action on the critical habitat features and conservation value of designated critical habitat. This opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we relied upon a new regulatory definition that defines destruction or adverse modification as "a direct or indirect alteration that appreciably diminishes the

value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features." (81 FR 7214). For designated critical habitat, we assess the consequences of responses given exposure on the value of the critical habitat for the conservation of the species for which the habitat has been designated.

8) We describe any cumulative effects of the proposed action in the action area. Cumulative effects, as defined in our implementing regulations (50 CFR §402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate Section 7 consultation.

9) We integrate and synthesize factors one through nine by considering the effects of the action to the environmental baseline and the cumulative effects to determine whether the action could reasonably be expected to:

   a) Reduce appreciably the likelihood of both survival and recovery of the ESA-listed species in the wild by reducing its numbers, reproduction, or distribution; or

   b) Reduce the conservation value of designated critical habitat. These assessments are made in full consideration of the status of the species and critical habitat.

10) We state our conclusions regarding jeopardy and the destruction or adverse modification of critical habitat.

If, in completing the last step in the analysis, we determine the action under consultation is likely to jeopardize the continued existence of ESA-listed species or destroy or adversely modify designated critical habitat, we must identify a reasonable and prudent alternative to the action. The reasonable and prudent alternative must not be likely to jeopardize the continued existence of ESA-listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements.

To conduct these analyses, we rely on all the best scientific and commercial evidence available to us. This evidence consists of:

- The application submitted by the Dr. Metz to the Permit's Division
- Monitoring reports submitted for past research
- Reports from NMFS Science Centers
- Reports prepared by natural resource agencies in states and other countries
- Reports from nongovernmental organizations involved in marine conservation issues

- The information provided by NMFS’ Permits Division when it initiated formal consultation
- The general scientific literature
- Our expert opinion

To conduct these analyses, we rely on the best scientific and commercial evidence available to us. This evidence consists of the application submitted by the Permit’s Division, monitoring reports of past research, reports from NMFS Science Centers; reports prepared by natural resource agencies in states and other countries, reports from non-governmental organizations involved in marine conservation issues, the information provided by NMFS’ Permits and Conservation Division when it initiated formal consultation, the general scientific literature, and our expert opinion. We also referred to an internal electronic library that represents a major repository on the biology of ESA-listed species under the NMFS’ jurisdiction.

We supplemented these searches with electronic searches of doctoral dissertations and master’s theses. These searches specifically tried to identify data or other information that supports a particular conclusion (for example, a study that suggests whales will exhibit a particular response to biopsy or capture techniques) as well as data that do not support that conclusion. When data are equivocal or when faced with substantial uncertainty, our decisions are designed to avoid the risks of incorrectly concluding that an action will not have an adverse effect on listed species when, in fact, such adverse effects are likely (i.e., Type II error).

4 STATUS OF ESA-LISTED SPECIES

This section identifies the ESA-listed species that potentially occur within the action area that may be affected by permit 18029 (Table 2). It then summarizes the biology and ecology of those species that is pertinent to this consultation and what is known about species' life histories in the action area. The species potentially occurring within the action area are ESA-listed in Table 2, with their regulatory status. This does not include species that we do not expect will be affected by the action.

Table 2. Threatened, and endangered species that may be affected by the Permit Division's proposed permit 18029.

Species	ESA Status	Critical Habitat	Recovery Plan
Green sea turtle (*Chelonia mydas*): Florida breeding population	Threatened E – 43 FR 32800	-- --	NOAA website
Green sea turtle (*Chelonia mydas*): North Atlantic DPS	Threatened E – 80 FR 15271		
Hawksbill sea turtle (*Eretmochelys imbricata*)	Endangered E - 35 FR 8491	-- --	57 FR 38818
Kemp's ridley sea turtle (*Lepidochelys kempii*)	Endangered E – 35 FR 18319	-- --	56 FR 38424
Loggerhead sea turtle (*Caretta caretta*): Northwest Atlantic DPS	Threatened E – 76 FR 58868	78 FR 43005	74 FR 2995

4.1 ESA-listed species and critical habitat not likely to be adversely affected

NMFS uses two criteria to identify the ESA-listed species or critical habitat that are not likely to be adversely affected by the proposed action, as well as the effects of activities that are interrelated to or interdependent with the Federal agency's proposed action. The first criterion is exposure, or some reasonable expectation of a co-occurrence, between one or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If we conclude that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, we must also conclude the species or critical habitat is not likely to be adversely affected by those activities.

The second criterion is the probability of a response given exposure. ESA-listed species or designated critical habitat that is exposed to a potential stressor but is likely to be unaffected by the exposure is also not likely to be adversely affected by the proposed action. We applied these criteria to the ESA-listed species in Table 2 and we summarize our results below.

An action warrants a "may affect, not likely to be adversely affected" finding when its effects are wholly *beneficial*, *insignificant* or *discountable*. *Beneficial* effects have an immediate positive effect without any adverse effects to the species or habitat. Beneficial effects are usually discussed when the project has a clear link to the ESA-listed species or its specific habitat needs and consultation is required because the species may be affected.

Insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen, but will not rise to constituting an adverse effect. That means the ESA-listed species may be expected to be affected, but not harmed or harassed.

Discountable effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that will be an adverse effect if it did impact a listed species), but it is very unlikely to occur.

4.2 Leatherback turtles

Leatherback sea turtles inhabit the waters off the coast of Texas and Louisiana and may therefore be incidentally harassed through net capture (particularly for set nets). However, the researchers under permit 18029 are experienced in turtle surveys, have been conducting the proposed research in the same areas for years, and have yet to encounter a leatherback sea turtle. Based on these data, NMFS believes the probability of this species being exposed to the effects of the research activities to be highly unlikely and the threats posed to this species are discountable. Therefore, the proposed action is not likely to adversely affect leatherback sea turtles and this species will not be considered further in this Opinion.

4.3 Largetooth sawfish

Largetooth sawfish historically occupied waters in the Gulf of Mexico off Texas and Louisiana and therefore have the possibility of being present during research activities. However, sightings of largetooth sawfish in the northwestern Gulf of Mexico are extremely rare and the last reported sighting of the species is decades old. Researchers did not report any sightings of largetooth sawfish in monitoring reports. While the possibility exists that transient fish may enter Texas' and Louisiana'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 largetooth sawfish and this species will not be considered further in this Opinion.

4.4 ESA-listed species and critical habitat likely to be adversely affected

This opinion examines the status of each ESA-listed species (green, Kemp's ridley, hawksbill, and northwestern Atlantic DPS loggerhead sea turtles) that is likely to be affected by the proposed action. The status is determined by the level of risk the ESA-listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The *Status of ESA-Listed Species* section helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02.

One factor affecting the range-wide status of sea turtles, and aquatic habitat at large, is climate change. Although the effects of climate change are ongoing, many of the expected effects are likely to occur years to centuries from now, well beyond when the proposed permits would expire. We primarily discuss climate change as a threat common to all species addressed in this opinion, rather than in each of the species-specific narratives. As we better understand responses to climate change, we address these effects in relevant species-specific sections.

In general, based on forecasts made by the Intergovernmental Panel on Climate Change, climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the near future (IPCC 2002; IPCC 2014). From 1906 to 2006, global surface temperatures have risen 0.74º C and continue at an accelerating pace; 11 of the 12 warmest years on record since 1850 have occurred since 1995 (Poloczanska et al. 2009). Furthermore, the Northern Hemisphere (where a greater proportion of ESA-listed species occur) is warming faster than the Southern Hemisphere, although land temperatures are rising more rapidly than over the oceans (Poloczanska et al. 2009). North Atlantic and Pacific sea surface temperatures have shown trends in being anomalously warm in recent years (Blunden and Arndt 2013). The ocean along the United States (US) eastern seaboard is also much saltier than historical averages (Blunden and Arndt 2013). The direct effects of climate change will result in increases in atmospheric temperatures, changes in sea surface temperatures, patterns of precipitation, and sea level. For sea turtles, temperature increases generally lead toward female-biased nests (Hill et al. 2015). For sea turtles nesting in the Caribbean, temperature projections in 2030 suggest less than 3% of hatchlings will be male in leatherback, hawksbill, and green sea turtles; all of these are 36% male or less at present (Laloë et al. 2016). This can result in heavily feminized populations incapable of fertilization of available females (Laloë et al. 2014). This is not considered to be imminent and presently has the advantage of shifting the natural rates of population growth higher (Laloë et al. 2014). Fecundity of hatchlings from the Gulf of Mexico can also be influenced by nest temperatures (Lamont and Fujisaki 2014). Oceanographic models project a weakening of the thermohaline circulation resulting in a reduction of heat transport into high latitudes of Europe as well as an increase in the mass of the Antarctic and Greenland ice sheets, although the magnitude of these changes remain unknown. Species that are shorter-lived, larger body size, or generalist in nature are liable to be better able to adapt to climate change over the long term versus those that are longer-lived, smaller-sized, or rely on specialized habitats (Brashares 2003; Cardillo 2003; Cardillo et al. 2005; Issac 2009; Purvis et al. 2000). Climate change is most likely to have its most pronounced effects on species whose populations are already in tenuous positions (Isaac 2008). As such, we expect the risk of extinction to listed species to rise with the degree of climate shift associated with global warming.

Acevedo-Whitehouse and Duffus (2009) proposed that the rapidity of environmental changes, such as those resulting from global warming, can harm immunocompetence and reproductive parameters in wildlife to the detriment of population viability and persistence. An example of this is the altered sex ratios observed in sea turtle populations worldwide (Fuentes et al. 2009a;

Mazaris et al. 2008; Reina et al. 2008; Robinson et al. 2008). Altered ranges can also result in the spread of novel diseases to new areas via shifts in host ranges (Schumann et al. 2013; Simmonds and Eliott. 2009). It has also been suggested that increases in harmful algal blooms could be a result from increases in sea surface temperature (Simmonds and Eliott. 2009).

Climate change has been linked to changing ocean currents as well. Rising carbon dioxide levels have been identified as a reason for a poleward shift in the Eastern Australian Current, shifting warm waters into the Tasman Sea and altering biotic features of the area (Johnson et al. 2011; Poloczanska et al. 2009). Similarly, the Kuroshio Current in the western North Pacific (an important foraging area for juvenile sea turtles) has shifted as a result of altered long-term wind patterns over the Pacific Ocean (Blunden and Arndt 2013; Poloczanska et al. 2009). Ocean temperatures around Iceland are linked with alterations in the continental shelf ecosystem there, including shifts in minke whale diet (Víkingsson et al. 2014).

Changes in global climatic patterns will likely have profound effects on the coastlines of every continent by increasing sea levels and the intensity, if not the frequency, of hurricanes and tropical storms (Wilkinson and Souter 2008). A half degree Celsius increase in temperatures during hurricane season from 1965-2005 correlated with a 40% increase in cyclone activity in the Atlantic. Sea levels have risen an average of 1.7 mm/year over the 20th century due to glacial melting and thermal expansion of ocean water; this rate will likely increase. The current pace is nearly double this, with a 20-year trend of 3.2 mm/year (Blunden and Arndt 2013). This is largely due to thermal expansion of water, with minor contributions from melt water (Blunden and Arndt 2013). Based on computer models, these phenomena would inundate nesting beaches of sea turtles, change patterns of coastal erosion and sand accretion that are necessary to maintain those beaches, and would increase the number of turtle nests destroyed by tropical storms and hurricanes (Wilkinson and Souter 2008). Inundation itself reduces hatchling success by creating hypoxic conditions within inundated eggs (Pike et al. 2015). In addition, flatter beaches preferred by smaller sea turtle species would be inundated sooner than would steeper beaches preferred by larger species (Hawkes et al. 2014a). The loss of nesting beaches, by itself, would have catastrophic effects on sea turtle populations globally if they are unable to colonize new beaches that form or if the beaches do not provide the habitat attributes (sand depth, temperature regimes, refuge) necessary for egg survival. In some areas, increases in sea level alone may be sufficient to inundate sea turtle nests and reduce hatching success (Caut et al. 2009). Storms may also cause direct harm to sea turtles, causing “mass” strandings and mortality (Poloczanska et al. 2009). Increasing temperatures in sea turtle nests alters sex ratios, reduces incubation times (producing smaller hatchling), and reduces nesting success due to exceeded thermal tolerances (Fuentes et al. 2009b; Fuentes et al. 2010; Fuentes et al. 2009c). Smaller individuals likely experience increased predation (Fuentes et al. 2009b).

Climactic shifts also occur because of natural phenomena. In the North Atlantic, this primarily concerns fluctuations in the North Atlantic Oscillation (NAO), which results from changes in atmospheric pressure between a semi-permanent high pressure feature over the Azores and a subpolar low pressure area over Iceland (Curry and McCartney 2001; Hurrell 1995; Stenseth et al. 2002). This interaction affects sea surface temperatures, wind patterns, and oceanic circulation in the North Atlantic (Stenseth et al. 2002). The NAO shifts between positive and negative phases, with a positive phase having persisted since 1970 (Hurrell 1995). North Atlantic conditions experienced during positive NAO phases include warmer than average winter weather in central and eastern North America and Europe and colder than average temperatures in Greenland and the Mediterranean Sea (Visbeck 2002). Effects are most pronounced during winter (Taylor et al. 1998). This can change the oceanographic characteristics of hawksbill sea turtle habitat, which could affect the ability of areas to support foraging, breeding, or other vital life history parameters. Fluctuations in North Atlantic sea surface temperature are linked with variations in hawksbill nesting in the southern Gulf of Mexico (del Monte-Luna et al. 2012).

4.4.1 North Atlantic green sea turtle

Green sea turtles (

Figure 5) are sea turtles that spend almost their entire life in the ocean, coming ashore only to lay eggs or occasionally bask in the sun. When hatched, turtles weight 25 grams and 50 mm long, but can grow to be 135-150 kg and be 1 m long. They have four flippers and a head that does not fully retract into their shells (which are black, gray, green, brown, or yellow on top and yellowish white on bottom).

Figure 5. Green sea turtle. Photo taken by Andy Bruckner, NOAA.

Populations. Populations are distinguished generally by ocean basin and more specifically by nesting location. However, NMFS recently designated green sea turtles in the North Atlantic as a separate DPS (81 FR 20057) based on genetic discreteness and lack of overlap in breeding range of other DPSs (Seminoff et al. 2015)(Table 3).

Table 3. Locations and most recent abundance estimates of North Atlantic green sea turtles as annual nesting females (AF).

Location	Most recent abundance	Reference
Western Atlantic Ocean		
Tortuguero, Costa Rica	17,402-37,290 AF	(Troëng and Rankin 2005)
Aves Island, Venezuela	335-443 AF	(Vera 2007)
Galibi Reserve, Suriname	1,803 AF	(Weijerman et al. 1998)
Isla Trindade, Brazil	1,500-2,000 AF	(Moreira and Bjorndal 2006)

Distribution. Green sea turtles have a circumglobal distribution, occurring throughout tropical, subtropical waters, and, to a lesser extent, temperate waters.

Growth and reproduction. Most green sea turtles exhibit particularly slow growth rates, which have been attributed to their largely plant-eating diet (Bjorndal 1982). Growth rates of juveniles vary substantially among populations, ranging from less than 1 cm/year (Green 1993) to more than 5 cm/year (McDonald Dutton and Dutton 1998), likely due to differences in diet quality, duration of foraging season (Chaloupka et al. 2004), and density of turtles in foraging areas (Balazs and Chaloupka 2004; Bjorndal et al. 2000; Seminoff et al. 2002b). Hart et al. (2013a) found growth rates of green sea turtles in the US Virgin Islands to range from 0 to 9.5 cm annually (mean of 4.1, standard deviation of 2.4). The largest growth rates were in the 30-39 cm class. If individuals do not feed sufficiently, growth is stunted and apparently does not compensate even when greater-than-needed resources are available (Roark et al. 2009). In general, there is a tendency for green sea turtles to exhibit monotonic growth (declining growth rate with size) in the Atlantic and non-monotonic growth (growth spurt in mid-size classes) in the Pacific, although this is not always the case (Balazs and Chaloupka 2004; Chaloupka and Musick 1997; Seminoff et al. 2002b). It is estimated that green sea turtles reach a maximum size just under 100 cm in carapace length (Tanaka 2009). A female-bias has been identified from studies of green sea turtles (Wibbels 2003).

Consistent with slow growth, age-to-maturity for green sea turtles appears to be the longest of any sea turtle species and ranges from about 20 to 40 years or more (Balazs 1982; Chaloupka et al. 2004; Chaloupka and Musick 1997; Frazer and Ehrhart 1985b; Hirth 1997; Limpus and Chaloupka 1997; Seminoff et al. 2002b; Zug et al. 2002; Zug and Glor 1998). Estimates of reproductive longevity range from 12 to 26 years in the North Atlantic beaches studied (Frazer and Ladner 1986; Richards et al. 2011). Considering that mean duration between females returning to nest ranges from 2 to 3 years (Troëng and Chaloupka 2007a; Witherington and Ehrhart 1989; Zurita et al. 1994), these reproductive longevity estimates suggest that a female may nest 3 to 11 seasons over the course of her life. Each female deposits 1-7 clutches (usually 2-3) during the breeding season at 9-18 day intervals (Hart et al. 2013b; Johnson and Ehrhart 1996; Troeng et al. 2005; Witherington and Ehrhart 1989). Mean clutch size is highly variable among populations, but averages 110-115 eggs/nest. Roughly 62% of eggs hatch in Florida nests (Seminoff et al. 2015). Females usually have 2-4 or more years between breeding seasons, whereas males may mate every year (Balazs 1983). Based on reasonable means of three nests per season and 100 eggs per nest (Hirth 1997), a female may deposit 9 to 33 clutches, or about 900 to 3,300 eggs, during her lifetime. Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al. 2010). Temperatures affects sex determination, with 81% of green sea turtle eggs being female in Florida nests (Rogers 2013).

Once hatched, sea turtles emerge and orient towards a light source, such as light shining off the ocean. They enter the sea in a “frenzy” of swimming activity, which decreases rapidly in the first few hours and then gradually over the first several weeks (Ischer et al. 2009; Okuyama et al. 2009). Factors in the ocean environment have a major influence on reproduction (Chaloupka 2001; Limpus and Nicholls 1988; Solow et al. 2002). It is also apparent that during years of heavy nesting activity, density dependent factors (beach crowding and digging up of eggs by nesting females) may impact hatchling production (Tiwari et al. 2005; Tiwari et al. 2006). Precipitation, proximity to the high tide line, and nest depth can also significantly affect nesting success (Cheng et al. 2009). Precipitation can also be significant in sex determination, with greater nest moisture resulting in a higher proportion of males (Leblanc and Wibbels 2009). Green sea turtles often return to the same foraging areas following nesting migrations (Broderick et al. 2006; Godley et al. 2002). Once there, they move within specific areas, or home ranges, where they routinely visit specific localities to forage and rest (Godley et al. 2003; Makowski et al. 2006; Seminoff and Jones 2006; Seminoff et al. 2002a; Taquet et al. 2006). It is also apparent that some green sea turtles remain in pelagic habitats for extended periods, perhaps never recruiting to coastal foraging sites (Pelletier et al. 2003).

In general, survivorship tends to be lower for juveniles and subadults than for adults. Adult survivorship has been calculated to range from 0.82-0.97 versus 0.58-0.89 for juveniles (Chaloupka and Limpus 2005; Seminoff et al. 2003; Troëng and Chaloupka 2007b), with lower values coinciding with areas of human impact on green sea turtles and their habitats (Bjorndal et al. 2003; Campbell and Lagueux 2005).

Habitat. Green turtles appear to prefer waters that usually remain around 20º C in the coldest month, but may occur considerably north of these regions during warm-water events, such as El Niño. Stinson (1984) found green turtles to appear most frequently in US coastal waters with temperatures exceeding 18º C. Further, green sea turtles seem to occur preferentially in drift lines or surface current convergences, probably because of the prevalence of cover and higher prey densities that associate with flotsam. For example, in the western Atlantic Ocean, drift lines commonly containing floating *Sargassum* species are capable of providing juveniles with shelter (NMFS and USFWS 1998). Underwater resting sites include coral recesses, the underside of ledges, and sand bottom areas that are relatively free of strong currents and disturbance. Available information indicates that green turtle resting areas are near feeding areas (Bjorndal and Bolten 2000). Strong site fidelity appears to be a characteristic of juveniles green sea turtles along the Pacific Baja coast (Senko et al. 2010).

Green sea turtles in the Gulf of Mexico tend to remain along the coast (lagoons, channels, inlets, and bays), with nesting primarily occurring in Florida and Mexico and infrequent nesting in all other areas (Landry and Costa 1999; Meylan et al. 1995; NMFS and USFWS 1991; USAF 1996). Foraging areas seem to be based on seagrass and macroalgae abundance, such as in the Laguna Madre of Texas. Abundance of green sea turtles along coastal Texas appears to be increasing (Metz and Landry Jr. 2013). However, green sea turtles may also occur in offshore regions, particularly during migration and development. Sea turtles frequently forage far from their nesting beaches. Sea turtles foraging in the western Gulf of Mexico almost exclusively stem from Gulf of Mexico and northern Caribbean rookeries (Anderson et al. 2013).

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

On April 6, 2016, NMFS finalized a relisting of green sea turtles as separate DPSs globally (81 FR 20057). The new listing designations have the North Atlantic DPS (threatened) co-occurring with the action areas of all permits. The North Atlantic DPS extends from the boundary of South and Central America, north to 10.5° North, 77° West, then extending due east across the Atlantic Ocean at 19° North latitude to the African continent, and extending north along the western coasts of Africa and Europe (west of 5.5° West longitude) to 48° North latitude (Figure 6).

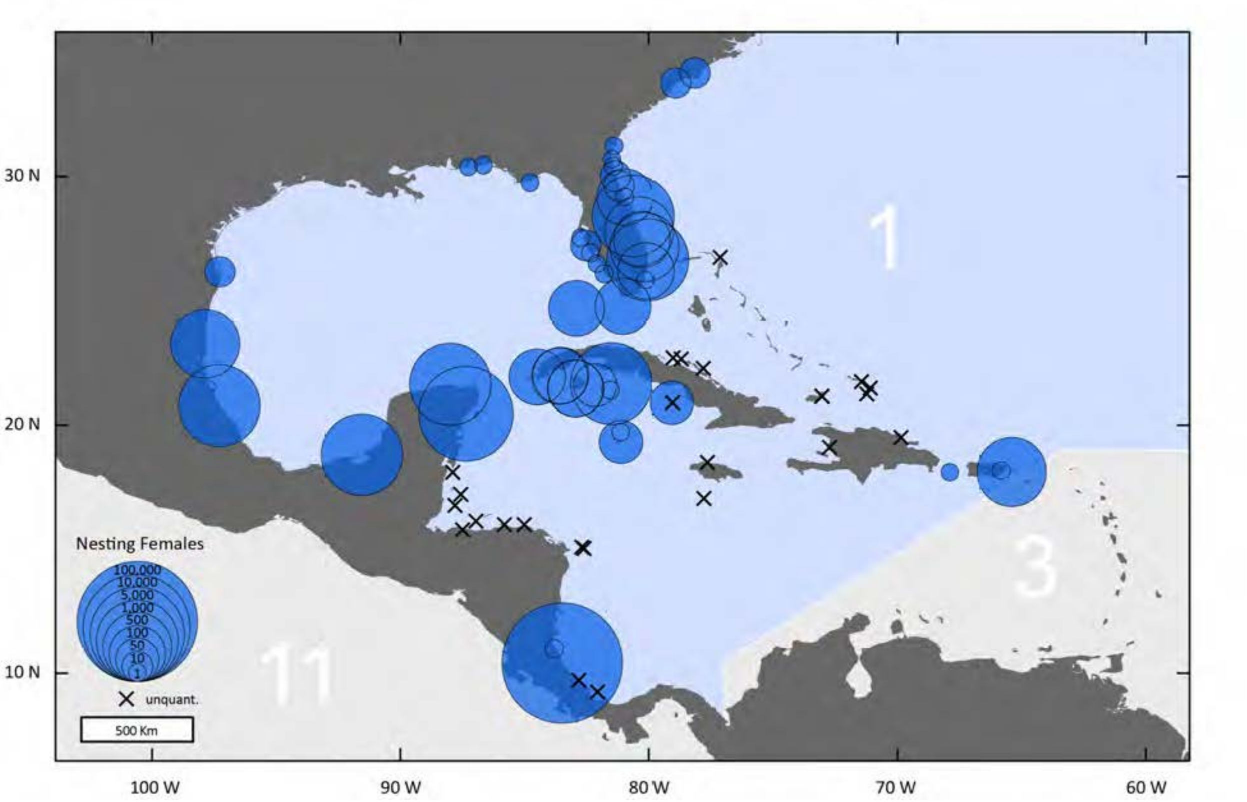

Figure 6. Close up of nesting distribution of green turtles in the western North Atlantic DPS (blue shading). Size of circles indicates estimated nester abundance. Locations marked with 'x' indicate nesting sites lacking abundance information (Limpus 2008).

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

Atlantic Ocean. A total of 73 nesting beaches are known to host green sea turtle nesting in the North Atlantic, of which 48 have been assessed for abundance (Seminoff et al. 2015). Primary sites for green sea turtle nesting in the Atlantic/Caribbean include: (1) Yucatán Peninsula, Mexico; (2) Tortuguero, Costa Rica; (3) Aves Island, Venezuela; (4) Galibi Reserve, Suriname; (5) Isla Trindade, Brazil; (6) Ascension Island, United Kingdom; (7) Bioko Island, Equatorial Guinea; and (8) Bijagos Achipelago, Guinea-Bissau (NMFS and USFWS 2007a).

Nesting at all of these sites was considered to be stable or increasing with the exception of Bioko Island and the Bijagos Archipelago where the lack of sufficient data precludes a meaningful trend assessment for either site (NMFS and USFWS 2007a). Tortuguero hosts roughly 79% of the 167,000 nesters estimated to occur in the North Atlantic DPS (Seminoff et al. 2015). Seminoff (2004) reviewed green sea turtle nesting data for eight sites in the western, eastern, and central Atlantic. Seminoff (2004) concluded that all sites in the central and western Atlantic showed increased nesting, with the exception of nesting at Aves Island, Venezuela, while both sites in the eastern Atlantic demonstrated decreased nesting. These sites are not inclusive of all green sea turtle nesting in the Atlantic. However, other sites are not believed to support nesting levels high enough that would change the overall status of the species in the Atlantic (NMFS and USFWS 2007a). Only one nester was observed in 2011-2012 in Manatee County (Seminoff et al. 2015), which forms the southern border of the action area.

By far, the most important nesting concentration for green sea turtles in the western Atlantic is in Tortuguero, Costa Rica (NMFS and USFWS 2007a). Nesting in the area has increased considerably since the 1970s and nest count data from 1999-2003 suggest nesting by 17,402-37,290 females per year (NMFS and USFWS 2007a). The number of females nesting per year on beaches in the Yucatán, at Aves Island, Galibi Reserve, and Isla Trindade number in the hundreds to low thousands, depending on the site (NMFS and USFWS 2007a).

Connectivity of nesting groups seems good, with a given foraging region generally supporting individuals from multiple breeding areas (Seminoff et al. 2015).

Natural threats. Herons, gulls, dogfish, and sharks prey on hatchlings. Adults face predation primarily by sharks and to a lesser extent by killer whales. Predators (primarily of eggs and hatchlings) also include dogs, pigs, rats, crabs, sea birds, reef fishes, and groupers (Bell et al. 1994; Witzell 1981). All sea turtles except leatherbacks can undergo “cold stunning” if water temperatures drop below a threshold level, which can be lethal. Several such events have occurred over the past decade from Texas to New England, involving hundreds of green sea turtles each time (Seminoff et al. 2015). For unknown reasons, the frequency of a disease called FP is much higher in green sea turtles than in other species and threatens a large number of existing subpopulations. The incidence of FP varies widely by location (including areas close to one another), but ranges from 8-72% in Florida waters and seems to be linked to degradation of foraging habitat (Seminoff et al. 2015). A to-date unidentified virus may aid in the development of FP (Work et al. 2009). Green sea turtles with an abundance of barnacles have been found to have a much greater probability of having health issues (Flint et al. 2009). The fungal pathogens *Fusarium falciforme* and *F. keratoplasticum* can kill in excess of 90% of sea turtle embryos they infect and may constitute a major threat to nesting productivity under some conditions (Sarmiento-Ramırez et al. 2014).

Anthropogenic threats. Major anthropogenic impacts to the nesting and marine environment affect green sea turtle survival and recovery (Patino-Martinez 2013).

At nesting beaches, green sea turtles rely on intact dune structures, native vegetation, and normal beach temperatures for nesting (Ackerman 1997). Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997b). These factors may directly, through loss of beach habitat, or indirectly, through changing thermal profiles and increasing erosion, serve to decrease the amount of nesting area available to nesting females and may evoke a change in the natural behaviors of adults and hatchlings (Ackerman 1997; Witherington et al. 2003; Witherington et al. 2007).

Ingestion of plastic and other marine debris is another source of morbidity and mortality (Stamper et al. 2009), apparently due to the resemblance to jellyfish prey (Schuyler et al. 2014). Marine debris easily blocks the digestive tract (Santos et al. 2015). Vessel strike has been documented in about 18% of stranded green sea turtles in the southeastern US from 2005 to 2009, so vessel strike is likely a significant cause of injury and mortality in the region (Seminoff et al. 2015).

The introduction of alien algae species threatens the stability of some coastal ecosystems and may lead to the elimination of preferred dietary species of green sea turtles (De Weede 1996).

Very few green sea turtles are bycaught in US fisheries (Finkbeiner et al. 2011), with the exception of shrimp trawl fisheries. From 1997 to 2009, 481 (just under 10%) of stranded green sea turtles in Florida were reported entangled, hooked, or otherwise involved with fishery gear such as hook and lines or trap pots (Seminoff et al. 2015). Low-level bycatch has also been documented in longline fisheries (Petersen et al. 2009). From 1997 to 1998, Epperly et al. (2002b) estimated 48,239 green sea turtle interactions with shrimp trawls. NMFS (2002a) estimated 4,620-7,055 green sea turtles are killed or injured in Gulf of Mexico and southern US shrimp trawls annually.

Between 1991 and 2011, an average of 8,169 green sea turtles were illegally harvested for food annually along the Caribbean coast of Nicaragua (over 171,000 over this period); a rate that has been in decline potentially due to population depletion (Lagueux et al. 2014), but still likely impacts population-level fitness. Low-levels of female nester and egg harvest occur at Tortuguero Beach, but are much reduced compared to former levels (Seminoff et al. 2015). Green sea turtles are also harvested illegally in Cuba (Seminoff et al. 2015). Nicaragua formerly harvested 10,000 green sea turtles annually until the practice was outlawed in 1977 (Seminoff et al. 2015). Illegal levels are now reduced, but remain a threat for local breeding groups as thousands of turtles have still been taken in recent years (Seminoff et al. 2015). Harvesting, either legal or illegal, also continues in Belize, Puerto Rico, The Bahamas, Jamaica, and the Cayman Islands (Seminoff et al. 2015).

Sea level rise may have significant impacts on green turtle nesting on Pacific atolls. These low-lying, isolated locations could be inundated by rising water levels associated with global warming, eliminating nesting habitat (Baker et al. 2006; Fuentes et al. 2010). Green sea turtles along Florida nest earlier in association with higher sea surface temperatures (Weishampel et al.

2010). Fuentes et al. (2010) predicted that rising temperatures would be a much greater threat in the long term to the hatching success of sea turtle turtles in general and green sea turtles along northeastern Australia particularly. Green sea turtles emerging from nests at cooler temperatures likely absorb more yolk that is converted to body tissue than do hatchlings from warmer nests (Ischer et al. 2009). Predicted temperature rises may approach or exceed the upper thermal tolerance limit of sea turtle incubation, causing widespread failure of nests (Fuentes et al. 2010). Although the timing of loggerhead nesting depends on sea-surface temperature, green sea turtles do not appear to be affected (Pike 2009).

Green sea turtles have been found to contain the organochlorines chlordane, lindane, endrin, endosulfan, dieldrin, dichlorodiphenyltrichloroethane (DDT), and polychlorinated biphenyl (PCB) (Gardner et al. 2003; Miao et al. 2001). Levels of PCBs found in eggs are considered far higher than what is fit for human consumption (Van de Merwe et al. 2009). The heavy metals copper, lead, manganese, cadmium, and nickel have also been found in various tissues and life stages (Barbieri 2009). Arsenic also occurs in very high levels in green sea turtle eggs (Van de Merwe et al. 2009). These contaminants have the potential to cause deficiencies in endocrine, developmental, and reproductive health, as well as depress immune function in loggerhead sea turtles (Keller et al. 2006; Storelli et al. 2007). Exposure to sewage effluent may also result in green sea turtle eggs harboring antibiotic-resistant strains of bacteria (Al-Bahry et al. 2009). Dichlorodiphenyldichloroethylene (DDE) has not been found to influence sex determination at levels below cytotoxicity (Keller and McClellan-Green 2004; Podreka et al. 1998). To date, no tie has been found between pesticide concentration and susceptibility to FP, although degraded habitat and pollution have been tied to the incidence of the disease (Aguirre et al. 1994; Foley et al. 2005). Flame retardants have been measured from healthy individuals (Hermanussen et al. 2008). It has been theorized that exposure to tumor-promoting compounds produced by the cyanobacteria *Lyngbya majuscule* could promote the development of FP (Arthur et al. 2008). It has also been theorized that dinoflagellates of the genus *Prorocentrum* that produce the tumorogenic compound okadoic acid may influence the development of FP (Landsberg et al. 1999). Poor water quality has also been implicated in the development of FP (da Silva et al. 2015; Jones et al. 2015) .

4.4.2 Hawksbill sea turtle

Hawksbill sea turtles (Figure 7) are adapted to live in the ocean, like all other sea turtles, and come onto land only to lay eggs. They are the second-smallest sea turtle, growing to only 65-90 cm in length and 45-70 kg. They get their name from the curved tip of their upper beak, which is more pronounced than in other sea turtle species. The top of their shell is golden brown, streaked with orange, red, and/or black while the bottom shell is yellowish.

Figure 7. Hawksbill sea turtle. Photo courtesy of Johan Chevalier.

Populations. Populations are distinguished generally by ocean basin and more specifically by nesting location. Our understanding of population structure is relatively poor. For example, genetic analysis of hawksbill sea turtles foraging off the Cape Verde Islands identified three closely-related haplotypes in a large majority of individuals sampled that did not match those of any known nesting population in the Western Atlantic, where the vast majority of nesting has been documented (McClellan et al. 2010; Monzon-Arguello et al. 2010). Hawksbills in the Caribbean seem to have dispersed into separate populations (rookeries) after a bottleneck roughly 100,000-300,000 years ago based on genetic data (Leroux et al. 2012).

Distribution. The hawksbill has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical waters of the Atlantic Ocean. Satellite tagged turtles have shown significant variation in movement and migration patterns. In the Caribbean, distance traveled between nesting and foraging locations ranges from a few kilometers to a few hundred kilometers (Byles and Swimmer 1994; Hillis-Starr et al. 2000; Horrocks et al. 2001; Lagueux et al. 2003; Miller et al. 1998; Prieto et al. 2001).

Migration and movement. Upon first entering the sea, neonatal hawksbills in the Caribbean are believed to enter an oceanic phase that may involve long distance travel and eventual recruitment to nearshore foraging habitat (Boulon Jr. 1994). In the marine environment, the oceanic phase of juveniles (i.e., the "lost years") remains one of the most poorly understood aspects of hawksbill life history, both in terms of where turtles occur and how long they remain oceanic. Three subadult hawksbill sea turtles captured and satellite tracked in the Dry Tortugas National Park showed high-degrees of site fidelity for extended periods, although all three eventually moved to other areas outside the park (Hart et al. 2012). The same trend was found for adults tracked after nesting in the Dominican Republic, with some remaining for extended periods in the nesting area and others migrating to Honduras and Nicaragua (Hawkes et al. 2012). Satellite tracking for these individuals showed repeated returns to the same Dominican and Central American areas (Hawkes et al. 2012). However, another study from the Caribbean suggests hawksbill sea turtles may show lower site fidelity for nesting than Hawkes et al (2012) found (Esteban et al. 2015). Hawksbills dispersing from nesting areas along Brazil moved along coastal areas until they reached foraging areas (Marcovaldi et al. 2012). Here, genetically-identified hawksbill-loggerhead hybrids dispersed more broadly than pure-bred hawksbills (Marcovaldi et al. 2012). Home ranges tend to be small (a few square kilometers; Berube et al. 2012).

Habitat. Hawksbill sea turtles are highly migratory and use a wide range of broadly separated localities and habitats during their lifetimes (Musick and Limpus 1997; Plotkin 2003). Small juvenile hawksbills (5-21 cm straight carapace length) have been found in association with *Sargassum* species in both the Atlantic and Pacific Oceans (Musick and Limpus 1997) and observations of newly hatched hawksbills attracted to floating weed have been made (Hornell 1927; Mellgren and Mann 1996; Mellgren et al. 1994). Post-oceanic hawksbills may occupy a range of habitats that include coral reefs or other hard-bottom habitats, sea grass, algal beds, mangrove bays and creeks (Bjorndal and Bolten 2010; Musick and Limpus 1997), and mud flats (R. von Brandis, unpublished data in NMFS and USFWS 2007d).

Eastern Pacific adult females have recently been tracked in saltwater mangrove forests along El Salvador and Honduras, a habitat that this species was not previously known to occupy (Gaos et al. 2011). Individuals of multiple breeding locations can occupy the same foraging habitat (Bass 1999; Bowen et al. 1996; Bowen et al. 2007; Diaz-Fernandez et al. 1999; Velez-Zuazo et al. 2008). As larger juveniles, some individuals may associate with the same feeding locality for more than a decade, while others apparently migrate from one site to another (Blumenthal et al. 2009a; Mortimer et al. 2003; Musick and Limpus 1997). Larger individuals may prefer deeper habitats than their smaller counterparts (Blumenthal et al. 2009a). Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al. 2010).

Hawksbill sea turtles appear to be rare visitors to the Gulf of Mexico, with Florida being the only Gulf state with regular sightings (Hildebrand 1983; NMFS and USFWS 1993; Rabalais and Rabalais 1980; Rester and Condrey 1996; Witzell 1983). Individuals stranded in Texas are generally young (hatchlings or yearlings) originating from Mexican nesting beaches (Amos 1989; Collard and Ogren 1990; Hildebrand 1983; Landry and Costa 1999). The applicant of the proposed permit captured a hawksbill on one occasion during the course of more than two decades of research activities in the region.

Within United States territories and US dependencies in the Caribbean Region, hawksbill sea turtles nest principally in Puerto Rico and the US Virgin Islands, particularly on Mona Island and Buck Island. They also nest on other beaches on St. Croix, Culebra Island, and Vieques Island, mainland Puerto Rico, St. John, and St. Thomas. Within the continental United States, hawksbill sea turtles nest only on beaches along the southeast coast of Florida and in the Florida Keys.

Growth and reproduction. The best estimate of age at sexual maturity for hawksbill sea turtles is 20-40 years (Chaloupka and Limpus 1997; Crouse 1999). Reproductive females undertake periodic (usually non-annual) migrations to their natal beaches to nest. Movements of reproductive males are less well known, but are presumed to involve migrations to their nesting beach or to courtship stations along the migratory corridor (Meylan 1999). Females nest an average of 3-5 times per season (Meylan and Donnelly 1999; Richardson et al. 1999). Clutch size up to 250 eggs; larger than that of other sea turtles (Hirth 1980). Reproductive females may exhibit a high degree of fidelity to their nest sites.

The life history of hawksbills consists of a pelagic stage that lasts from hatching until they are approximately 22-25 cm in straight carapace length (Meylan 1988; Meylan and Donnelly 1999), followed by residency in coastal developmental habitats. Growth accelerates early on until turtles reach 65-70 cm in curved carapace length, after which it slows to negligible amounts after 80 cm (Bell and Pike 2012). As with other sea turtles, growth is variable and likely depends on nutrition available (Bell and Pike 2012). Juvenile hawksbills along the British Virgin Islands grow at a relatively rapid rate of roughly 9.3 cm per year and gain 3.9 kg annually (Hawkes et al. 2014b).

Hatchlings in Brazil exhibit a strong female bias of 89-96% (dei Marcovaldi et al. 2014).

Diving. Hawksbill diving ability varies with age and body size. As individuals increase in age, diving ability in terms of duration and depth increases (Blumenthal et al. 2009b). Studies of hawksbills in the Caribbean have found diurnal diving behavior, with dive duration nearly twice as long during nighttime (35-47 minutes) compared to daytime (19-26 min Blumenthal et al. 2009b; Van Dam and Diez 1997). Daytime dives averaged 5 m, while nighttime dives averaged 43 m (Blumenthal et al. 2009b). However, nocturnal differences were not observed in the eastern Pacific (Gaos et al. 2012).

Hawksbills have long dive durations, although dive depths are not particularly deep. Adult females along St. Croix reportedly have average dive times of 56 minutes, with a maximum time of 73.5 minutes (Starbird et al. 1999). Average day and night dive times were 34–65 and 42–74 minutes, respectively. Immature individuals have much shorter dives of 8.6–14 minutes to a mean depth of 4.7 m while foraging (Van Dam and Diez 1997).

Status and trends. Hawksbill sea turtles received protection on June 2, 1970 (35 FR 8495) under the Endangered Species Conservation Act and since 1973 have been listed as endangered under the ESA. Although no historical records of abundance are known, hawksbill sea turtles are considered to be severely depleted due to the fragmentation and low use of current nesting beaches (NMFS and USFWS 2007d). Worldwide, an estimated 21,212-28,138 hawksbills nest each year among 83 sites. Among the 58 sites for with historic trends, all show a decline during the past 20 to 100 years. Among 42 sites for which recent trend data are available, 10 (24%) are increasing, three (7%) are stable and 29 (69%) are decreasing. Genetics supports roughly 6,000-9,000 adult females within the Caribbean (Leroux et al. 2012).

Atlantic Ocean. Atlantic nesting sites include: Antigua (Jumby Bay), the Turks and Caicos, Barbados, the Bahamas, Puerto Rico (Mona Island), the US Virgin Islands, the Dominican Republic, Sao Tome, Guadeloupe, Trinidad and Tobago, Jamaica, Martinique, Cuba (Doce

Leguas Cays), Mexico (Yucatan Peninsula), Costa Rica (Tortuguero National Park), Guatemala, Venezuela, Bijagos Archipelago, Guinea-Bissau, and Brazil.

Hawksbill sea turtles in the action area stem from populations nesting in the Caribbean region. Population increase has been greater in the Insular Caribbean than along the Western Caribbean Mainland or the eastern Atlantic (including Sao Tomé and Equatorial Guinea). Nesting populations of Puerto Rico appeared to be in decline until the early 1990s, but have universally increased during the survey periods. Mona Island now hosts 199-332 nesting females annually, and the other sites combined host 51-85 nesting females annually (R.P. van Dam and C.E. Diez, unpublished data in NMFS and USFWS 2007d) C.E. Diez, Chelonia, Inc., in litt. to J. Mortimer 2006). The US Virgin Islands have a long history of tortoiseshell trade (Schmidt 1916). At Buck Island Reef National Monument, protection has been in force since 1988, and during that time, hawksbill nesting has increased by 143% to 56 nesting females annually, with apparent spill over to beaches on adjacent St. Croix (Z. Hillis-Starr, National Park Service, in litt. to J. Mortimer 2006). However, St. John populations did not increase, perhaps due to the proximity of the legal turtle harvest in the British Virgin Islands (Z. Hillis-Starr, National Park Service, in litt. to J. Mortimer 2006). Populations have also been identified in Belize and Brazil as genetically unique (Hutchinson and Dutton 2007). An estimated 50-200 nests are laid per year in the Guinea-Bissau (Catry et al. 2009).

Natural threats. Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo “cold stunning” if water temperatures drop below a threshold level, which can be lethal. The only other significant natural threat to hawksbill sea turtles is from hybridization of hawksbills with other species of sea turtles. This is especially problematic at certain sites where hawksbill numbers are particularly low (Mortimer and Donnelly in review). Predators (primarily of eggs and hatchlings) include dogs, pigs, rats, crabs, sea birds, reef fishes, groupers, feral cats, and foxes (Bell et al. 1994; Ficetola 2008). In some areas, nesting beaches can be almost completely destroyed by predators and all nests can sustain some level of depredation (Ficetola 2008). The fungal pathogens *Fusarium falciforme* and *F. keratoplasticum* can kill in excess of 90% of sea turtle embryos they infect and may constitute a major threat to nesting productivity under some conditions (Sarmiento-Ramırez et al. 2014).

Anthropogenic threats. Threats to hawksbill sea turtles are largely anthropogenic, both historically and currently. Impacts to nesting beaches include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997b). Because hawksbills prefer to nest under vegetation (Horrocks and Scott 1991; Mortimer 1982), they are particularly impacted by beachfront development and clearing of dune vegetation (Mortimer and Donnelly in review). The presence of lights on or adjacent to nesting beaches alters the behavior of nesting adults (Witherington 1992) and is often fatal to emerging hatchlings as they are attracted to light sources and drawn away from the water

(Witherington and Bjorndal 1991). One of the most detrimental human threats to hawksbill sea turtles is the intensive harvest of eggs from nesting beaches.

In addition to impacting the terrestrial zone, anthropogenic disturbances also threaten coastal marine habitats. These impacts include contamination from herbicides, pesticides, oil spills, and other chemicals, as well as structural degradation from excessive boat anchoring and dredging (Francour et al. 1999; Lee Long et al. 2000; Waycott et al. 2005). Hawksbills are typically associated with coral reefs, which are among the world's most endangered marine ecosystems (Wilkinson 2000). Although primarily spongivorous, bycatch of hawksbill sea turtles in the swordfish fishery off South Africa occurs (Petersen et al. 2009). Finkbeiner et al. (2011) estimated that annual bycatch interactions total at least 20 individuals annually for US Atlantic fisheries (resulting in less than ten mortalities) and no or very few interactions in US Pacific fisheries.

Future impacts from climate change and global warming may result in significant changes in hatchling sex ratios. The fact that hawksbill turtles exhibit temperature-dependent sex determination (Wibbels 2003) suggests that there may be a skewing of future hawksbill cohorts toward strong female bias (since warmer temperatures produce more female embryos).

4.4.3 Kemp's ridley sea turtle

Kemp's ridley sea turtles (**Figure 8**) have four flipeprs that they use to swim and only come onto land to lay eggs. They are grayish-green in color on top, but yellow on their bottom shell. Kemp's ridleys are the smallest sea turtles, growing to only 60-70 cm long and 45 kg.

Figure 8. Kemp's ridley sea turtle. Photo taken by the National Park Service.

Population. Kemp's ridley sea turtles are considered to consist of a single population, although expansion of nesting may indicate differentiation.

Distribution. The Kemp's ridley was formerly known only from the Gulf of Mexico and along the Atlantic coast of the US (TEWG 2000b). However, recent records support Kemp's ridley sea turtles distribution extending into the Mediterranean Sea on occasion (Tomas and Raga 2008). The vast majority of individuals stem from breeding beaches at Rancho Nuevo on the Gulf of

Mexico coast of Mexico, with some reintroduction expansion into Texas (Shaver and Caillouet Jr. 2015).

Growth and reproduction. Kemp's ridleys require approximately 1.5 to two years to grow from a hatchling to a size of approximately 7.9 inches long, at which size they are capable of making a transition to a benthic coastal immature stage, but can range from one to four years or more (Caillouet et al. 1995; Ogren 1989; Schmid 1998; Schmid and Witzell 1997b; Snover et al. 2007b; TEWG 2000b; Zug et al. 1997). Based on the size of nesting females, it is assumed that turtles must attain a size of approximately 23.6 inches long prior to maturing (Marquez-M. 1994). Growth models based on mark-recapture data suggest that a time period of seven to nine years would be required for this growth from benthic immature to mature size (Schmid and Witzell 1997b; Snover et al. 2007b). Currently, age to sexual maturity is believed to range from approximately 10 to 17 years for Kemp's ridleys (Caillouet Jr. et al. 1995; Schmid and Witzell 1997a; Snover et al. 2007a; Snover et al. 2007b). However, estimates of 10 to 13 years predominate in previous studies (Caillouet et al. 1995; Schmid and Witzell 1997b; TEWG 2000b).

Habitat. Stranding data indicate that immature turtles in this benthic stage are found in coastal habitats of the entire Gulf of Mexico and US Atlantic coast (Morreale et al. 2007; TEWG 2000b). Developmental habitats for juveniles occur throughout the entire coastal Gulf of Mexico and US Atlantic coast northward to New England (Morreale et al. 2007; Schmid 1998; Wibbels et al. 2005). Key foraging areas in the Gulf of Mexico include Sabine Pass, Texas; Caillou Bay and Calcasieu Pass, Louisiana; Big Gulley, Alabama; Cedar Keys, Florida; and Ten Thousand Islands, Florida (Carr and Caldwell 1956; Coyne et al. 1995; Ogren 1989; Schmid 1998; Schmid et al. 2002; Witzell et al. 2005). Foraging areas studied along the Atlantic coast include Pamlico Sound, Chesapeake Bay, Long Island Sound, Charleston Harbor, and Delaware Bay. Near-shore waters of 120 feet or less provide the primary marine habitat for adults, although it is not uncommon for adults to venture into deeper waters (Byles 1989; Mysing and Vanselous 1989; Renaud et al. 1996; Shaver et al. 2005; Shaver and Wibbels 2007a).

Benthic coastal waters of Louisiana and Texas seem to be preferred foraging areas for Kemp’s ridley sea turtles (particularly passes and beachfronts), although individuals may travel along the entire coastal margin of the Gulf of Mexico (Landry and Costa 1999; Landry et al. 1996; Renaud 1995; Seney and Landry 2011; Shaver et al. 2013). Sightings are less frequent during winter and spring, but this is likely due to lesser sighting effort during these times (Keinath et al. 1996; Shoop and Kenney 1992).

Status and trends. The Kemp’s ridley sea turtle was listed as endangered on December 2, 1970 (35 FR 18319). Internationally, the Kemp’s ridley is considered the most endangered sea turtle (NRC 1990a; USFWS 1999).

During the mid-20th century, the Kemp's ridley was abundant in the Gulf of Mexico. Historic information indicates that tens of thousands of Kemp’s ridleys nested near Rancho Nuevo, Mexico, during the late 1940s (Hildebrand 1963). From 1978 through the 1980s, arribadas were

200 turtles or less, and by 1985, the total number of nests at Rancho Nuevo had dropped to approximately 740 for the entire nesting season, or a projection of roughly 234 turtles (TEWG 2000b; USFWS and NMFS 1992). Beginning in the 1990s, an increasing number of beaches in Mexico were being monitored for nesting, and the total number of nests on all beaches in Tamaulipas and Veracruz in 2002 was over 6,000; the rate of increase from 1985 ranged from 14-16% (Heppell et al. 2005; TEWG 2000b; USFWS 2002). In 2006, approximately 7,866 nests were laid at Rancho Nuevo with the total number of nests for all the beaches in Mexico estimated at about 12,000 nests, which amounted to about 4,000 nesting females based on three nests per female per season (Rostal 2007; Rostal et al. 1997; USFWS 2006). Considering remigration rates, the population included approximately 7,000 to 8,000 adult female turtles at that time (Marquez et al. 1989; Rostal 2007; TEWG 2000b). The 2007 nesting season included an arribada of over 4,000 turtles over a three-day period at Rancho Nuevo (P. Burchfield, pers. comm. in NMFS and USFWS 2007b). The increased recruitment of new adults is illustrated in the proportion of first time nesters, which has increased from 6% in 1981 to 41% in 1994. Average population growth was estimated at 13% per year between 1991 and 1995 (TEWG 1998). In 2008, there were 17,882 nests in Mexico (Gladys Porter Zoo 2008), and nesting in 2009 reached 21,144 (Burchfield 2010). In 2010, nesting declined significantly, to 13,302 but it is too early to determine if this is a one-time decline or if is indicative of a change in the trend. Preliminary estimates of 2011 and 2012 nesting supports 19,368 and 20,197 nests, respectively (back to 2009 levels; Gallaway et al. 2013). Population modeling used by the TEWG (2000a) projected that Kemp’s ridleys could reach the recovery plan’s intermediate recovery goal of 10,000 nesters by the year 2015. Recent calculations of nesting females determined from nest counts show that the population trend is increasing towards that recovery goal, with an estimate of 4,047 nesters in 2006 and 5,500 in 2007 (NMFS and USFWS 2007c). Over one million hatchlings were released in 2011 and 2012 (Gallaway et al. 2013).

Nesting has also expanded geographically, with a Headstart program reestablishing nesting on South Padre Island starting in 1978. Growth remained slow until 1988, when rates of return started to grow slowly (Shaver and Wibbels 2007b). Nesting rose from 6 in 1996 to 128 in 2007, 195 in 2008, and 197 in 2009. Texas nesting then experienced a decline similar to that seen in Mexico for 2010, with 140 nests (National Park Service data, http://www.nps.gov/pais/naturescience/strp.htm), but nesting rebounded in 2011 with a record 199 nests (National Park Service data, http://www.nps.gov/pais/naturescience/current-season.htm).

Gallaway et al. (2013) estimated that nearly 189,000 female Kemp’s ridley sea turtles over the age of two years were alive in 2012. Extrapolating based on sex bias, the authors estimated that nearly a quarter million age-two or older Kemp’s ridleys were alive at this time.

Natural threats. Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo “cold stunning” if water temperatures drop below a threshold level, which can pose lethal effects. Kemp’s ridley sea turtles are particularly prone to this phenomenon along Cape Cod (Innis et al. 2009). In the last five years (2006-2010), the number of cold-stunned turtles on Cape Cod beaches averaged 115 Kemp's ridleys. The fungal pathogens *Fusarium falciforme* and *F. keratoplasticum* can kill in excess of 90% of sea turtle embryos they infect and may constitute a major threat to nesting productivity under some conditions (Sarmiento-Ramırez et al. 2014).

Anthropogenic threats. Population decline has been curtailed due to the virtual elimination of sea turtle and egg harvesting, as well as assistance in hatching and raising hatchlings (Headstart). However, habitat destruction remains a concern in the form of bottom trawling and shoreline development. Trawling destroys habitat utilized by Kemp's ridley sea turtles for feeding and construction activities can produce hazardous runoff. Bycatch is also a source of mortality for Kemp's ridley sea turtles (McClellan et al. 2009), with roughly three-quarters of annual mortality attributed to shrimp trawling prior to turtle excluder device (TED) regulations (Gallaway et al. 2013). However, this has dropped to an estimated one-quarter of total mortality nearly 20 years after TEDS were implemented in 1990 (Gallaway et al. 2013). In 2010, due to reductions in shrimping effort and TED use, shrimp-trawl related mortality appears to have dropped to 4% (1,884) of total mortality (65,505 individuals; Gallaway et al. 2013). This increased to 3,300 individuals in 2012 (20% of total mortality; Gallaway et al. 2013). Finkbeiner et al. (2011) estimated that annual bycatch interactions total at least 98,300 individuals annually for US Atlantic fisheries (resulting in 2,700 mortalities or more). The vast majority of fisheries interactions with sea turtles in the US are either Kemp's ridley's or loggerhead sea turtles (Finkbeiner et al. 2011).

Toxin burdens in Kemp's ridley sea turtles include DDT, DDE, PCBs, perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), chlordane, and other organochlorines (Keller et al. 2005; Keller et al. 2004a; Lake et al. 1994; Rybitski et al. 1995). These contaminants have the potential to cause deficiencies in endocrine, developmental and reproductive health, and are known to depress immune function in loggerhead sea turtles (Keller et al. 2006; Storelli et al. 2007b). Along with loggerheads, Kemp's ridley sea turtles have higher levels of PCB and DDT than leatherback and green sea turtles (Pugh and Becker 2001a). Organochlorines, including DDT, DDE, dichlorodiphenyldichloroethane, and PCBs have been identified as bioaccumulative agents and in greatest concentration in subcutaneous lipid tissue (Rybitski et al. 1995). PCBs have also been identified in the liver at levels that are several fold higher than in other sea turtle species (Lake et al. 1994). However, concentrations are reportedly 5% of that which causes reproductive failure in snapping turtles. Blood samples may be appropriate proxies for organochlorines in other body tissues (Keller et al. 2004a).

Perfluorinated compounds in the forms of PFOA and PFOS have been identified in the blood of Kemp's ridley turtles (Keller et al. 2005). Perfluorinated carboxylic acids have also been detected. It is likely that age and habitat are linked to perfluorinated chemicals bioaccumulation.

Oil can also be hazardous to Kemp's ridley turtles, with fresh oil causing significant mortality and morphological changes in hatchlings, but aged oil having no detectable effects (Fritts and

McGehee 1981). Blood levels of metals are lower in Kemp’s ridley sea turtles than in other sea turtles species or similar to them, with copper, lead, mercury, silver, and zinc having been identified (Innis et al. 2008; Orvik 1997). It is likely that blood samples can be used as an indicator of metal concentration. Mercury has been identified in all turtle species studied, but are generally an order of magnitude lower than toothed whales. The higher level of contaminants found in Kemp’s ridley sea turtles are likely due to this species tendency to feed higher on the food chain than other sea turtles. Females from sexual maturity through reproductive life should have lower levels of contaminants than males because contaminants are shared with progeny through egg formation.

4.4.4 Loggerhead sea turtle- Northwest Atlantic DPS

Loggerhead sea turtles (**Figure 9**) are one of the larger sea turtle species, growing to 113 kg and about 1 m in length. Their shells are reddish-brown on top, but yellow on the bottom shell. They swim (and crawl on land when laying eggs) using four flattened flippers.

Figure 9. Loggerhead sea turtle. Photo taken by NOAA staff.

Populations. Five groupings represent loggerhead sea turtles by major sea or ocean basin: Atlantic, Pacific, and Indian oceans, as well as Caribbean and Mediterranean seas. As with other sea turtles, populations are frequently divided by nesting aggregation (Hutchinson and Dutton 2007). On September 22, 2011, the NMFS designated nine DPSs of loggerhead sea turtles: South Atlantic Ocean and southwest Indian Ocean as threatened as well as Mediterranean Sea, North Indian Ocean, North Pacific Ocean, northeast Atlantic Ocean, northwest Atlantic Ocean, South Pacific Ocean, and southeast Indo-Pacific Ocean as endangered (75 FR 12598). Recent ocean-basin scale genetic analysis supports this conclusion, with additional differentiation apparent based on nesting beaches (Shamblin et al. 2014).

Atlantic Ocean. Western Atlantic nesting locations include The Bahamas, Brazil, and numerous locations from the Yucatán Peninsula to North Carolina (Addison 1997; Addison and

Morford 1996; Marcovaldi and Chaloupka 2007). This group comprises five nesting subpopulations: Northern, Southern, Dry Tortugas, Florida Panhandle, and Yucatán. Additional nesting occurs on Cay Sal Bank (Bahamas), Cuba, the Bahamian Archipelago, Quintana Roo (Yucatan Peninsula), Colombia, Brazil, Caribbean Central America, Venezuela, and the eastern Caribbean Islands. Genetic studies indicate that, although females routinely return to natal beaches, males may breed with females from multiple populations and facilitate gene flow Bowen et al. (2005).

Distribution. Loggerheads are circumglobal occurring throughout the temperate and tropical regions. Loggerheads are the most abundant species of sea turtle found in US coastal waters.

Reproduction and growth. Loggerhead nesting is confined to lower latitudes temperate and subtropic zones but absent from tropical areas (NMFS and USFWS 1991b; NRC 1990b; Witherington et al. 2006b). The life cycle of loggerhead sea turtles can be divided into seven stages: eggs and hatchlings, small juveniles, large juveniles, subadults, novice breeders, first year emigrants, and mature breeders (Crouse et al. 1987). Hatchling loggerheads migrate to the ocean (to which they are drawn by near ultraviolet light; Kawamura et al. 2009), where they are generally believed to lead a pelagic existence for as long as 7-12 years (Avens et al. 2013; NMFS 2005). Loggerhead sea turtles born along the northern Gulf of Mexico are generally likely to leave the Gulf of Mexico after hatching (Lamont et al. 2015). Loggerheads in the Mediterranean, similar to those in the Atlantic, grow at roughly 11.8 cm/year for the first six months and slow to roughly 3.6 cm/year at age 2.5-3.5. As adults, individuals may experience a secondary growth pulse associated with shifting into neritic habitats, although growth is generally monotypic (declines with age; Casale et al. 2009a; Casale et al. 2009b). Individually-based variables likely have a high impact on individual-to-individual growth rates (Casale et al. 2009b). At 15-38 years, loggerhead sea turtles become sexually mature, although the age at which they reach maturity varies widely among populations (Casale et al. 2009b; Frazer and Ehrhart 1985a; Frazer et al. 1994; NMFS 2001; Witherington et al. 2006). However, based on new data from tag returns, strandings, and nesting surveys, NMFS (2001) estimated ages of maturity ranging from 20-38 years and benthic immature stage lasting from 14-32 years. Notably, data from several studies showed decreased growth rates of loggerheads in US Atlantic waters from 1997-2007, corresponding to a period of 43% decline in Florida nest counts (Bjorndal et al. 2013). Adult females tend to forage in neritic habitats between nesting events and just after nesting (Lamont et al. 2015).

Loggerhead mating likely occurs along migration routes to nesting beaches, as well as in offshore from nesting beaches several weeks prior to the onset of nesting (Dodd 1988; NMFS and USFWS 1998d). Females usually breed every 2-3 years, but can vary from 1-7 years (Dodd 1988; Richardson et al. 1978). Females lay an average of 4.1 nests per season (Murphy and Hopkins 1984) , although recent satellite telemetry from nesting females along southwest Florida support 5.4 nests per female per season, with increasing numbers of eggs per nest during the course of the season (Tucker 2009). The authors suggest that this finding warrants revision of the number of females nesting in the region. The western Atlantic breeding season is March-August. Nesting sites appear to be related to beaches with relatively high exposure to wind or wind-generated waves (Santana Garcon et al. 2010).

Gender, age, and survivorship. Although information on males is limited, several studies identified a female bias, although a single study has found a strong male bias to be possible (Dodd 1988; NMFS 2001; Rees and Margaritoulis 2004). Nest temperature seems to drive sex determination. Along Florida, males primarily derive from earlier-season (LeBlanc et al. 2012). Here, nests ranged from an average sex ratio of 55% female to 85% between 2000 and 2004 (LeBlanc et al. 2012). This number has been found to be even higher in some cases (89%; Rogers 2013). Juvenile and adult age classes have a slight female bias in the central Mediterranean Sea of 51.5% (Casale et al. 2014).

Additionally, little is known about longevity, although Dodd (1988) estimated the maximum female life span at 47-62 years. Towaszewicz et al. (2015) estimated that loggerhead sea turtles in the Gulf of California may not reach maturity until 25 years of age. Heppell et al. (2003a) estimated annual survivorship to be 0.81 (southeast US adult females) and 0.68-0.89 (southeast US benthic juveniles). Another recent estimate suggested a survival rate of 0.41 or 0.60 (confidence intervals 0.20-0.65 and 0.40-0.78, respectively), depending on assumptions within the study (Sasso et al. 2011). Survival rates for hatchlings during their first year are likely very low (Heppell et al. 2003a; Heppell et al. 2003). Higher fecundity is associated with warmer February and lower May temperatures for loggerheads on the northern Gulf of Mexico (Lamont and Fujisaki 2014).

Status and trends. Loggerhead sea turtles were listed as threatened under the ESA of 1973 on July 28, 1978 (43 FR 32800).

There is general agreement that the number of nesting females provides a useful index of the species’ population size and stability at this life stage, even though there are doubts about the ability to estimate the overall population size (Bjorndal et al. 2005). An important caveat for population trends analysis based on nesting beach data is that this may reflect trends in adult nesting females, but it may not reflect overall population growth rates well. Adult nesting females often account for less than 1% of total population numbers. The global abundance of nesting female loggerhead turtles is estimated at 43,320–44,560 (Spotila 2004).

Atlantic Ocean. The greatest concentration of loggerheads occurs in the Atlantic Ocean and the adjacent Caribbean Sea, primarily on the Atlantic coast of Florida, with other major nesting areas located on the Yucatán Peninsula of Mexico, Columbia, Cuba, South Africa (EuroTurtle 2006 as cited in LGL Ltd. 2007; Márquez 1990).

Among the five subpopulations, loggerhead females lay 53,000-92,000 nests per year in the southeastern US and the Gulf of Mexico, and the total number of nesting females are 32,000-56,000. All of these are currently in decline or data are insufficient to access trends (NMFS 2001; TEWG 1998). Loggerheads from western North Atlantic nesting aggregations may or may not feed in the same regions from which they hatch. Loggerhead sea turtles from the northern nesting aggregation, which represents about 9% of the loggerhead nests in the western North Atlantic, comprise 25-59% of individuals foraging from Georgia up to the northeast US (Bass et al. 1998; Norrgard 1995; Rankin-Baransky 1997; Sears 1994; Sears et al. 1995). Loggerheads associated with the South Florida nesting aggregation occur in higher frequencies in the Gulf of Mexico (where they represent about 10% of the loggerhead captures) and the Mediterranean Sea (where they represent about 45% of loggerhead sea turtles captured). About 4,000 nests per year are laid along the Brazilian coast (Ehrhart et al. 2003).

The northern recovery unit along Georgia, South Carolina, and North Carolina has a forty-year time-series trend showing an overall decline in nesting, but the shorter comprehensive survey data (20 years) indicate a stable population (Georgia Department of Natural Resources, North Carolina Department of Natural Resources, and South Carolina Department of Natural Resources, nesting data located at www.seaturtle.org). NMFS scientists have estimated that the northern subpopulation produces 65% males (NMFS 2001).

The peninsular Florida recovery unit is the largest loggerhead nesting assemblage in the northwest Atlantic. A near-complete nest census (all beaches including index nesting beaches) undertaken from 1989 to 2007 showed a mean of 64,513 loggerhead nests per year, representing approximately 15,735 nesting females annually (NMFS and USFWS 2008). The statewide estimated total for 2010 was 73,702 (Florida Wildlife Research Institute nesting database). An analysis of index nesting beach data shows a 26% nesting decline between 1989 and 2008, and a mean annual rate of decline of 1.6% despite a large increase in nesting for 2008, to 38,643 nests (Florida Wildlife Research Institute nesting database; NMFS and USFWS 2008; Witherington et al. 2009). In 2009, nesting levels, while still higher than the lows of 2004, 2006, and 2007, dropped below 2008 levels to approximately 32,717 nests, but in 2010 a large increase was seen, with 47,880 nests on the index nesting beaches (Florida Wildlife Research Institute nesting database). The 2010 index nesting number is the largest since 2000. With the addition of data through 2010, the nesting trend for the northwestern Atlantic DPS is slightly negative and not statistically different from zero (no trend; NMFS and USFWS 2010). Preliminary, unofficial reports indicate that 2011 nesting may be a high nesting year on par with 2010. Although not directly comparable to these index nesting numbers, nesting counts from 2010-2014 have shown no clear trend.

Because of its size, the south Florida subpopulation of loggerheads may be critical to the survival of the species in the Atlantic, and in the past it was considered second in size only to the Oman nesting aggregation (NMFS 2006e; NMFS and USFWS 1991b). The South Florida population increased at about 5.3% per year from 1978-1990, and was initially increasing at 3.9-4.2% after 1990. An analysis of nesting data from 1989-2005, a period of more consistent and accurate surveys than in previous years, showed a detectable trend and, more recently (1998-2005), has shown evidence of a declining trend of approximately 22.3% (FFWCC 2007a; FFWCC 2007b; Witherington et al. 2009). This is likely due to a decline in the number of nesting females within the population (Witherington et al. 2009). Nesting data from the Archie Carr Refuge (one of the most important nesting locations in southeast Florida) over the last 6 years shows nests declined from approximately 17,629 in 1998 to 7,599 in 2004, also suggesting a decrease in population size[1]. Loggerhead nesting is thought to consist of just 60 nesting females in the Caribbean and Gulf of Mexico (NMFS 2006c). Based on the small sizes of almost all nesting aggregations in the Atlantic, the large numbers of individuals killed in fisheries, and the decline of the only large nesting aggregation, we suspect that the extinction probabilities of loggerhead sea turtle populations in the Atlantic are only slightly lower than those of populations in the Pacific.

Natural threats. Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo “cold stunning” if water temperatures drop below a threshold level, which can pose lethal effects. In January 2010, an unusually large cold-stunning event occurred throughout the southeast US, with well over 3,000 sea turtles (mostly greens but also hundreds of loggerheads) found cold-stunned. Most survived, but several hundred were found dead or died after being discovered in a cold-stunned state. High temperatures before hatchlings emerge from their nests can also reduce hatchling success, as can bacterial contamination and woody debris in nests (Trocini 2013). Eggs are commonly eaten by raccoons and ghost crabs along the eastern US (Barton and Roth 2008), in Australia (Trocini 2013), and on Cape Verde Island, where an average of 50% of eggs are consumed by ghost crabs (Marco et al. 2015). In the water, hatchlings are hunted by herons, gulls, dogfish, and sharks. Heavy loads of barnacles are associated with unhealthy or dead stranded loggerheads (Deem et al. 2009). Brevetoxin-producing algal blooms can result in loggerhead sea turtle death and pathology, with nearly all stranded loggerheads in affected areas showing signs of illness or death resulting from exposure (Fauquier et al. 2013). The fungal pathogens *Fusarium falciforme* and *F. keratoplasticum* can kill in excess of 90% of sea turtle embryos they infect and may constitute a major threat to nesting productivity under some conditions (Sarmiento-Ramırez et al. 2014).

Anthropogenic threats. Anthropogenic threats impacting loggerhead nesting habitat are numerous: coastal development and construction, placement of erosion control structures, beachfront lighting, vehicular and pedestrian traffic, sand extraction, beach erosion, beach nourishment, beach pollution, removal of native vegetation, and planting of non-native vegetation (Baldwin 1992; Margaritoulis et al. 2003; Mazaris et al. 2009b; Patino-Martinez 2013; USFWS 1998). Surprisingly, beach nourishment also hampers nesting success, but only in the first year post-nourishment before hatching success increases (Brock et al. 2009). Loggerhead sea turtles face numerous threats in the marine environment as well, including oil and gas exploration, marine pollution, trawl, purse seine, hook and line, gill net, pound net,

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[1] While this is a long period of decline relative to the past observed nesting pattern at this location, aberrant ocean surface temperatures complicate the analysis and interpretation of these data. Although caution is warranted in interpreting the decreasing nesting trend given inherent annual fluctuations in nesting and the short time period over which the decline has been noted, the recent nesting decline at this nesting beach is reason for concern.

longline, and trap fisheries, underwater explosions, dredging, offshore artificial lighting, power plant entrapment, entanglement in debris, ingestion of marine debris, marina and dock construction and operation, boat collisions, and poaching.

The major factors inhibiting their recovery include mortalities caused by fishery interactions and degradation of the beaches on which they nest. Shrimp trawl fisheries account for the highest number of captured and killed loggerhead sea turtles. Along the Atlantic coast of the US, the NMFS estimated that shrimp trawls capture almost 163,000 loggerhead sea turtles each year in the Gulf of Mexico, of which 3,948 die. However, more recent estimates from suggest interactions and mortality has decreased from pre-regulatory periods, with a conservative estimate of 26,500 loggerheads captured annually in US Atlantic fisheries causing mortality up to 1,400 individuals per year (Finkbeiner et al. 2011). Commercial gillnet fisheries are estimated to have killed 52 loggerheads annually along the US mid-Atlantic (Murray 2013). Each year, various fisheries capture about 2,000 loggerhead sea turtles in Pamlico Sound, of which almost 700 die.

Wallace et al. (2010) estimated that between 1990 and 2008, at least 85,000 sea turtles were captured as bycatch in fisheries worldwide. This estimate is likely at least two orders of magnitude low, resulting in a likely bycatch of nearly half a million sea turtles annually (Wallace et al. 2010); many of these are expected to be loggerhead sea turtles. Major sea turtle bycatch in longline fisheries occurs off the US east coast (Lewison et al. 2014).

Marine debris ingestion can be a widespread issue for loggerhead sea turtles. More than one-third of loggerheads found stranded or bycaught had injected marine debris in a Mediterranean study, with possible mortality resulting in some cases (Lazar and Gračan 2010). Another study in the Tyrrhenian Sea found 71% of stranded and bycaught sea turtles had plastic debris in their guts (Campani et al. 2013). Another threat marine debris poses is to hatchlings on beaches escaping to the sea. Two thirds of loggerheads contacted marine debris on their way to the ocean and many became severely entangled or entrapped by it (Triessnig et al. 2012).

Climate change may also have significant implications on loggerhead populations worldwide. In addition to potential loss of nesting habitat due to sea level rise, loggerhead sea turtles are very sensitive to temperature as a determinant of sex while incubating. Ambient temperature increase by just 1-2º C can potentially change hatchling sex ratios to all or nearly all female in tropical and subtropical areas (Hawkes et al. 2007). Over time, this can reduce genetic diversity, or even population viability, if males become a small proportion of populations (Hulin et al. 2009). Sea surface temperatures on loggerhead foraging grounds correlate to the timing of nesting, with higher temperatures leading to earlier nesting (Mazaris et al. 2009a; Schofield et al. 2009) as well as to greater fecundity (Lamont and Fujisaki 2014). Higher ocean temperatures during February and lower May temperatures were associated with higher nesting success in the Gulf of Mexico (Lamont and Fujisaki 2014). Increasing ocean temperatures may also lead to reduced primary productivity and eventual food availability. Warmer temperatures may also decrease the energy needs of a developing embryo (Reid et al. 2009). Pike (2014) estimated that loggerhead populations in tropical areas produce about 30% fewer hatchlings than do populations in temperate areas. Historical climactic patterns have been attributed to the decline in loggerhead nesting in Florida, but evidence for this is tenuous (Reina et al. 2013).

Tissues taken from loggerheads sometimes contain very high levels of organochlorines chlorobiphenyl, chlordanes, lindane, endrin, endosulfan, dieldrin, PFOS, PFOA, DDT, and PCB (Alava et al. 2006; Corsolini et al. 2000; Gardner et al. 2003; Guerranti et al. 2013; Keller et al. 2005; Keller et al. 2004a; Keller et al. 2004b; McKenzie et al. 1999; Monagas et al. 2008; Oros et al. 2009; Perugini et al. 2006; Rybitski et al. 1995; Storelli et al. 2007a). It appears that levels of organochlorines have the potential to suppress the immune system of loggerhead sea turtles and may affect metabolic regulation (Keller et al. 2004c; Keller et al. 2006; Oros et al. 2009). These contaminants could cause deficiencies in endocrine, developmental, and reproductive health (Storelli et al. 2007a). It is likely that the omnivorous nature of loggerheads makes them more prone to bioaccumulating toxins than other sea turtle species (Godley et al. 1999; McKenzie et al. 1999). Polyaromatic hydrocarbons pollution from petroleum origins has been found in Cape Verde loggerheads, where oil and gas extraction is not undertaken in the marine environment (Camacho et al. 2012).

Heavy metals, including arsenic, barium, cadmium, chromium, iron, lead, nickel, selenium, silver, copper, zinc, and manganese, have also been found in a variety of tissues in levels that increase with turtle size (Anan et al. 2001; Fujihara et al. 2003; Garcia-Fernandez et al. 2009; Gardner et al. 2006; Godley et al. 1999; Saeki et al. 2000; Storelli et al. 2008). These metals likely originate from plants and seem to have high transfer coefficients (Anan et al. 2001; Celik et al. 2006; Talavera-Saenz et al. 2007). Elevated mercury levels are associated with deformities in hatchlings versus healthy individuals (Trocini 2013).

Loggerhead sea turtles have higher mercury levels than any other sea turtle studied, but concentrations are an order of magnitude less than many toothed whales (Godley et al. 1999; Pugh and Becker 2001b). Arsenic occurs at levels several fold more concentrated in loggerhead sea turtles than marine mammals or seabirds.

Also of concern is the spread of antimicrobial agents from human society into the marine environment. Loggerhead sea turtles may harbor antibiotic-resistant bacteria, which may have developed and thrived as a result of high use and discharge of antimicrobial agents into freshwater and marine ecosystems (Foti et al. 2009).

5 ENVIRONMENTAL BASELINE

The “environmental baseline” includes the past and present impacts of all Federal, state, 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 which are contemporaneous with the consultation in process (50 CFR 402.02).

5.1 Habitat degradation

A number of factors may be directly or indirectly affecting listed species in the action area by degrading habitat. These include ocean noise, marine debris, military activities, invasive species, pollution, scientific research, dredging, storms, and fisheries impacts.

In-water construction activities (e.g., pile driving associated with shoreline projects) in both inland waters as well as coastal waters in the action area can produce sound levels sufficient to disturb sea turtles under some conditions. Pressure levels from 190-220 decibels (dB) re 1 micropascal were reported for piles of different sizes in a number of studies (NMFS 2006b). The majority of the sound energy associated with pile driving is in the low frequency range (less than 1,000 Hertz; Illingworth and Rodkin Inc. 2001; Illingworth and Rodkin Inc. 2004; Reyff 2003), which is the frequency range sea turtles hear best at. Dredging operations also have the potential to emit sounds at levels that could disturb sea turtles. Depending on the type of dredge, peak sound pressure levels from 100 to 140 dB re 1 micropascal were reported in one study (Clarke et al. 2003). As with pile driving, most of the sound energy associated with dredging is in the low-frequency range, less than 1,000 Hertz (Clarke et al. 2003).

Several measures have been adopted as best practice or as part of Federal or State permitting to reduce the sound pressure levels associated with in-water construction activities or prevent exposure of sea turtles to sound. For example, a six-inch block of wood placed between the pile and the impact hammer used in combination with a bubble curtain can reduce sound pressure levels by about 20 dB (NMFS 2008). Alternatively, pile driving with vibratory hammers produces peak pressures that are about 17 dB lower than those generated by impact hammers (Nedwell and Edwards 2002). Other measures used in the action area to reduce the risk of disturbance from these activities include avoidance of in-water construction activities during times of year when sea turtles may be present; monitoring for sea turtles during construction activities; and maintenance of a buffer zone around the project area, within which sound-producing activities would be halted when sea turtles enter the zone (NMFS 2008).

Marine debris is a significant concern for listed species and their habitats. Marine debris accumulates in gyres throughout the oceans. The input of plastics into the marine environment also constitutes a significant degradation to the marine environment. In 2010, an estimated 4.8-12.7 million metric tons of plastic entered the ocean globally (Baulch and Simmonds 2015). Law et al. (2010) presented a time series of plastic content at the surface of the western North Atlantic Ocean and Caribbean Sea from 1986 to 2008. More than 60% of 6,136 surface plankton net tows collected small, buoyant plastic pieces. The data identified an accumulation zone east of Bermuda that is similar in size to the accumulation zone in the Pacific Ocean and is a major accumulation center for anthropogenic debris (Schuyler et al. 2015).

For sea turtles, marine debris is a problem due primarily to individuals ingesting debris and blocking the digestive tract, causing death or serious injury (Laist et al. 1999; Lutcavage et al. 1997a). Schuyler et al. (2015) estimated that, globally, 52% of individual sea turtles have ingested marine debris.Of Pacific green sea turtles, 91% had marine debris (mostly plastics) in their guts (Wedemeyer-Strombel et al. 2015). Gulko and Eckert (2003) estimated that between one-third and one-half of all sea turtles ingest plastic at some point in their lives; this figure is supported by data from Lazar and Gracan (2010), who found 35% of loggerheads had plastic in their gut. Over 50% of loggerheads had marine debris in their guts (greater than 96% of which was plastic) in the Indian Ocean (Hoarau et al. 2014). One study found 37% of dead leatherback turtles had ingested various types of plastic (Mrosovsky et al. 2009). A Brazilian study found that 60% of stranded green sea turtles had ingested marine debris (primarily plastic and oil; Bugoni et al. 2001). Loggerhead sea turtles had a lesser frequency of marine debris ingestion. Plastic is possibly ingested out of curiosity or due to confusion with prey items; for example, plastic bags can resemble jellyfish (Milton and Lutz 2003). Marine debris consumption has been shown to depress growth rates in post-hatchling loggerhead sea turtles, elongating the time required to reach sexual maturity and increasing predation risk (McCauley and Bjorndal 1999). Sea turtles can also become entangled and die in marine debris, such as discarded nets and monofilament line (Laist et al. 1999; Lutcavage et al. 1997a; NRC 1990c; O'Hara et al. 1988). Studies of shore cleanups have found that marine debris washing up along the northern Gulf of Mexico shoreline amounts to about 100 kg/km (ACC 2010; LADEQ 2010; MASGC 2010; TGLO 2010). Sea turtles can also become entangled and die in marine debris, such as discarded nets and monofilament line (Laist et al. 1999; Lutcavage et al. 1997a; NRC 1990c; O'Hara et al. 1988).

5.2 Entrapment and entanglement in fishing gear

Globally, 6.4 million tons of fishing gear is lost in the oceans every year (Wilcox et al. 2015). Fishery interaction remains a major factor in sea turtle recovery and, frequently, the lack thereof. NMFS (2002b) estimated that 62,000 loggerhead sea turtles have been killed as a result of incidental capture and drowning in shrimp trawl gear. Although TEDs and other bycatch reduction devices have significantly reduced the level of bycatch to sea turtles and other marine species in US waters, mortality still occurs in Gulf of Mexico waters. This is discussed further in the *Status of ESA-listed Species* section.

In addition to commercial bycatch, recreational hook-and-line interaction also occurs. Cannon and Flanagan (1996) reported that from 1993 to 1995, at least 170 Kemp’s ridley sea turtles were hooked or tangled by recreational hook-and-line gear in the northern Gulf of Mexico. Of these, 18 were dead stranded turtles, 51 were rehabilitated turtles, five died during rehabilitation, and 96 were reported as released by fishermen.

5.3 Dredging

Marine dredging vessels are common within US coastal waters. Construction and maintenance of federal navigation channels and dredging in sand mining sites have been identified as sources of sea turtle mortality and are currently being undertaken along the US East Coast, such as in Port Everglades, Florida. Hopper dredges in the dredging mode are capable of moving relatively quickly compared to sea turtle swimming speed and can thus overtake, entrain, and kill sea turtles as the suction draghead(s) of the advancing dredge catch up to resting or swimming turtles. Entrained sea turtles rarely survive. Relocation trawling frequently occurs in association with dredging projects to reduce the potential for dredging to injure or kill sea turtles (Dickerson et al. 2007). Dredging has been documented to capture or kill 168 sea turtles from 1995 to 2009 in the Gulf of Mexico, including 97 loggerheads, 35 Kemp’s ridleys, 32 greens, and three unidentified sea turtles (USACOE 2010).

5.4 US Navy training and testing activities

Naval activities conducted during training exercises in designated naval operating areas and training ranges have the potential to adversely harm sea turtles. Species occurring in the action area could experience stressors from several naval training ranges or facilities listed below. Listed individuals travel widely in the North Atlantic and could be exposed to naval activities in several ranges.

- The Virginia Capes, Cherry Point, and Jacksonville-Charleston Operating Areas, which are situated consecutively along the migratory corridor for sea turtles, and
- The Key West, Gulf of Mexico, Bermuda, and Puerto Rican Complexes have the potential to overlap the range of sea turtles species.

Naval activities to which individuals could be exposed include, among others, vessel and aircraft transects, munition detonations, and sonar use.

Anticipated impacts from harassment include changes from foraging, resting, and other behavioral states that require lower energy expenditures to traveling, avoidance, and behavioral states that require higher energy expenditures and, therefore, would represent significant disruptions of the normal behavioral patterns of the animals that have been exposed. Behavioral responses that result from stressors associated with these training activities are expected to be temporary and would not affect the reproduction, survival, or recovery of these species.

From 2009-2012, NMFS issued a series of biological opinions to the US Navy for training activities occurring within their Virginia Capes, Cherry Point, and Jacksonville Range Complexes that anticipated annual levels of take of listed species incidental to those training activities through 2014. During the proposed activities 344 hardshell sea turtles (any combination of green, hawksbill, Kemp’s ridley, or northwest Atlantic loggerhead sea turtles) per year were expected to be harassed as a result of their behavioral responses to mid- and high frequency active sonar transmissions.

In 2014, NMFS issued a biological opinion to the US Navy on all testing and training activities in the Atlantic basin (Table 4 and

Table 5). These actions would include the same behavioral and hearing loss effects as described above, but would also include other sub-lethal injuries that lead to fitness consequences and mortality that can lead to the loss of individuals from their populations.

Table 4. Annual take authorized for US Navy testing activities in the North Atlantic.

Sea turtle species	Behavioral and temporary threshold shift	Permanent threshold shift	Organ injury	Mortality
Hardshell sea turtles	5,132	10	242	49
Kemp's ridley	292	0	17	4
Loggerhead	1,017	15	578	81

Table 5. Annual take authorized for US Navy training activities in the North Atlantic.

Sea turtle species	Behavioral and temporary threshold shift	Permanent threshold shift	Organ injury	Mortality
Hardshell sea turtles	12,216	22	4	2
Kemp's ridley	302	2	1	1
Loggerhead	16,812	34	7	4

5.5 Pollutants

The Gulf of Mexico is a sink for massive levels of pollution from a variety of marine and terrestrial sources, which ultimately can interfere with ecosystem health and particularly that of sea turtles (see *Status of ESA-listed Species* section). Sources include the petrochemical industry in and along the Gulf of Mexico, wastewater treatment plants, septic systems, industrial facilities, agriculture, animal feeding operations, and improper refuse disposal. The Mississippi River drains 80% of United States cropland (including the fertilizers, pesticides, herbicides, and other contaminants that are applied to it) and discharges into the Gulf of Mexico (MMS 1998). Agricultural discharges, as well as discharges from large urban centers (ex.: Tampa) contribute contaminants as well as coliform bacteria to Gulf of Mexico habitats (Garbarino et al. 1995). These contaminants can be carried long distances from terrestrial or nearshore sources and ultimately accumulate in offshore pelagic environments (USCOP 2004). The ultimate impacts of this pollution are poorly understood.

Significant attention has been paid to nutrient enrichment of Gulf of Mexico waters, which leads to algal blooms (including harmful algal blooms), oxygen depletion, loss of seagrass and coral reef habitat, and the formation of a hypoxic “dead zone” (USCOP 2004). This hypoxic event occurs annually from as early as February to as late as October, spanning roughly 12,700 square kilometers (although in 2005 the “dead zone” grew to a record size of 22,000 square kilometers) from the Mississippi River Delta to Galveston, Texas (LUMCON 2005; MMS 1998; Rabalais et al. 2002; USGS 2010). Although sea turtles do not extract oxygen from sea water, numerous staple prey items of sea turtles, such as fish, shrimp, and crabs, do and are killed by the hypoxic conditions (Craig et al. 2001). More generally, the “dead zone” decreases biodiversity, alters marine food webs, and destroys habitat (Craig et al. 2001; Rabalais et al. 2002). High nitrogen loads entering the Gulf of Mexico from the Mississippi River is the likely culprit; nitrogen concentrations entering the Gulf of Mexico have increased three fold over the past 60 years (Rabalais et al. 2002).

5.6 Oil spills and releases

Oil pollution has been a significant concern in the Gulf of Mexico for several decades due to the large amount of extraction and refining activity in the region. Routine discharges into the northern Gulf of Mexico (not including oil spills) include roughly 88,200 barrels of petroleum per year from municipal and industrial wastewater treatment plants and roughly 19,250 barrels from produced water discharged overboard during oil and gas operations (MMS 2007b; USN 2008). These sources amount to over 100,000 barrels of petroleum discharged into the northern Gulf of Mexico annually. Although this is only 10% of the amount discharged in a major oil spill, such as the Exxon *Valdez* spill (roughly 1 million barrels), this represents a significant and “unseen” threat to Gulf of Mexico wildlife and habitats. Generally, accidental oil spills may amount to less than 24,000 barrels of oil discharged annually in the northern Gulf of Mexico, making non-spilled oil normally one of the leading sources of oil discharge into the Gulf of Mexico, although incidents such as the 2010 *Deepwater Horizon* incident are exceptional (MMS 2007a). The other major source from year to year is oil naturally seeping into the northern Gulf of Mexico. Although exact figures are unknown, natural seepage is estimated at between 120,000 and 980,000 barrels of oil annually (MacDonald et al. 1993; MMS 2007b).

Although non-spilled oil is the primary contributor to oil introduced into the Gulf of Mexico, concern over accidental oil spills is well-founded (Campagna et al. 2011). Over five million barrels of oil and one million barrels of refined petroleum products are transported in the northern Gulf of Mexico daily (MMS 2007b); worldwide, it is estimated that 900,000 barrels of oil are released into the environment as a result of oil and gas activities annually (Epstein and (Eds.). 2002). Even if a small fraction of the annual oil and gas extraction is released into the marine environment, major, concentrated releases can result in significant environmental impacts. Because of the density of oil extraction, transport, and refining facilities in the Houston/Galveston and Mississippi Delta areas (and the extensive activities taking place at these facilities), these locations have the greatest probability of experiencing oil spills. Oil released into the marine environment contains aromatic organic chemicals known to be toxic to a variety of marine life; these chemicals tend to dissolve into the air to a greater or lesser extent, depending on oil type and composition (Yender et al. 2002). Solubility of toxic components is generally low, but does vary and can be relatively high (0.5-167 parts per billion; Yender et al. 2002). Use of dispersants can increase oil dispersion, raising the levels of toxic constituents in the water column, but speeding chemical degradation overall (Yender et al. 2002). The remaining oil becomes tar, which forms floating balls that can be transported thousands of kilometers into the North Atlantic. The most toxic chemicals associated with oil can enter marine food chains and bioaccumulate in invertebrates such as crabs and shrimp to a small degree (prey of some sea turtles; Law and Hellou 1999; Marsh et al. 1992), but generally do not bioaccumulate or biomagnify in finfish (Baussant et al. 2001; Meador et al. 1995; Varanasi et al. 1989; Yender et al. 2002). Sea turtles are known to ingest and attempt to ingest tar balls, which can block their digestive systems, impairing foraging or digestion and potentially causing death (NOAA 2003), ultimately reducing growth, reproductive success, as well as increasing mortality and predation risk (Fraser 2014). Tarballs were found in the digestive tracts of 63% of post hatchling loggerheads in 1993 following an oil spill and 20% of the same species and age class in 1997 (Fraser 2014). Although the effects of dispersant chemicals on sea turtles is unknown, testing on other organisms have found currently used dispersants to be less toxic than those used in the past (NOAA 2003). It is possible that dispersants can interfere with surfactants in the lungs (surfactants prevent the small spaces in the lungs from adhering together due to surface tension, facilitating large surface areas for gas exchange), as well as interfere with digestion, excretion, and salt gland function (NOAA 2003). Oil exposure can also cause acute damage on direct exposure to oil, including skin, eye, and respiratory irritation, reduced respiration, burns to mucous membranes such as the mouth and eyes, diarrhea, gastrointestinal ulcers and bleeding, poor digestion, anemia, reduced immune response, damage to kidneys or liver, cessation of salt gland function, reproductive failure, and death (NOAA 2003; NOAA 2010b; Vargo et al. 1986b; Vargo et al. 1986c; Vargo et al. 1986a). Nearshore spills or large offshore spills can oil beaches on which sea turtles lay their eggs, causing birth defects or mortality in the nests (NOAA 2003; NOAA 2010b).

Several oil spills have impacted the northern Gulf of Mexico over the past few years, largely due to hurricanes. The impacts of Hurricane Ivan in 2004 on the Gulf Coast included pipeline damage causing 16,000 barrels of oil to be released and roughly 4,500 barrels of petroleum products from other sources (BOEMRE 2010; USN 2008). The next year, Hurricane Katrina caused widespread damage to onshore oil storage facilities, releasing 191,000 barrels of oil (LHR 2010). Another 4,530 barrels of oil were released from 70 other smaller spills associated with hurricane damage. Shortly thereafter, Hurricane Rita damaged offshore facilities resulting in 8,429 barrels of oil released (USN 2008).

Major oil spills have impacted the Gulf of Mexico for decades (NMFS 2010). Until 2010, the largest oil spill in North America occurred in the Bay of Campeche (1979), when a well “blew out”, allowing oil to flow into the marine environment for nine months, releasing 2.8-7.5 million barrels of oil. Oil from this release eventually reached the Texas coast, including the Kemp's ridley sea turtle nesting beach at Rancho Nuevo, where 9,000 hatchlings were airlifted and released offshore (NOAA 2003). Over 7,600 cubic meters of oiled sand was eventually removed from Texas beaches and 200 gallons of oil were removed from the area around Rancho Nuevo (NOAA 2003). Eight dead and five live sea turtles were recovered during the oil spill event; although cause of deaths were not determined, oiling was suspected to play a part (NOAA 2003). Also in 1979, the oil tanker *Burmah Agate* collided with another vessel near Galveston, Texas, causing an oil spill and fire that ultimately released 65,000 barrels of oil into estuaries, beachfronts, and marshland along the northern and central Texas coastline (NMFS 2010). Clean-up of these areas was not attempted due to the environmental damage such efforts would have caused. Another 195,000 barrels of oil are estimated to have been burned in a multi-month-long fire aboard the *Burmah Agate* (NMFS 2010). The tanker *Alvenus* grounded in 1984 near Cameron, Louisiana, spilling 65,500 barrels of oil which spread west along the shoreline to Galveston (NMFS 2010). One oiled sea turtle was recovered and released (NOAA 2003). In 1990, the oil tanker *Megaborg* experienced an accident near Galveston during the lightering process and released 127,500 barrels of oil, most of which burned off in the ensuing fire (NMFS 2010).

On April 20 2010, a fire and explosion occurred aboard the semisubmersible drilling platform *Deepwater Horizon* roughly 80 km southeast of the Mississippi Delta (NOAA 2010a). The platform had 17,500 barrels of fuel aboard, which likely burned, escaped, or sank with the platform (NOAA 2010a). However, once the platform sank, the riser pipe connecting the platform to the wellhead on the seafloor broke in multiple locations, initiating an uncontrolled release of oil from the exploratory well. Over the next three months, oil was released into the Gulf of Mexico, resulting in oiled regions of Texas, Louisiana, Mississippi, Alabama, and Florida and widespread oil slicks throughout the northern Gulf of Mexico that closed more than one-third of the Gulf of Mexico Exclusive Economic Zone to fishing due to contamination concerns. Apart from the widespread surface slick, massive undersea oil plumes formed, possibly through the widespread use of dispersants and reports of tarballs washing ashore throughout the region were common. Although estimates vary, roughly 4.1 million barrels of oil were released directly into the Gulf of Mexico (USDOI 2012). During surveys in offshore oiled areas, 1,050 sea turtles were seen and half of these were captured (Witherington et al. 2012). Of the 520 sea turtles captured, 394 showed signs of being oiled (Witherington et al. 2012). A large majority of these were juveniles, mostly green (311) and Kemp's ridley sea turtles (451) (Witherington et al. 2012). An additional 78 adult or subadult loggerheads were observed (Witherington et al. 2012). However, specific causes of injury or death have not yet been established for many of these individuals as investigations into the role of oil in these animals' health status continue. Captures of sea turtles along the Louisiana's Chandeleur Islands in association with emergency sand berm construction resulted in 185 loggerheads, eight Kemp's ridley, and a single green sea turtle being captured and relocated (Dickerson and Bargo 2012). In addition, 274 nests along the Florida panhandle were relocated that ultimately produced 14,700 hatchlings, but also had roughly 2% mortality associated with the translocation (MacPherson et al. 2012). Females that laid these nests continued to forage in the area, which was exposed to the footprint of the oil spill (Hart et al. 2014). Large areas of *Sargassum* were affected, with some heavily oiled or dispersant-coated *Sargassum* sinking and other areas accumulating oil where sea turtles could inhale, ingest, or contact it (Powers et al. 2013; USDOI 2012). Of 574 sea turtles observed in these *Sargassum* areas, 464 were oiled (USDOI 2012).

Oil can also cause indirect effects to sea turtles through impacts to habitat and prey organisms. Seagrass beds may be particularly susceptible to oiling as oil contacts grass blades and sticks to them, hampering photosynthesis and gas exchange (Wolfe et al. 1988). If spill cleanup is attempted, mechanical damage to seagrass can result in further injury and long-term scarring. Loss of seagrass due to oiling would be important to green sea turtles, as this is a significant component of their diets (NOAA 2003). The loss of invertebrate communities due to oiling or oil toxicity would also decrease prey availability for hawksbill, Kemp's ridley, and loggerhead sea turtles (NOAA 2003). Furthermore, Kemp's ridley and loggerhead sea turtles, which commonly forage on crustaceans and mollusks, may ingest large amounts of oil due oil adhering to the shells of these prey and the tendency for these organisms to bioaccumulate the toxins found in oil (NOAA 2003). It is suspected that oil adversely impacted the symbiotic bacteria in the gut of herbivorous marine iguanas when the Galapagos Islands experienced an oil spill, contributing to a more than 60% decline in local populations the following year. The potential exists for green sea turtles to experience similar impacts, as they also harbor symbiotic bacteria to aid in their digestion of plant material (NOAA 2003). Dispersants are believed to be as toxic to marine organisms as oil itself.

Marine and anadromous fish species can be impacted by oil contamination directly through uptake by the gills, ingestion of oil or oiled prey, effects on eggs and larval survival, and through contamination of foraging and spawning sites. Studies after the Exxon *Valdez* oil spill demonstrated that fish embryos exposed to low levels of polyaromatic hydrocarbons in weathered crude oil develop a syndrome of edema and craniofacial and body axis defects (Incardona et al. 2005).

5.7 Seismic surveys and oil and gas development

The northern Gulf of Mexico is the location of massive industrial activity associated with oil and gas extraction and processing. Over 4,000 oil and gas structures are located outside of state waters in the northern Gulf of Mexico; 90% of these occur off Louisiana and Texas (USN 2009). This is both detrimental and beneficial for sea turtles. These structures appreciably increase the amount of hard substrate in the marine environment, providing shelter and foraging opportunities for species like loggerhead sea turtles (Parker et al. 1983; Stanley and Wilson 2003). However, the Minerals Management Service requires that structures must be removed within one year of lease termination. Many of these structures are removed by explosively severing the underwater supportive elements, which produces a shock wave that kills, injures, or disrupts marine life in the blast radius (Gitschlag et al. 1997). For sea turtles, this means death or serious injury for individuals within a few hundred meters of the structure and overt behavioral (potentially physiological) impacts for individuals further out (Duronslet et al. 1986; Klima et al. 1988). Although observers and procedures are in place to mitigate impacts to sea turtles (i.e., not blasting when sea turtles are present), not all sea turtles are observed all the time and low-level sea turtle injury and mortality still occurs (Gitschlag and Herczeg 1994; Gitschlag et al. 1997); two loggerheads were killed in August 2010 and one Kemp's ridley was killed in July 2013, along with several additional stunning or at least sub-lethal injuries reported over the past five years (G. Gitschlag, NOAA, pers. comm.). Current annual authorized takes due to the Minerals Management Services' outer continental shelf oil and gas exploration, development, production, and abandonment activities are 30 sea turtles, including no more than one each of Kemp's ridley, green, hawksbill, or leatherback turtles and no more than ten loggerhead turtles (NMFS 1988). These levels were far surpassed by the *Deepwater Horizon* incident.

5.8 Hurricanes

The Gulf of Mexico is prone to major tropical weather systems, including tropical storms and hurricanes. The impacts of these storms on sea turtles in the marine environment is not known, but storms can cause major impacts to sea turtle eggs on land, as nesting frequently overlaps with hurricane season, particularly Kemp's ridley sea turtles (NRC 1990c). Mortality can result both from drowning of individuals while still in the egg or emerging from the nest as well as causing major topographic alteration to beaches, preventing hatchling entry to marine waters. Kemp's ridley sea turtles are likely highly sensitive to hurricane impacts, as their only nesting locations are in a limited geographic area along southern Texas and northern Mexico (Milton et al. 1994). In 2010, Hurricane Alex made landfall in this area; surprisingly, few nests were lost (Jaime Pena, Gladys Porter Zoo, pers. comm.). Tropical storm Hermine arrived too late in 2010 to impact eggs or hatchlings at Rancho Nuevo (Donna Shaver, NPS, pers. comm.).

5.9 Entrainment in power plants

Sea turtles entering coastal or inshore areas have been affected by entrainment in the cooling-water systems of electrical generating plants. A comprehensive biological opinion that covers all power plant cooling water intakes was issued by the USFWS and NMFS in May 2014, but does not identify amount or extent of ESA-listed species expected to be taken. This will be undertaken on a case-by-case basis for each power plant, but would generally involve stress from being captured in entrainment structures and mortality of individuals stuck on entrainment grates or sucked into coolant systems.

5.10 Ship-strikes

Sea turtle ship strikes are a poorly-studied threat, but have the potential to be an important source of mortality to sea turtle populations (Work et al. 2010). All sea turtles must surface to breathe and several species are known to bask at the surface for long periods. Although sea turtles can move rapidly, sea turtles apparently are not able to move out of the way of vessels moving at more than 4 km/hour; most vessels move far faster than this in open water (Hazel et al. 2007;

Work et al. 2010). This, combined with the massive level of vessel traffic in the Gulf of Mexico, has the potential to result in frequent injury and mortality to sea turtles in the region (MMS 2007b). Hazel et al. (2007) suggested that green sea turtles may use auditory cues to react to approaching vessels rather than visual cues, making them more susceptible to strike as vessel speed increases. Each state along the Gulf of Mexico has several hundred thousand recreational vessels registered, including Florida with nearly one million-the highest number of registered boats in the United States-and Texas with over 600,000 (ranked sixth nationally; NMMA 2007; USCG 2003; USCG 2005). Commercial vessel operations are also extensive. Vessels servicing the offshore oil and gas industry are estimated to make 115,675-147,175 trips annually, apart from commercial vessels travelling to and from some of the largest ports in the US (such as New Orleans and Houston; MMS 2007a; USN 2008).

Sea turtles may also be harassed by the high level of helicopter activity over Gulf of Mexico waters. It is estimated that between roughly 900,000 and 1.5 million helicopter take-offs and landings are undertaken in association with oil and gas activities in the Gulf of Mexico annually (NRC 1990c; USN 2008). This likely includes numerous overflights of sea turtles, an activity which has been observed to startle and at least temporarily displace sea turtles (USN 2009).

5.11 Scientific research and permits

Scientific research permits issued by the NMFS currently authorize studies of ESA-listed species in the North Atlantic Ocean, some of which extend into portions of the action area for the proposed project. Authorized research on ESA-listed sea turtles includes capture, handling, and restraint, satellite, sonic, and PIT tagging, blood and tissue collection, lavage, ultrasound, captive experiments, laparoscopy, and imaging. Research activities involve "takes" by harassment, with some resulting mortality. It is noteworthy that although the numbers tabulated below represent the maximum number of "takes" authorized in a given year, monitoring and reporting indicate that the actual number of "takes" rarely approach the number authorized. Therefore, it is unlikely that the level of exposure to research techniques indicated below has or will occur in the near term. However, our analysis assumes that these "takes" will occur since they have been authorized. It is also noteworthy that these "takes" are distributed across the Atlantic Ocean, mostly from Florida to Maine, and in the eastern Gulf of Mexico. Although sea turtles are generally wide-ranging, we do not expect many of the authorized "takes" to involve individuals who would also be "taken" under the proposed research considered in this opinion. There are numerous permits[2] issued since 2009 under the provisions of the ESA authorizing scientific research on sea turtles. The consultations which took place on the issuance of these ESA scientific research permits each found that the authorized activities would not result in jeopardy to the species or adverse modification of designated critical habitat.

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[2] Permit numbers: 633-1778, 775-1875, 1036-1744, 1058-1733, 10014, 14451, 14856, 15575, 16109, 16239, 16325, 16388, and 17355. See https://apps.nmfs.noaa.gov/index.cfm for additional details.

Tables 6-9 show the number of takes authorized for green, Kemp's ridley, hawksbill, and loggerhead sea turtles in the action area in scientific research permits.

Table 6. Green sea turtle takes in the Atlantic Ocean.

Year	Capture/handling /restraint	Satellite,sonic, or pit tagging	Blood/tissue collection	Lavage	Ultrasound	Captive experiment	Laparoscopy	Imaging	Mortality
2009	3,093	3,093	3,009	1,860	555	66	74	72	6
2010	3,753	3,753	3,669	2,480	555	66	74	72	6
2011	4,255	4,255	3,505	2,990	564	66	74	72	20
2012	3,354	3,354	2,622	2,210	704	66	74	72	18.2
2013	5,001	5,001	4,325	3,654	1,903	91	398	396	4.2
2014	4,336	3,686	3,660	3,044	1,408	65	324	324	4.2
2015	4,280	3,630	3,610	3,044	1,408	65	324	324	4.2
2016	2,960	2,960	2,940	1,734	1,408	65	324	324	4.2
Total	**31,032**	**29,732**	**27,340**	**21,016**	**8,505**	**550**	**1,666**	**1,656**	**67**

Permit numbers: 1450, 1462, 1501, 1506, 1507, 1518, 1522, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 10014, 10022, 13306, 13307, 13543, 13544, 13573, 14506, 14508,14622, 14655, 14726, 14949, 15112, 15135, 15552, 15556, 15575, 15606, 15802, 16134, 16146, 16174, 16194, 16253, 16556, 16598, 16733, 17183, 17304, 17355, 17381, 17506, and 18069.

Table 7. Hawksbill sea turtle takes in the Atlantic Ocean.

Year	Capture/handling /restraint	Satellite,sonic, or pit tagging	Blood/tissue collection	Lavage	Ultrasound	Captive experiment	Mortality
2009	1,088	1,088	1,081	464	254	0	3
2010	1,424	1,424	1,417	534	254	0	3
2011	1,959	1,959	1,955	914	255	0	4.4
2012	1,462	1,456	1,452	904	255	0	3.6
2013	1,423	1,417	1,415	844	320	39	1.6
2014	1,114	1,108	1,106	550	66	39	1.6
2015	1,032	1,026	1,026	550	66	39	1.6
2016	1,106	1,050	1,013	500	66	39	1.6
Total	**10,608**	**10,528**	**10,465**	**5,260**	**1,536**	**156**	**20.4**

Permit numbers: 1462, 1501, 1506, 1507, 1518, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 1599, 10014, 10022, 13306, 13307, 13543, 13544, 14272, 14508, 14726, 14506, 14508, 14622, 14655, 14726, 14949, 15112, 15135, 15552, 15566, 15575, 15606, 15802, 16134, 16146, 16194, 16253, 16598, 16733, 17183, 17304, 17355, 17381, and 17506

Table 8. Kemp's ridley sea turtle takes in the Atlantic Ocean.

Year	Capture/handling /restraint	Satellite,sonic, or pit tagging	Blood/tissue collection	Lavage	Ultrasound	Captive experiment	Laparoscopy	Imaging	Mortality
2009	1,394	1,394	1,195	425	371	56	53	53	5
2010	1,402	1,402	1,203	426	371	56	53	53	5
2011	2,210	2,210	1,368	976	400	56	53	53	9
2012	2,229	2,219	1,561	972	450	56	53	53	7.2
2013	2,836	2,852	2,190	1,627	990	116	213	218	3.2
2014	2,010	2,026	1,964	706	619	60	160	165	3.2
2015	1,833	1,849	1,819	706	619	60	160	165	3.2
2016	1,420	1,436	1,406	300	264	40	125	125	3.2
Total	**15,334**	**15,388**	**12,706**	**6,138**	**4,084**	**500**	**870**	**885**	**39**

Permit numbers: 1462, 1501, 1506, 1507, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 10014, 10022, 13306, 13543, 13544, 14508, 14726, 14506, 14622, 14655, 14726, 15112, 15135, 15552, 15566, 15575, 15606, 15802, 16134, 16194, 16253, 16556, 16598, 16733, 17183, 17304, 17355, 17381, 17506, and 18069.

Table 9. Loggerhead sea turtle takes in the North Atlantic Ocean.

Year	Capture/handling /restraint	Satellite,sonic, or pit tagging	Blood/tissue collection	Lavage	Ultrasound	Captive experiment	Laparoscopy	Imaging	Mortality
2009	5,462	5,462	5,044	1,165	1,322	200	109	123	111
2010	5,464	5,464	5,046	1,205	1,322	200	109	116	111
2011	7,165	7,165	6,097	1,420	1,667	200	148	114	122.2
2012	4,791	4,791	3,741	1,370	1,429	200	161	114	29.8
2013	5,909	5,909	4,859	2,609	2,519	305	401	354	24.8
2014	4,052	3,912	3,862	1,460	1,543	105	292	240	24.8
2015	3,935	3,795	3,795	1,470	1,543	105	292	240	7.8
2016	3,510	3,510	3,510	1,255	1,543	105	292	240	7.8
Total	**40,288**	**40,008**	**35,954**	**11,954**	**12,888**	**1,420**	**1,804**	**1,541**	**439.2**

Permit numbers: 1450, 1462, 1501, 1506, 1507, 1522, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 1599, 10014, 10022, 13306, 13307, 13543, 13544, 14249, 14622, 14506, 14508, 14622, 14655, 14726, 15112, 15552, 15566, 15575, 15606, 15802, 16134, 16146, 16194, 16253, 16556, 16598, 16733, 17183, 17304, 17355, 17381, 17506, and 18069.

5.12 The impact of the baseline on ESA-listed species

ESA-listed resources are exposed to a wide variety of past and present state, Federal, or private actions and other human activities that have already occurred or continue to occur, in the action area. Federal projects in the action area that have already undergone formal or early Section 7 consultation, and state or private actions that are contemporaneous with this consultation also impact ESA-listed resources. However, the impact of those activities on the status, trend, or the demographic processes of threatened and endangered species remains largely unknown. To the best of our ability, we summarize the effects we can determine based on the information available to us in this section.

Climate change has and will continue to impact sea turtles throughout the action area as well as throughout the range of the populations. Sex ratios of several species are showing a bias, sometimes very strongly, towards females due to higher incubation temperatures in nests. We expect this trend will continue and possibly may be exacerbated to the point that nests may become entirely feminized, resulting in severe demographic issues for affected populations in the future. Hurricanes may become more intense and/or frequent, impacting the nesting beaches of sea turtles and resulting in increased loss of nests over wide areas.

Ingestion and entanglement in marine debris is expected to result in sea turtle morbidity and mortality. Some individuals may be killed in dredging operations. Oil spill, as well as oil and gas development activities, have directly harmed sea turtles as well as damaged the habitat in which sea turtles live through releases of pollutants and increasing oceanic sound levels within the region. Agricultural releases into the Mississippi River particular and North American waters in general have resulted in areas of anoxia and habitat deterioration in which sea turtle prey cannot survive or experience regular, high-level mortality. Military activities are likely to cause individual fitness or mortality issues in most sea turtle populations along the eastern seaboard. This is due to exposure to high-level sounds from detonations and other activities. Disease and prey distributions may well shift in response to changing ocean temperatures or current patterns, altering the morbidity and mortality regime faced by sea turtles and the availability of prey. Additional mortality is expected from entrainment in power plants and shipstrike. Stress, metabolic costs, and mortality are expected to result from permitted research activities.

6 EFFECTS OF THE ACTION ON ESA-LISTED SPECIES

Section 7 regulations define "effects of the action" as the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the *Environmental Baseline* (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but are reasonably certain to occur. This effects analyses section is organized following the stressor, exposure, response, risk assessment framework.

The jeopardy analysis relies on the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

The proposed issuance of permit 18029 will authorize "takes" by harassment of green, hawksbill, Kemp's ridley, and northwest Atlantic loggerhead sea turtles during the proposed research by directed close approach, tangle, cast, or hoop net and rodeo capture, restraint, handling, epibiont removal, flipper and PIT tagging, biopsy, blood sampling, measurement, and satellite tagging. In this section, we describe the potential physical, chemical, or biotic stressors associated with the proposed actions, the probability of individuals of ESA-listed species being exposed to these stressors based on the best scientific and commercial evidence available, and the probable responses of those individuals (given probable exposures) based on the available evidence. As described in the *Approach to the Assessment* section, for any responses that would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, or lifetime reproductive success), the assessment would consider the risk posed to the viability of the population(s) those individuals comprise and to the ESA-listed species those populations represent. The purpose of this assessment and, ultimately, of this Opinion is to determine if it is reasonable to expect the proposed action to have effects on ESA-listed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

For this consultation, we are particularly concerned about behavioral and stress-based physiological disruptions and potential unintentional pathology that may result in animals that fail to survive, feed, or breed successfully or fail to complete their life history because these responses are likely to have population-level consequences as well as the potential for mortality. The ESA does not define harassment nor has the NMFS defined the term pursuant to the ESA through regulation. For this Opinion, we define harassment similar to the USFWS's regulatory definition of "harass": an intentional or unintentional human act or omission that creates the probability of injury to an individual animal by disrupting one or more behavioral patterns that are essential to the animal's life history or its contribution to the population the animal represents.

6.1 Stressors associated with the proposed action

The assessment for this consultation identified several possible stressors associated with the proposed research activities, including

1. research vessel transit,
2. capture,
3. handling and restraint (including morphometrics) following capture,
4. epibiont removal,
5. application of flipper, satellite, and/or PIT tags, as well as
6. tissue and blood sampling.

Based on a review of available information, this Opinion determined which of these possible stressors would be likely to occur, and which would be discountable or insignificant.

Research vessel transit introduces sound energy into the marine environment and poses a risk for shipstrike of ESA-listed sea turtles. We are unaware of any communications or acoustic cues that sea turtles would miss as a result of sound energy introduced by vessels associated with the proposed research and thus consider this aspect insignificant. The level of vessel transit is expected to be relatively low compared to the amount of overall vessel traffic and the incidence of ship strike that is known to occur. Considering the level of vessel transit that researchers propose to undertake and lack of shipstrike known to occur in the researcher’s past, the risk of shipstrike is extremely unlikely to occur and is therefore discountable and not considered further in this opinion.

6.2 Mitigation to minimize or avoid exposure

Under permit 18029, numerous measures will be taken to avoid exposing ESA-listed species to the proposed activities and to reduce the potential for stress or pathological outcomes of exposed individuals. This includes extensive disinfection protocols, protection from temperature extremes, separate materials used on FP individuals, continual monitoring of nets, limiting soak time between visual checks to 20-30 minutes, limiting blood volume that can be sampled, and limiting the size of attachments that can be used, among others.

6.3 Exposure analysis

Exposure analyses identify the ESA-listed species that are likely to co-occur with the actions’ effects on the environment in space and time, and identify the nature of that co-occurrence. The *Exposure analysis* also identifies, as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the actions’ effects and the population(s) or subpopulation(s) those individuals represent. The proposed permit identifies these parameters and will allow for capture, handling, restraint, as well as flipper and PIT tagging, epibiont removal, blood, tissue, and biopsy sampling, morphometric measurements, and satellite tagging (Table 10). The applicant is requesting to conduct multiple activities on any given animal. For example, an individual will likely be exposed to a minimum of capture, handling, restraint, flipper and/or PIT tagging (if these tags are not already present), morphometrics, blood sampling, and biopsy under the proposed permit. The applicant currently holds a permit and is conducting these activities on these species in these areas.

Table 10. Proposed "takes" of ESA-listed species under permit 18029.

Sea turtle species	Capture/ handling/ restraint	Flipper tag	PIT tagging	Morpho-metrics	Blood collection	Epiphyte sampling	Satellite tagging	Biopsy
Green	260	260	260	260	260	260	30	260
Hawksbill	15	15	15	15	15	15	10	15
Kemp's ridley	160	160	160	160	160	160	50	160
Loggerhead	30	30	30	30	30	30	30	30

The Permits Division based these estimates (Table 10) on qualitative assessments of the applicant's activities (hawksbill and loggerhead sea turtles), information from the applicant indicating how much effort she is expecting to undertake under the proposed permit (green sea turtles), as well as discussions with the ESA Interagency Cooperation Division of a quantitative method of assessing likely exposure/"take."

The applicant has been conducting long-term sea turtle research similar to that being proposed under permit 18029 for many years in the northwestern Gulf of Mexico. This research has required the applicant to report activities every year. These reports provide us with the opportunity to evaluate the applicant's "past performance" as a mechanism to estimate "future performance" (individual exposure, response, and "take"). We believe this is the best tool available to us to estimate the exposure, response, and "take" that green and Kemp's ridley sea turtles will be exposed to under proposed permit 18029.

The applicant's annual reports from 1998-2002 and 2008-2014 were available (2003-2007 were not) to evaluate the activities the applicant has undertaken in the recent past. These years all involved activities similar or identical to those proposed under permit 18029. We also considered the amount of effort undertaken during these years versus what the applicant intends to undertake under permit 18029. A difference in effort between past years and what is proposed for permit 18029 would change the estimates for the proposed permit. The applicant did not indicate that effort under permit 18029 would be meaningfully and predictably different from that undertaken in the past for Kemp's ridley sea turtles, but did indicate a difference for green sea turtle work. An adjustment for this was made in estimating green sea turtle exposure based upon this anticipated change in effort for green sea turtles (explained for fully below). We also considered that changes in populations of ESA-listed species exposed to the applicant's activities could also bias estimates. For example, if a population appears to be growing in abundance, more individuals may be available to be captured and sampled under the proposed permit versus what had been previously documented. Such an adjustment was necessary and is discussed below.

Exposure levels for green and Kemp's ridley sea turtle capture were determined by calculating means and standard deviations for each species. We do not believe enough data are available to perform such calculations for hawksbill and loggerhead sea turtles (the applicant has not documented hawksbill sea turtle interactions and recorded loggerhead captures of two loggerheads in two separate years, one in another year, and one in a third year). Four standard deviations were added to the mean to encompass a reasonably likely level of exposure in the future. This value was then rounded to the next whole number, leading to an expected number of 178 Kemp's ridley sea turtles being exposed to capture, handling, and restraint annually. As we have no indication of how many of these individuals would also be exposed to flipper and PIT tagging, epibiont removal, blood, tissue, and biopsy sampling, and morphometric measurements once captured, but expect most or all will (based upon the stated goals and rationale for the research activities), we assume that all captured individuals will also be exposed to these other activities. This represents the total number of Kemp's ridley sea turtles we expect to be exposed to capture, handling, restraint, as well as flipper and PIT tagging, epibiont removal, blood, tissue, and biopsy sampling, and morphometric measurements (not satellite tagging) annually.

As previously mentioned for green sea turtles, the applicant indicated that an increase in effort was expected. The applicant indicated that she intends to return to return to an older, higher level of effort that is roughly 292% of that undertaken from 2006-2010 in the Lower Laguna Madre, where green sea turtle work is conducted. To estimate the likely number of sea turtles exposed to the proposed actions under this level of effort, we increased the reported numbers of green sea turtles "taken" and reported for each year from 2006-2010 by 292%, rounding to the next whole number. We then generated a mean and standard deviation from these 2006-2010 data as described above. This value was then rounded to the next whole number, leading to an expected number of 290 green sea turtles being exposed to capture, handling, and restraint annually.

We then identified which populations that would likely occur in the action area were stable, increasing, or decreasing. The best available information on Kemp's ridley nesting show recent increases and decreases in adult female nesting abundance at Rancho Nuevo. Our best estimate for the future trend in Kemp's ridley abundance is that the species' numbers will be roughly stable over the five-year life of permit 18029 and we did not make adjustments to exposure numbers based upon population abundance changes for Kemp's ridley sea turtles. However, green turtle nesting populations whose individuals may occur in the action area (Anderson et al. 2013) are growing, although estimates are not well established. We assumed an annual growth rate (a robust but realistic estimate for sea turtle growth) of 10%. This increased our estimate of the number of green sea turtles that may be exposed to capture, handling, restraint, as well as flipper and PIT tagging, epibiont removal, blood, tissue, and biopsy sampling, and morphometric measurements (not satellite tagging) annually from 290 to 357. This represents the total number of green sea turtles we expect to be exposed to capture, handling, restraint, as well as flipper and PIT tagging, epibiont removal, blood, tissue, and biopsy sampling, and morphometric measurements (not satellite tagging) annually.

The applicant's history suggests that hawksbill sea turtles are unlikely to be encountered with much frequency. However, hawksbills have been encountered along the Texas and Louisiana coasts and may be exposed to the proposed activities at some low level. The applicant has encountered hawksbills twice since 1991. We qualitatively accept that the applicant's estimate of up to 15 hawksbill sea turtles being encountered annually is reasonably likely.

The applicant indicates that 23 loggerheads have been encountered from 1991 to 2014, but only six from 1998-present. Based upon this, The Permits Divisions and the ESA Interagency Cooperation Division agreed that, up to 30 individuals may be encountered during a given year and exposed to all activities (including satellite tagging) that the applicant intends to conduct.

We have no past performance data to indicate the number of satellite tags deployed on sea turtle species in particular years, so we cannot perform similar past performance estimates on satellite tagging as we have for capture. However, after discussing the applicants activities with the Permit's Division, we expect that the proposed annual levels of satellite tagging (30 green, 50 Kemp's ridley, 10 hawksbill, and 30 loggerhead sea turtles) are reasonably likely for a given species in a given year.

Mortality of some individuals has occurred over the course of the applicant's research activities. In the current permit (15606), mortality is authorized at low levels. However, after each instance of mortality, the applicant's activities have been reviewed and changes made to methods used. This has included more frequent net checks and more monitoring of nets. Based upon these changes and the lack of mortality since the implementation of new/modified protective measures (including measures in the current permit), we do not expect any sea turtle to die as a result of proposed activities.

This analytical approach could be improved with more data on specific activities and tagging done for each captured sea turtle. By having this information, more activity-specific estimates can be produced, rather than assuming that each captured individual would be exposed to all other activities (flipper and PIT tagging, epibiont removal, blood, tissue, and biopsy sampling, and morphometric measurements) except satellite tagging. This will allow for applicants to reach their scientific goals while minimizing the amount of anthropogenic activity to which ESA-listed individuals are exposed. We therefore are providing a conservation recommendation that more activity-specific documentation be provided than has been under the applicant's past and current permits.

We do not expect that an individual will be exposed to these stressors no more than once in a given year. This is due to the low number of expected captures anticipated to occur, the continuous movement of the research activities to new locations (the same can also be said for most the movements of individual sea turtles), and the hundreds to thousands of individuals that occur within each population. An individual of any life stage except hatchling could be exposed to the proposed activities. We expect both sexes would be exposed to the proposed stressors, but female green and loggerhead sea turtles exhibit a female-biased sex ratio in free ranging populations and would likely be exposed at a higher rate than their male counterparts (Binckley et al. 1998; Dodd 1988; James et al. 2007; NMFS 2001; Plotkin 1995; Rees and Margaritoulis 2004; Wibbels 2003).

6.4 Response analysis

As discussed in the *Overview of NMFS' Assessment Framework* section, response analyses determine how ESA-listed resources are likely to respond after exposure to an action's effects on the environment or directly on species themselves. For the purposes of consultation, our assessments try to detect potential lethal, sub-lethal (physiological), or behavioral responses that might result in reducing the fitness of ESA-listed individuals. Ideally, response analyses would consider and weigh evidence of adverse consequences as well as evidence suggesting the absence of such consequences.

There is mounting evidence that wild animals respond to human disturbance in the same way that they respond to predators (Beale and Monaghan 2004; Frid 2003; Frid and Dill 2002; Gill et al. 2001; Harrington and Veitch 1992; Lima 1998; Romero 2004). These responses manifest themselves as stress responses (in which an animal perceives human activity as a potential threat and undergoes physiological changes to prepare for a flight or fight response), interruptions of essential behavioral or physiological events, alteration of an animal's time budget, or some combinations of these responses (Frid and Dill 2002; Romero 2004; Sapolsky et al. 2000b; Walker et al. 2005). These responses have been associated with abandonment of sites (Sutherland and Crockford 1993), reduced reproductive success (Giese 1996; Mullner et al. 2004), and the death of individual animals (Bearzi 2000; Daan 1996; Feare 1976). Stress is an adaptive response and does not normally place an animal at risk. However, distress involves a stress response resulting in a biological consequence to the individual. The mammalian and reptilian stress response involves the hypothalamic-pituitary-adrenal axis being stimulated by a stressor, causing a cascade of physiological responses, such as the release of the stress hormones cortisol, adrenaline (epinephrine), glucocorticosteroids, and others (Atkinson et al. 2015; Busch and Hayward 2009). These hormones subsequently can cause short-term weight loss, the release of glucose into the blood stream, impairment of the immune and nervous systems, elevated heart rate, body temperature, blood pressure, fatigue, cardiovascular damage, and alertness, and other responses (Aguilera and Rabadan-Diehl 2000; Busch and Hayward 2009; Dierauf and Gulland 2001; Guyton and Hall 2000; NMFS 2006a; Omsjoe et al. 2009a; Queisser and Schupp 2012; Romero 2004), particularly over long periods of continued stress (Desantis et al. 2013; Sapolsky et al. 2000a). In some species, stress can also increase an individual's susceptibility to gastrointestinal parasitism (Greer 2008). In highly-stressful circumstances, or in species prone to strong "fight-or-flight" responses, more extreme consequences can result, including muscle damage and death (Cowan and Curry 1998; Cowan and Curry 2002; Cowan and Curry 2008;

Herraez et al. 2007). The most widely-recognized indicator of vertebrate stress, cortisol, normally takes hours to days to return to baseline levels following a significantly stressful event, but other hormones of the hypothalamic-pituitary-adrenal axis may persist for weeks (Dierauf and Gulland 2001). Mammalian stress levels can vary by age, sex, season, and health status (Cockrem 2013; Delehanty and Boonstra 2012; Gardiner and Hall 1997; Hunt et al. 2006; Keay et al. 2006; Place and Kenagy 2000; Romero et al. 2008; St. Aubin et al. 1996). Marine mammal hormones associated with stress responses as well as other body systems may become imbalanced due to exposure to chlorinated hydrocarbons (Brouwer et al. 1989; Jin et al. 2015). In general, stress response pathways appear to be very similar to those in better-studied terrestrial mammal systems, although important difference in the renin-angiotensin-aldosterone system and catecholamines exist likely stemming from fasting and diving life history traits in many marine mammals (Atkinson et al. 2015). Smaller mammals react more strongly to stress than larger mammals (Peters 1983); a trend reflected in data from Gauthier and Sears (1999) where smaller whale species react more frequently to biopsy than larger whales. Stress is lower in immature right whales than adults and mammals with poor diets or undergoing dietary change and have higher fecal cortisol levels (Hunt et al. 2006; Keay et al. 2006).

6.4.1 Capture

Capture is one of the means by which stress responses described above can occur in sea turtles (Gregory 1994; Gregory and Schmid 2001b; Hoopes et al. 1998; Jessop et al. 2004; Jessop et al. 2003; Thomson and Heithaus 2014).

Sea turtles capture will occur in one of several ways: hand (rodeo), entanglement netting, and cast netting. Cast netting and rodeo style are perhaps the least risky options, as they allow researchers to immediately remove captured individuals from the water, eliminating the possibility of drowning or injury resulting from forced submergence. Although corticosterone does not appear to increase with entanglement time for green and Kemp’s ridley sea turtles (Snoddy et al. 2009), we expect capture to be a stressful experience as indicated by severe metabolic and respiratory imbalances resulting from forced submergence (Gregory and Schmid 2001a; Harms et al. 2003; Stabenau and Vietti 2003). We also expect behavioral responses (attempts to break loose of the netting via rapid swimming and biting) as well as physiological responses (release of stress hormones; Gregory et al. 1996; Gregory and Schmid 2001a; Harms et al. 2003; Hoopes et al. 2000; Stabenau and Vietti 2003). We expect individuals captured via cast net to be rapidly removed from the cast net, although responses associated with subsequent stressors will continue. For example, handling has been shown to result in progressive changes in blood chemistry indicative of a continued stress response (Gregory and Schmid 2001a; Hoopes et al. 2000). Rodeo-style capture entails a risk of vessel-strike to sea turtles. However, as sea turtles would be evading capture, they will generally be moving away from the vessel. In addition, capture does not seek to place the vessel immediately next to the target individual, only near enough for a researcher to jump near the target sea turtle.

Additional risk to sea turtles is involved with capturing sea turtles in entanglement nets due to forced submersion. Sea turtles forcibly submerged in any type of restrictive gear eventually suffer fatal consequences from prolonged anoxia and/or seawater infiltration of the lungs (Lutcavage et al. 1997a). Trawl studies have found that no mortality or serious injury occurred in tows of 50 minutes or less, but these increased rapidly to 70% after 90 minutes (Epperly et al. 2002a; Henwood and Stuntz 1987). However, metabolic changes that can impair a sea turtles' ability to function can occur within minutes of a forced submergence. Serious injury and mortality is likely due to acid-base imbalances resulting from accumulation of carbon dioxide and lactate in the bloodstream (Lutcavage et al. 1997a); this imbalance can become apparent in captured, submerged sea turtles after a few minutes (Stabenau et al. 1991). Recovery times can take 20 hours or more (Henwood and Stuntz 1987). Sea turtles entangled in nets exhibiting lethargy can die even with professional supportive care, possibly due to severe exertion resulting in muscle damage (Phillips et al. 2015). To minimize the effects of this type of capture, nets will be tended continuously. We do not expect any sea turtle to require extensive recovery, but methodology proposed by the applicant (holding comatose or behaviorally abnormal sea turtles and monitoring sea turtles after research procedures are complete) should mitigate sea turtles being released that have not recovered from forced submergence and/or the accumulation of other stressors that can cumulatively impair physiological function. In addition, veterinary assistance would be sought for these individuals.

We also expect that activity budgets of captured individuals will be altered after release, with more time spent actively swimming for several hours to a day after release (Thomson and Heithaus 2014). After this period, we expect that individuals will engage in resting and feeding activities to a greater extent (Thomson and Heithaus 2014).

6.4.2 Morphometrics

Once sea turtles have been captured, individuals will be handled and exposed to various activities of greater or lesser degrees of invasiveness. Each sea turtle will be exposed to morphometric measurement, including carapace size and individual weight. Although these activities are not considered invasive, we expect individual sea turtles to experience a continued stress response due to the handling and restraint necessary to conduct these activities.

6.4.3 Flipper and internal tagging

All sea turtles will also be scanned or visually inspected for PIT and flipper tags, respectively. If either of these is absent, then individuals will be tagged with them. Both procedures involve the implantation of tags in or through skin and/or muscle of the flippers. The PIT tags remain internal while flipper tags have both internal and external components. For both, internal tag parts are expected to be biologically inert. In addition to the stress sea turtles are expected to experience by handling and restraint associated with inspection and tagging, we expect an additional stress response associated with the short-term pain experienced during tag implantation (Balazs 1999). We expect disinfection methods proposed by the applicant should mitigate infection risks from tagging. Wounds are expected to heal without infection. Tags are designed to be small, physiologically inert, and not hinder movement or cause chafing; we do not expect the tags themselves to negatively impact sea turtles (Balazs 1999). Flipper tags occasionally come off of turtle flippers, which may cause tissue ripping and subsequent trauma and infection risk. However, other researchers encounter individuals who have lost flipper tags and have not observed these individuals to be in any different body condition than turtles lacking tags or those who still retain their tags. The applicant and researcher assistants have tagged hundreds of sea turtles. Based upon these experiences, behavioral responses may or may not be evident during tag implantation; when evident, behavioral responses will be fleeting.

6.4.4 Biopsy

Sea turtles will also be biopsied during the course of the research. We expect that this will involve stress associated with pain stimuli (Balazs 1999). Although the skin will be breached and tissue exposed, we expect disinfection protocols to make the risk of infection minimal from the small hole that will be produced by the biopsy punch. Disinfection of biopsy punches and surgical equipment will also reduce the risk of pathogen spread between individuals.

6.4.5 Blood sampling

Sea turtles are also expected to experience a short-term stress response in association with the handling, restraint, and pain associated with blood sampling. Taking a blood sample from the sinuses in the dorsal side of the neck is a routine procedure (Owens 1999), although it requires knowledgeable and experienced staff to do correctly and requires the animal to be restrained (DiBello et al. 2010; Wallace and George 2007). According to Owens (1999), with practice, it is possible to obtain a blood sample 95% of the time and the sample collection time should be about 30 seconds in duration. The applicant has blood sampled several hundred sea turtles since 1991. No sea turtle mortalities have occurred during the applicant’s blood sampling activities. Sample collection sites are always sterilized prior to needle insertions, which would be limited to two on either side of the neck. Bjorndal et al. (2010) found that repeated scute, blood, and skin sampling of the same individual loggerhead sea turtles did not alter growth, result in scarring, or apparently impact other physiological or health parameters.

6.4.6 Satellite tagging

Sea turtles exposed to satellite tagging will experience invasive activities, such as sanding of the carapace, and will be held and restrained for hours in an unfamiliar environment. This is expected to cause a stress response. The applicant proposes to use methods that will minimize adverse impacts to sea turtles, including use of low-heat producing epoxy, covering skin and eyes to prevent epoxy contact with these surfaces, and ensuring adequate ventilation to prevent epoxy vapor accumulation. Sea turtles are not capable of hearing the frequencies produced by tags nor are their predators (Bartol et al. 1999; Casper et al. 2003; Casper and Mann 2004; Lenhardt 2003; Ridgeway et al. 1969). However, satellite tags have the potential to significantly increase hydrodynamic drag, reduce lift, and increase pitch (Watson and Granger 1998). This effect is important considering that sea turtles tagged in the action area would likely move or migrate hundreds of kilometers or more for foraging or breeding opportunities. Even though these and other research activities discussed will be consistent with best practice (SEFSC 2008), we expect sea turtles will expend significantly more energy to maintain the same pre-tagging speeds (Todd et al. 2011). Thus, determination of altered movement will be monitored following tagging. This is the best method available to us to identify fitness consequences that may result individually or cumulatively in tag affects. To date, the applicant has not found tagged sea turtles to move in ways suggesting locomotory hindrance.

6.5 Risk analysis

Research activities that would take place under the permit are not expected to result in sea turtle mortality. The research activities will, however, result in temporary stress to the animal, which is not expected to have more than short-term effects on individual green, hawksbill, Kemp's ridley, and loggerhead sea turtles. These effects are expected to be short-term based on previous experiences with other researchers and available scientific literature. This research will affect the individuals by harassing sea turtles during the research thus raising levels of stressor hormones, and individuals may experience some discomfort during capture, restraint, measuring, biopsy, blood sampling, tagging, and other procedures. Based on past observations of similar research, these effects are expected to dissipate within approximately a day.

Biopsy, tissue and blood sampling, and tagging are all activities that will break the integument and create the potential for infection or other physiological disruptions. The applicant has extensive procedures in place to reduce the potential for infection or disease transmission. To date, the applicant has not documented a case of infection or mortality in sea turtles which were exposed to these activities. Based on this past performance and the rigor of aseptic conditions, we do not expect any individuals to develop infections or experience other pathological conditions associated with these activities.

Flipper-tagged sea turtles will experience a greater degree of drag through the water than they otherwise would. This drag would be experienced continually over years after flipper tags are applied. However, we expect the amount of drag to be minimal. To date, many thousands of sea turtles have been flipper tagged in relatively standard ways and we are unaware of flipper tagging leading to reduced growth, impaired mobility or altered migration, deteriorated body condition, or other outcomes that could impair the survival, growth, or reproductive potential of any individual sea turtle.

Some individuals will also incur a metabolic cost due to loss of prey during lavage. However, this loss is expected to be small and easily replaceable.

Overall, for a large majority of sea turtles, the proposed action is not expected to have more than short-term stress effects and some longer-term effects associated with wound healing from biopsy, blood sampling, and tagging. The data generated by the applicant regarding these populations over the duration of this study will provide beneficial information that will be important to the management and recovery of threatened and endangered species. The information collected as a direct result of permit issuance will be used to implement the goals identified in the recovery plans for green, hawksbill, Kemp's ridley, and loggerhead sea turtles.

6.6 Cumulative effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action areas of the Federal actions subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

We expect that those aspects described in the *Status of the Species* and *Environmental Baseline* will continue to impact ESA-listed resources into the foreseeable future. We expect climate change, ship-strikes, research, pollution, oil and gas development, anthropogenic ocean noise, entrainment in power plants, exposure to military activities, dredging, directed harvest, entanglement, and bycatch to continue into the future. Movement towards bycatch reduction and greater foreign protections of sea turtles are generally occurring throughout the Atlantic Ocean and Gulf of Mexico, which may aid in recovery of sea turtle populations. Risk of ship strike will likely increase in the future as more vessels are used in commercial and recreational marine activities.

Although quantifying an incremental change in survival for the species considered in this consultation due to the cumulative effects is not possible, it is reasonably likely that those effects within the action areas will have a small, long-term, negative effect on the likelihood of their survival and recovery.

6.7 Integration and synthesis

The *Integration and synthesis* section is the final step in our assessment of the risk posed to species and critical habitat because of implementing the proposed action. In this section, we add the *Effects of the Action on ESA-Listed Species and Critical Habitat* (section 6) to the *Environmental Baseline* (section 5) and the *Cumulative effects* (section 6.6) to formulate the agency's biological opinion as to whether the proposed action is likely to: "reduce appreciably the likelihood of both the survival and recovery of a ESA-listed species in the wild by reducing its numbers, reproduction, or distribution." This assessment is made in full consideration of the *Status of ESA-Listed Species* (section 4).

As explained in the *Overview of NMFS' Assessment Framework* section, risks to listed individuals are measured using changes to an individual's "fitness" – i.e., the individual's growth, survival, annual reproductive success, and lifetime reproductive success. When ESA-listed animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the population(s) those individuals represent or the species those populations comprise (Anderson 2000; Brandon 1978; Mills and Beatty 1979; Stearns 1992). As a result, if the assessment indicates that ESA-listed animals are not likely to experience reductions in their fitness, we conclude our assessment. If possible reductions in individuals' fitness are likely to occur, the assessment considers the risk posed to population(s) to which those individuals belong, and then to the species those population(s) represent.

The *Status of ESA-Listed Species* discussion describes how listed sea turtles range-wide have been adversely affected by human-induced factors such as climate change, commercial fisheries, direct harvest of sea turtles, and modification or degradation of the sea turtle's terrestrial and aquatic habitat. Effects occurring in terrestrial habitats have generally resulted in the loss of eggs or hatchling sea turtles, or nesting females, while those occurring in aquatic habitat have caused the mortality of juvenile, subadult and adult sea turtles through ingestion of debris or pollution. Similarly, the actions discussed in the *Environmental Baseline*, as well as those considered under *Cumulative effects* all pose the potential to result in take of sea turtle species that resulted in stress or possible mortality.

The following discussion summarizes the probable risks the proposed actions pose to threatened and endangered species and critical habitat that are likely to be exposed. These summaries integrate the exposure profiles presented previously with the results of our response analyses for each of the actions considered in this opinion.

We expect that 357 green, 178 Kemp's ridley, 15 hawksbill, and 30 northeastern Atlantic DPS loggerhead sea turtles may be exposed to capture, handling, restraint, as well as flipper and PIT tagging, epibiont removal, blood, tissue, and biopsy sampling, and morphometric measurements (not satellite tagging) annually. Of these, we expect that up to 30 green, 50 Kemp's ridley, 10 hawksbill, and 30 northeastern Atlantic DPS loggerhead sea turtles may also be exposed to satellite tagging activities. We expect all targeted sea turtles to experience some degree of stress response to approach, capture, restraint, biopsy, blood and tissue sampling, and tagging. We also expect many of these individuals to respond behaviorally by attempting to elude capture, fight when initially captured, startle when blood sampled, biopsied, or tagged, and strongly swim away when released. We do not expect more than temporary displacement or removal of individuals for a period of hours from small areas as a result of the proposed actions. Individuals responding in such ways may temporarily cease feeding, breeding, resting, or otherwise disrupt vital activities. However, we do not expect that these disruptions will cause a measureable impact to any individual's growth or reproduction. We expect all tagged individuals to experience additional physiological reactions associated with foreign body penetration into the muscle, including inflammation, scar tissue development, and/or a small amount of drag associated with the applied tags. We also do not expect any pathological responses to procedures that breach the skin. A small metabolic cost to individuals held for several hours will also occur. Responses here should be limited to wound healing that should not impair the survival, growth, or reproduction of any individual. Overall, we do not expect any single individual to experience a fitness consequence as a result of the proposed actions and, by extension, do not expect population-level effects.

7 CONCLUSION

After reviewing the *Status of ESA-listed Species*, the *Environmental Baseline* within the action areas, the *Effects of the Action on ESA-Listed Species*, any effects of interrelated and interdependent actions, and *Cumulative effects*, it is NMFS' opinion these proposed actions are not likely to jeopardize the continued existence of green, hawksbill, Kemp's ridley, or northwestern Atlantic DPS loggerhead sea turtles North Atlantic DPS green sea turtles. No critical habitat is expected to be affected.

8 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to Section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a 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 regulation to include significant habitat modification or degradation that results in death or injury to ESA-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. Section 7(b)(4) and Section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

We do not expect incidental take of threatened or endangered species as a result of the proposed actions because all actions that may affect ESA-listed species would be undertaken in a directed manner.

9 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 the threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans or develop information (50 CFR 402.02).

1. The Endangered Species Act Interagency Cooperation Division recommends that annual reports submitted to the Permits Division require detail on the exposure and response of listed individuals to permitted activities. The specific activities that each sea turtle is exposed should be identified. A minimum of general comments on response can be informative regarding methodological, population, researcher-based responses in future consultations. The number and types of responses observed should be summarized and include responses of both target and non-target individuals. This will greatly aid in analyses of likely impacts of future activities.

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

10 REINITIATION OF CONSULTATION

This concludes formal consultation for the Permit's Division proposed issuance of permit 18029. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action that may affect ESA-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 ESA-listed species or critical habitat that was not considered in this opinion, or (4) a new species is ESA-listed or critical habitat designated that may be affected by the action.

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